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Population-level effects of automated smoking cessation help programs: a randomized controlled trial

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ABSTRACT

Aims To test the population impact of offering automated smoking cessation interventions via the internet and/or by mobile phone. **Design** Pragmatic randomized controlled trial with five conditions: offer of (i) minimal intervention control; (ii) QuitCoach personalized tailored internet-delivered advice program; (iii) onQ, an interactive automated text-messaging program; (iv) an integration of both QuitCoach and onQ; and (v) a choice of either alone or the combined program. **Setting** Australia, via a mix of internet and telephone contacts. **Participants** A total of 3530 smokers or recent quitters recruited from those interested in quitting, and seeking self-help resources ($n = 1335$) or cold-contacted from internet panels ($n = 2195$). **Measurements** The primary outcome was self-report of 6 months sustained abstinence at 7 months post-recruitment. **Findings** Only 42.5% of those offered one of the interventions took it up to a minimal level. The intervention groups combined had a non-significantly higher 6-month sustained abstinence rate than the control [odds ratio (OR) = 1.48; 95% confidence interval (CI): 0.98–2.24] (missing cases treated as smokers), with no differences between the interventions. Among those who used an intervention, there was a significant overall increase in abstinence (OR = 1.95; CI: 1.04–3.67), but not clearly so when analysing only cases with reported outcomes. Success rates were greater among those recruited after seeking information compared to those cold-contacted. **Conclusions** Smokers interested in quitting who were assigned randomly to an offer of either the QuitCoach internet-based support program and/or the interactive automated text-messaging program had non-significantly greater odds of quitting for at least 6 months than those randomized to an offer of a simple information website.

Keywords Internet, mobile phone, smoking cessation, tailored.

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INTRODUCTION

Structured support and advice during a quit attempt increases the likelihood of maintaining abstinence from smoking, up to 15–20% independent of any effect of pharmacotherapy [1]. However, high-intensity behavioural interventions such as face-to-face or telephone counselling have low reach [2] and are expensive. Web-based automated programs have the potential to add to the range of cessation services available [3–5] and to service a proportion of the smoking population in a cost-effective manner [6,7].

Other forms of technology can also be utilized to deliver automated, tailored cessation assistance. Mobile phones and similar devices have been shown to be effective for this purpose [8,9]. These interventions deliver brief snippets of advice via the short message service (SMS; text-messaging), which can help to keep the person on track, and the messages can be tailored to where the smoker is in their quitting trajectory. Such programs may be even more effective as a complement to those that provide detailed advice, at least when delivered by a relatively passive mode such as the internet [10,11].

This paper reports on the findings of a randomized controlled trial (RCT) designed to evaluate the probable population impact of offering a demonstrably effective [12] automated personalized advice program delivered via the internet (the QuitCoach), as well as a newly

developed program of structured, tailored SMS messaging (onQ). The QuitCoach has been available to the public at http://www.quitcoach.org.au. Users are typically of moderate dependence, and most are preparing to quit [13]. We hypothesized that offering each intervention (Quit Coach and onQ) would be more effective than a minimal treatment control, and expected some additional benefit of offering both. We were also interested in whether offering the two interventions as a choice of options or as an integrated package would affect uptake and/or efficacy, as this might affect both uptake and the extent to which the two interventions were used together.

We recruited from two sources: those having recently sought cessation assistance (mainly Quitline callers wanting self-help materials) and from a cold-contacted sample, enabling us to explore possible effects of the interventions by recent interest in seeking assistance to quit.

This was not a typical RCT, as participants were not pre-committed to consider using the intervention(s) they were offered. Because a considerable proportion of those in the intervention groups do not take up the offered interventions, between-group comparisons underestimate intervention efficacy. We propose a method to estimate more accurately the true magnitude of effects among those who use the interventions to a criterion level.

The aims of this paper are to:

- Determine whether an offer of the interventions increased quit success; and
- Whether the effects were similar for the QuitCoach and onQ programs.
- Test for an interactive or additive benefit of the integrated program (QuitCoach onQ); and
- Whether the way the two interventions were offered affected outcomes.
- Estimate the impacts of the interventions among those who used them to a criterion level; and
- Whether the effects were similar for those recruited after seeking information about cessation versus those cold-contacted.

METHOD

Participants

A total of 3530 smokers and recent quitters (quit within the last 2 weeks) were recruited between November 2008 and November 2009. Recent quitters were included because the interventions have a relapse prevention component. Power (80% for $P < 0.05$) was based on a base rate of 12% cessation for the controls, 18% for both single interventions and 23% for the combined interventions (based on effective use of the interventions of approximately 70%), requiring 405 in the control group and 810 in each of the intervention groups (total = 3645), numbers we just failed to achieve. There were two main sources of recruitment: (i) information-seekers ($n = 1335$), mainly callers to the Victorian or South Australian Quitlines who were not seeking assistance from a counsellor; 1139 of 2643 by telephone (21.4% were ineligible, 15.2% refused and 16.1% were not contacted) and 196 via the study website due to either a recruitment e-mail to the above sample or via a link on the Quit Victoria website; and (ii) a cold-contacted sample ($n = 2195$), taken from two internet survey panels maintained by iView, a Melbourne-based market and social research company: the first 952 (10.9%) from 8766 previously identified smokers at some recent time and 1315 (1.9%) of 70 884 people of unknown smoking status; all enrolled on the study website.

Females were over-represented (60%), mean age 42.1 years (range 18–80); 87.4% were currently smoking, and participants smoked an average of 16.9 cigarettes per day. As expected, there were substantial differences between the two samples, with those in the information-seeker sample more highly motivated to quit.

Design

Participants consented to take part in a study of 'how effective internet and telephone-based resources are in helping smokers quit' that involved completing a brief questionnaire at the time and two follow-up surveys 1 and 7 months later. They were also told that they might be given suggestions about resources to use. Thus, we avoided creating expectancies regarding receipt of any particular intervention or that the control group was missing out on anything by not mentioning specific interventions at recruitment, thus providing an unbiased estimate of effect that controls for rate of uptake. Randomization was via a random number generator embedded within the baseline survey.

The four intervention conditions were: (i) QuitCoach only ($n = 809$); (ii) onQ only ($n = 756$); (iii) both as an integrated package (integrated) ($n = 785$); and (iv) a choice of all three above (choice condition) ($n = 758$). A minimal treatment control group ($n = 422$: allocated at half the rate of the other conditions) was given brief information on web- and telephone-based assistance available in Australia (http://www.quitnow.org.au and the Quitline number). This represents a modification of a 2×2 design (see Table 1), with two groups offered both, but in different ways.

At the completion of the baseline survey, participants were offered the opportunity to use the intervention to which they were allocated, but there was no obligation or pressure to use. The interventions all encouraged concurrent use of stop-smoking medication where appropriate, and did not attempt to restrict use of other forms of help.

Table 1 The 'modified 2 × 2' analysis.

		Offered QuitCoach	
		Yes	*No*
Offered onQ	Yes	Integrated and choice	onQ
	No	QuitCoach	Control

The interventions

QuitCoach is a personalized, automated tailored cessation program based on cognitive–behavioural principles that generates two- to four-page letters of advice with suggestions about strategy, both actions and ways of thinking, and encouragement to persist. The advice is based on answers to an assessment questionnaire and is complemented by some untailored additional resources [see [12,14]; Appendix S1 (online supporting information, please see details at the end of the paper) or http://www.quitcoach.org.au]. The QuitCoach is designed to be used multiple times, as the questions asked and advice given changes with progress in the quit attempt.

The onQ program is based on the same cognitive–behavioural model. It provides a stream of SMS messages to the person that mix snippets of advice on strategy and things to do with motivational messages. The user can interact with it by reporting changes (e.g. a quit attempt) so that appropriate stage-specific messages are sent, and once quit can also call up messages in crisis situations. The frequency of messages changes, with peaks on entry, around any actual quit attempt, and around any reported relapse crisis (see Appendix S2, online supporting information, please see details at the end of the paper).

In the integrated condition both QuitCoach and onQ were offered as a package, but in reality users could subsequently use either or both parts. The two programs have complementary advice, with the brief snippets of advice in the text messages often summarizing more detailed material in the tailored advice and supplementary materials. When integrated with QuitCoach, a few onQ messages were based on responses to the QuitCoach assessment.

The choice condition was an explicit offer of either or both interventions, with the person encouraged to make an upfront choice. However, they could subsequently change their minds, and take up whatever aspects they wanted.

Measures

Baseline smoking status was assessed as no quit date, set quit date or already quit. Other smoking-related variables measured at baseline included cigarettes per day and any quit attempts in the previous year. Demographics collected included age, gender, level of education and employment status.

Outcome data were collected at 1- and 7-month follow-up. Links to the follow-up surveys were e-mailed to those with addresses, but those who did not complete them online within a few days were telephoned. The main outcome was 6-month sustained abstinence at 7 months (not possible if smoking at 1 month). Secondary outcomes were 7-day point prevalence abstinence at 1- and 7-month follow-ups, and the proportion having made a quit attempt by 1 month.

Cessation outcomes were established by asking frequency of smoking (daily, at least weekly, less often than weekly or not at all); and for those not smoking, length of time quit and whether they had smoked in the last week. Those who reported smoking 'less often than weekly' could meet the 7-day point prevalence criterion if they had not smoked in the last week. At 1 month, participants were also questioned on use of other forms of cessation assistance since joining the study, including the internet, telephone-based resources (e.g. Quitline), cessation advice from a health professional (brief or extensive) and use of stop-smoking medication [nicotine replacement therapy (NRT), bupropion or varenicline]. Extensive use of external behavioural assistance, defined as likely to be equal to or more potent than our interventions, included attending a quit smoking clinic or group, or having spoken to the Quitline more than once. Any other, lesser, use of behavioural assistance was defined as minimal.

Uptake of the interventions was known from server log files. Criterion use of the QuitCoach was having completed an assessment and downloaded the tailored advice. Below-criterion use included failure to generate tailored advice or reported use of the program at 1-month follow-up, but no record from server log files. Criterion use of onQ was defined as having received text messages for a minimum of 4 days, with below-criterion use (trying it) any use less than this.

Data analysis

The primary analyses were conducted on an intention-to-treat basis. Missing data were dealt with using various forms of imputation: the common one of assuming that they are smokers, but also assuming that they are quit, using their last known status, and analysing only cases with identified outcomes [15]. At 1 month, one case was excluded from the outcome analyses due to hospitalization. At 7 months, two participants were reported to have died. This resulted in a final sample for analysis of 3529 at 1 month and 3528 at 7 months.

Initial analyses compared the integrated and choice conditions separately. Where these two groups were

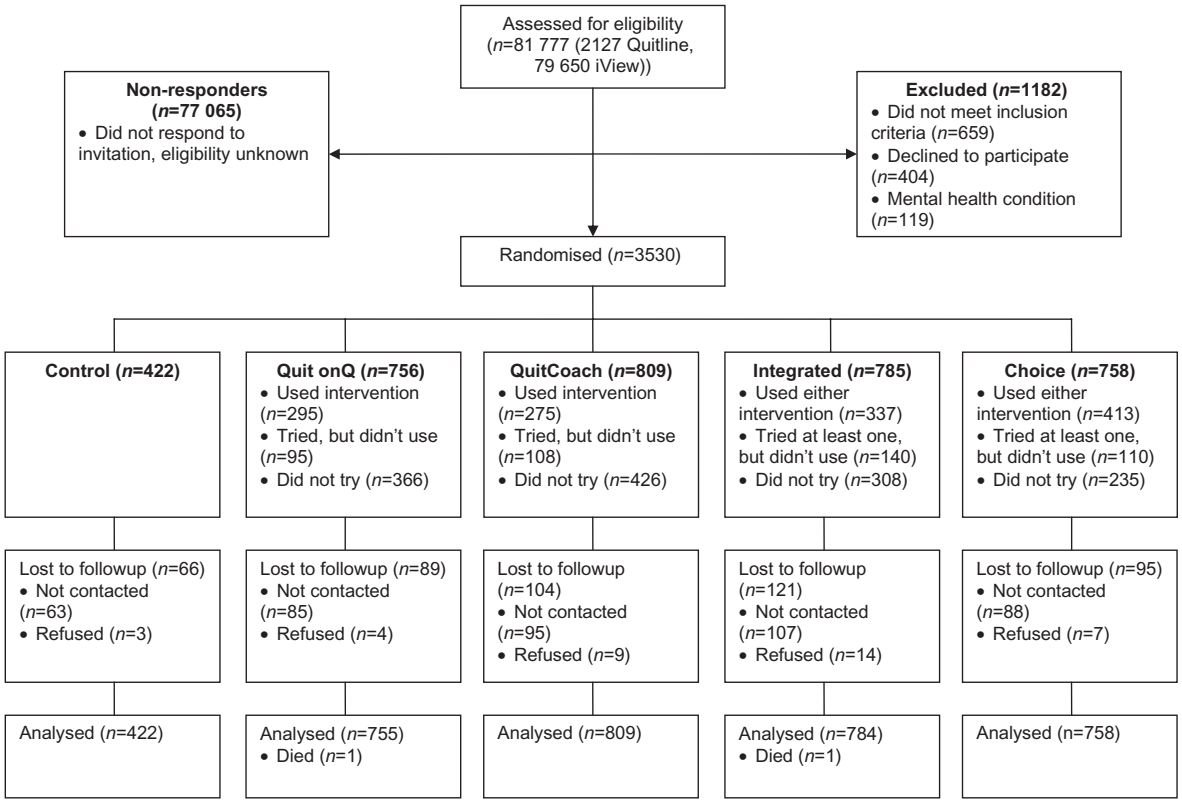

Figure 1 Consort diagram

equivalent, we conducted 2 × 2 analyses (Table 1). We also compared the four intervention conditions combined with the control group to determine an overall intervention effect.

Logistic regression was used to examine differences by condition, controlling for demographics, recruitment source, cigarettes per day and baseline smoking status and, in subsidiary analyses, use of medication.

To estimate more clearly the effectiveness of the interventions when used, the following methods were used. We estimate the proportion of the control group that would have taken up an intervention if offered, and the proportion that would not. Cessation rates for the latter are assumed to be the same as for the subset who did not take up the interventions in the intervention groups (Ir). We also know the observed cessation rate in the entire control group (Ct), and what proportion of participants took up an intervention (Pu). From this we can calculate the predicted cessation rate among those who would have taken up the intervention if offered (Eu). Eu = [Ct – Ir(1-Pu)]/Pu. We used the overall outcomes averaged across all interventions for this estimation.

RESULTS

Retention was high: 88.0% at 1 month and 86.5% at 7 months, with no differences by condition for either ($\chi^2_{(4)} = 1.74$, $P = 0.78$: $\chi^2_{(4)} = 6.96$, $P = 0.14$, respectively). Retention was higher in the information-seeker sample than among those cold-contacted (93.1% versus 84.9% at 1 month, $\chi^2_{(1)} = 53.25$, $P < 0.001$; 88.3% versus 85.5% at 7 months, $\chi^2_{(1)} = 5.78$, $P = 0.02$). Most completed the surveys by telephone (58.0% at 1 month and 67.3% at 7 months), particularly in the information-seeker sample, where approximately 90% did so.

The QuitCoach was used by 701 participants (29.8% of those offered it, alone or in combination with onQ), and 862 participants used onQ (37.5% of those offered it). A full consort diagram, including intervention usage, is shown in Fig. 1. Only 42.5% of those offered an intervention used it to our criterion level; a further 14.6% tried it, and 43.0% did not use it. Intervention uptake ranged from 34.0% in the QuitCoach only group to 54.5% in the choice condition ($P < 0.001$). There were greater rates of intervention uptake and use of external cessation assistance in the information-seeker compared to the cold-contacted sample.

Outcomes by condition

Outcomes by condition are presented in Table 2. No differences in any outcome were found between the choice and integrated conditions, so they were combined allowing 2 × 2 analyses (Table 1), where relevant. There were

Table 2 Outcomes by condition, and comparing the integrated with the choice condition.

	Total	*Control*	*onQ only*	*QuitCoach only*	*Integrated*	*Choice*	*x2(4)*[a]	*x2(1)*[b]
1-month outcomes								
All cases analyses (*n*)	3529	421	756	809	785	758		
Made a quit attempt	50.5%	49.6%	52.1%	47.2%	50.4%	53.0%	6.35	1.04
7-day point prevalence	19.0%	15.2%	21.4%	16.2%	20.6%	20.2%	13.02*	0.05
Odds ratio (95% CI)		1.00	1.52 (1.11–2.09)	1.08 (0.78–1.49)	1.45 (1.06–1.99)	1.41 (1.03–1.94)		
Available data only (*n*)	3106	378	665	713	683	667		
Made a quit attempt	57.4%	55.0%	59.2%	53.6%	58.0%	60.3%	8.4	0.73
7-day point prevalence	21.6%	16.9%	24.4%	18.4%	23.7%	22.9%	14.74**	0.12
Odds ratio (95% CI)		1.00	1.49 (1.07–2.08)	1.05 (0.75–1.47)	1.36 (0.98–1.90)	1.36 (0.98–1.90)		
7-month outcomes								
All cases analyses (*n*)	3528	422	755	809	784	758		
7-day point prevalence	21.9%	20.1%	24.1%	21.3%	21.2%	21.9%	3.35	0.12
Odds ratio (95% CI)		1.00	1.26 (0.94–1.68)	1.07 (0.80–1.43)	1.07 (0.79–1.42)	1.11 (0.83–1.49)		
6-month sustained (missing coded as smoker)	8.5%	6.2%	9.0%	8.7%	8.7%	9.1%	3.61	0.09
Odds ratio (95% CI)		1.00	1.51 (0.94–2.41)	1.44 (0.91–2.30)	1.45 (0.91–2.31)	1.53 (0.96–2.44)		
6-month sustained (missing coded as quit)	23.8%	23.9%	23.2%	23.1%	25.9%	23.0%	2.57	1.80
6-month sustained (missing coded as last known status)	12.0%	10.0%	12.8%	11.4%	12.9%	12.0%	3.07	0.27
Available data only (*n*)	3055	356	667	705	664	663		
7-day point prevalence	25.2%	23.9%	27.3%	24.4%	25.0%	25.0%	2.13	0.00
Odds ratio (95% CI)		1.00	1.20 (0.89–1.61)	1.03 (0.76–1.39)	1.06 (0.79–1.44)	1.07 (0.79–1.44)		
6-month sustained	9.9%	7.3%	10.2%	9.9%	10.2%	10.4%	3.04	0.01
Odds ratio (95% CI)		1.00	1.44 (0.90–2.31)	1.40 (0.88–2.24)	1.45 (0.90–2.32)	1.47 (0.92–2.36)		

*$P < 0.05$; **$P < 0.01$. [a]Comparison of the five conditions; [b]comparison of integrated and choice. CI: confidence interval.

no differences in the proportion who reported making a quit attempt by the 1-month follow-up. There was a significant difference in 7-day abstinence using both all cases (missing = smoker) and those with identified outcomes. In both cases the control group had the lowest percentage quit. Those offered onQ were significantly more likely to be abstinent at 1 month [odds ratio (OR) = 1.39, 95% confidence interval (CI): 1.16–1.67], but there was no significant effect of offer of QuitCoach (OR = 0.99, 95% CI: 0.82–1.18).

At the 7-month follow-up, 8.5% of the sample achieved 6-month sustained abstinence. No significant differences were found by condition, but the control condition was numerically least successful. Odds ratios for all four intervention conditions relative to the control were in the vicinity of 1.50. The only analysis to approach significance compared all four conditions combined to the control (8.9% versus 6.2%, $\chi^2 = 3.45$, $P = 0.063$). The odds ratio for this comparison was 1.48 (95% CI: 0.98–2.24).

Abstinence rates were consistently higher in the information-seeker sample than in the cold-contacted sample (see Table 3). For example, 17.5% of the information-seeker sample achieved 6-month sustained abstinence, compared with only 3.1% of those cold-contacted ($P < 0.001$). Within the information-seeker sample, those recruited by telephone (17.0%) were comparable to the small web-enrolled group (19.9%).

A series of stepwise logistic regression analyses predicting 6-month sustained abstinence were conducted, each using only intervention group at the first step, controlling for demographics and recruitment source at the second step, and smoking-related variables (cigarettes per day, initial intention to quit and a quit attempt in the past year) at the third step. The key sets of analyses, with missing cases coded as smokers, are summarized in Table 4. The first set of analyses utilized the 2 × 2 design. A marginally significant main effect of offered onQ was found, which reduced slightly when the smoking-related variables were added. No significant effect was found for offered QuitCoach, although the OR was only marginally lower. There was no evidence of an interaction, suggesting no additional benefit from having been offered the combined intervention. The second set of analyses used the binary variable which contrasted all four intervention groups with the control. Here, a significant effect at step 2 (controlling for demographics and recruitment source) was found, but this dropped to marginal significance with the addition of the smoking-related variables. In both cases, the variable that reduced the effect was baseline smoking status.

No significant effects were found when we analysed only cases with valid 6-month outcomes, or when we inferred either success or last known status to the missing cases (analyses not shown).

Table 3 Six-month sustained abstinence by condition, stratified by recruitment source.

	Control ($n = 422$)	*onQ only* ($n = 755$)	*QuitCoach only* ($n = 809$)	*Integrated* ($n = 784$)	*Choice* ($n = 758$)	*Interventions combined* ($n = 3106$)	$\chi^2_{(4)}$ [a]	$\chi^2_{(1)}$ [b]
Total sample								
6-month sustained	6.2%	9.0%	8.7%	8.7%	9.1%	8.9%	3.61	3.45#
Odds ratio (95% CI)	1.00	1.51 (0.94–2.41)	1.44 (0.91–2.30)	1.45 (0.91–2.31)	1.53 (0.96–2.44)	1.48 (0.98–2.24)		
Information-seeker	($n = 156$)	($n = 289$)	($n = 310$)	($n = 286$)	($n = 293$)	($n = 1178$)		
6-month sustained	14.7%	17.0%	18.1%	17.1%	19.1%	17.8%	1.51	0.91
Odds ratio (95% CI)	1.00	1.18 (0.69–2.02)	1.28 (0.75–2.16)	1.20 (0.70–2.05)	1.37 (0.80–2.32)	1.25 (0.79–2.00)		
Cold-contacted	($n = 266$)	($n = 466$)	($n = 499$)	($n = 498$)	($n = 465$)	($n = 1928$)		
6-month sustained	1.1%	4.1%	2.8%	3.8%	2.8%	3.4%	6.06	3.91*
Odds ratio (95% CI)	1.00	3.73 (1.09–12.71)	2.53 (0.72–8.89)	3.48 (1.02–11.86)	2.52 (0.71–8.93)	3.06 (0.95–9.80)		

*$P < 0.05$; #$P < 0.10$. [a]Comparison of the five conditions; [b]comparison of the four intervention conditions combined with the control. CI: confidence interval.

Table 4 Logistic regression analyses predicting 6-month sustained abstinence ($n = 3438$).

	n	*Step 1 (core predictor alone)*	*Step 2 (plus demographics and recruitment source)*	*Step 3 (plus smoking-related variables)*
Two × two analysis				
Offered onQ	2238	1.51 (0.94–2.41)	1.56 (0.96–2.54)	1.41 (0.85–2.33)
Offered QuitCoach	2288	1.43 (0.89–2.28)	1.46 (0.90–2.36)	1.37 (0.83–2.27)
Interaction term	3438	0.70 (0.40–1.22)	0.70 (0.39–1.25)	0.76 (0.42–1.39)
Intervention groups combined				
Intervention group (versus control)	3022	1.48 (0.98–2.24)	1.55 (1.01–2.38)*	1.42 (0.91–2.23)

*$P < 0.05$.

Table 5 Comparisons of 7-month outcomes by intervention usage, independent of condition (missing cases coded as smokers).

	Used only onQ	*Used only QuitCoach*	*Used both interventions*	$\chi^2_{(2)}$[a]	*Used any intervention*	$\chi^2_{(1)}$[b]	*Used neither*	$\chi^2_{(1)}$[c]	*Control group*
Overall	($n = 618$)	($n = 458$)	($n = 243$)		($n = 1319$)		($n = 1787$)		($n = 422$)
6-month sustained	15.4%	10.5%	13.6%	5.46	13.3%	57.26***	5.5%	0.25	6.2%
Information-seeker sample	($n = 443$)	($n = 127$)	($n = 111$)		($n = 681$)		($n = 497$)		($n = 156$)
6-month sustained	18.1%	26.8%	22.5%	4.98	20.4%	7.36**	14.3%	0.20	14.7%
Cold-contacted sample	($n = 175$)	($n = 331$)	($n = 132$)		($n = 638$)		($n = 1290$)		($n = 266$)
6-month sustained	8.6%	4.2%	6.1%	3.97	5.8%	17.26***	2.2%	1.23	1.1%

**$P < 0.01$; ***$P < 0.001$. [a]Comparison of used both, used QuitCoach only, and used onQ only; [b]comparison of used any and used neither; [c]comparison of used neither and the control group.

Outcome by intervention used

Table 5 shows that in both samples and overall, those who used any intervention to criterion level were significantly more likely to achieve 6-month sustained abstinence than those who did not. Indeed, those who did not use an intervention had similar outcomes to the control group.

To estimate more effectively the effect size for those using an intervention (see Analysis section), we estimated the probable quit rate among those in the control group who would have used the intervention if offered, using the proportion of those offered an intervention who used it to criterion (Pu = 0.425), the cessation rate in the control group (Ct = 6.2) and the rate in the intervention groups combined among those who did not use an intervention (Ir = 5.5). This worked out to be Eu = [6.2–5.5(1–0.425)]/0.425, i.e. 7.2% (missing cases coded as smokers). As the success rate for those taking up an intervention was 13.3%, the increase in the cessation rate (effective success rate) is computed as 13.3–7.2 = 6.1% (OR = 1.95; CI: 1.04–3.67) or relative risk (RR) = 1.83 (0.97–3.42). Conducting this analysis only on cases with outcome data, then the estimates are Pu = 0.425, Ct = 7.3 and Ir = 6.5, thus Eu = [7.3–6.5(1–0.425)]/0.425, which computes to 8.4%. The effective success rate was 14.9–8.4 = 6.5% (OR = 1.85; CI: 0.99–3.49); RR = 1.73 (0.91–3.22).

Outcome by source of recruitment

Table 6 reports the relationship between use of the interventions within each condition and 6-month outcome, both overall and by recruitment source. In all cases those using the interventions were numerically more likely to have a sustained quit, but the magnitude of effect varied considerably. Those offered onQ appeared to do better in the cold-contacted sample and those offered QuitCoach in the information-seeker group. A *post-hoc* analysis among those who used an intervention from the onQ and QuitCoach only conditions found this recruitment source × condition interaction to be significant ($P = 0.02$).

Use of external cessation assistance

At 1 month, we asked about use of help outside that provided by the study (see Table 7). Control group participants, who were encouraged to use the internet for smoking cessation help, reported using it more than intervention group participants ($\chi^2 = 16.79$, d.f. = 4, $P = 0.002$). However, use of the internet (independent of our interventions) was not associated with quit success ($\chi^2 = 0.34$, d.f. = 1, $P = 0.56$).

Equivalent numbers across groups (12%) indicated that they had used external behavioural assistance extensively (see Table 7). Overall, extensive use of any

Table 6 Use of trial interventions by recruitment source, and success rates among those using and not using.

	onQ only	*QuitCoach only*	*Integrated*	*Choice*	$\chi^2_{(4)}$	*P*
Total sample	(*n* = 756)	(*n* = 809)	(*n* = 785)	(*n* = 758)		
% used	39.0%	34.0%	42.9%	54.5%	72.33	<0.001
% quit, among those used	14.3%	11.6%	14.2%	13.1%	1.81	0.76
% quit, among those not used	5.6%	7.1%	4.5%	4.3%	4.45	0.22
Imputed OR[a]	2.13 (1.12–4.10)	1.68 (0.84–3.35)	2.12 (1.10–4.06)	1.92 (1.00–3.67)		
Information-seeker	(*n* = 290)	(*n* = 310)	(*n* = 286)	(*n* = 293)		
% used	65.2%	30.0%	65.4%	72.7%	138.12	<0.001
% quit, among those used	17.6%	26.9%	19.3%	21.1%	3.56	0.31
% quit, among those not used	15.8%	14.3%	13.1%	13.8%	0.33	0.96
Cold-contacted	(*n* = 466)	(*n* = 499)	(*n* = 499)	(*n* = 465)		
% used	22.7%	36.5%	30.1%	43.0%	47.85	<0.001
% quit, among those used	8.5%	3.8%	8.0%	4.5%	4.62	0.20
% quit, among those not used	2.8%	2.2%	2.0%	1.5%	1.21	0.75

[a]Estimates based on imputed success rate for control participants who would have used our intervention if offered (7.2%). OR: odds ratio.

cognitive–behavioural intervention (including criterion use of QuitCoach or onQ) was 50% for the intervention groups combined (43–60% across groups) compared with 11.9% for the controls. This gives an effective difference in intervention use of 38.1%. It is notable that, although not significant, the rates of quitting among those who used criterion-level help was lower in the control group (11.1%) than the intervention groups (14.8%), even though the proportion using was far smaller.

A third (33.7%) of the sample used stop-smoking medication, with no differences between groups. Use was associated with higher 6-month sustained abstinence (18.8%) than non-use (4.8%, $\chi^2_{(1)} = 159.02$, $P < 0.001$). When we added use of medication to the regression analyses using the subsample for which we had data, while related independently to success (OR = 2.17 in the model comparing all intervention conditions to the control), it did not change the ORs for the intervention conditions.

DISCUSSION

This study provides some weak evidence for the utility of automated interventions as a population-based cessation strategy when considered in the context of other studies. We failed to find clear significant effects between the intervention conditions and the control, due at least in part to the low rates of intervention uptake and the contaminating effects of use of alternative interventions by controls. As we fell marginally short of our planned sample size, inadequate power could also account for this. However, the magnitude of the effects we found for the QuitCoach were consistent with those reported in recent meta-analyses of internet-based cessation programs [3–5] and the short-term effects for onQ (1.5–2.0, depending on the basis for the estimate) were comparable to those reported in the few studies of text-messaging support [9]. It is therefore reasonable to conclude that these interventions are of similar efficacy to those evaluated in other studies. Use of either the onQ text-messaging program or the QuitCoach provided a similar effect, but we found no evidence that combining the two improved outcomes (however, nor did it interfere). Offering a choice of interventions increased the likelihood that one would be used, but did not improve outcomes.

The findings are not consistent with the evidence of an additive effect of text-messaging and interactive web-based help [11], which we note is based on indirect comparisons. This may be because there is no benefit, or that there was simply no benefit in this case, perhaps because the extent of integration of our two programs was not sufficient and thus they did not complement each other as we thought they would. More detailed exploration of how multi-mode interventions are used is required.

There was some evidence that QuitCoach was more effective (relative to onQ) among information-seekers, whereas onQ was of greater benefit among the cold-contacted subsample. By contrast, recruitment modality (telephone or web) was related strongly to intervention uptake in the opposite direction, with those recruited by web (predominantly the cold-contacted sample) more likely to use a web-based intervention (QuitCoach), whereas those recruited by telephone were more likely to accept onQ (see Table 6). The interaction might be due to a combination of less motivated participants using the modality consistent form of help (by accepting it passively when not really interested) and more motivated ones using the form they had to make additional effort to receive. Alternatively, it could be that structure (i.e. onQ) is more useful for those with low initial motivation who are prepared to give it a try, while more detailed advice

Table 7 Use of cessation assistance by condition and quit rates (6-month sustained abstinence) among those using each form.

	Control (n = 378)	*onQ only (n = 665)*	*QuitCoach only (n = 713)*	*Integrated (n = 683)*	*Choice (n = 667)*	*All intervention conditions (n = 2728)*	*Total (n = 3106)*	$\chi^2_{(4)}$[a]	*P*
Used external help from the internet									
% reporting	28.8%	21.4%	22.4%	18.3%	20.5%	20.7%	21.7%	16.79	0.002
% quit, among those reporting	6.4%	14.1%	7.5%	8.8%	7.3%	9.4%	8.9%	6.34	0.18
Used extensive external behavioural help (of any kind)									
% reporting	11.9%	11.4%	14.0%	11.7%	11.2%	12.1%	12.1%	3.33	0.50
% quit, among those reporting	11.1%	22.4%	22.0%	21.3%	22.7%	22.1%	20.7%	2.94	0.57
Used extensive behavioural help (trial or external)									
% reporting	11.9%	45.4%	43.1%	52.0%	60.1%	50.0%	45.4%	242.89	<0.001
% quit, among those reporting	11.1%	15.9%	14.3%	14.9%	14.2%	14.8%	14.7%	0.96	0.92
No use of extensive behavioural help of any kind									
% reporting	88.1%	54.6%	56.9%	48.0%	39.9%	50.0%	54.6%	242.89	<0.001
% quit, among those reporting	6.3%	5.2%	5.7%	4.3%	4.1%	4.9%	5.2%	2.20	0.70
Used medication									
% reporting	33.3%	35.0%	32.0%	35.6%	32.7%	33.8%	33.7%	2.89	0.58
% quit, among those reporting	11.9%	21.9%	21.1%	16.5%	19.7%	19.7%	18.8%	7.13	0.13
Used extensive behavioural help or medication									
% reporting	38.6%	57.6%	56.5%	64.1%	67.2%	61.3%	58.5%	92.45	<0.001
% quit, among those reporting	11.6%	15.7%	13.9%	13.9%	14.3%	14.4%	14.2%	1.56	0.82

[a]This compares all intervention conditions combined with the control group.

might be more useful to those with a higher initial commitment and thus less need for constant reminders.

Compared to the close to 100% difference in the use of help between the intervention and control groups normally engineered in a study, there was only an approximate 40% difference in the use of cognitive–behavioural cessation assistance, including the interventions trialled here. We did not try to control for use of help in the control condition in order not to create expectancy biases favouring the intervention groups (or more probably disadvantaging the controls), but as a consequence the main analysis was underpowered to find effects of the magnitude we observed. None the less, when we attempted to control for actual use by estimating effect size in the control group for those who might have used, we found a significant intervention effect. Moreover, if those in the control group who actually used a behavioural intervention were more motivated (as is assumed in the need for a RCT design), then the fact that these were numerically less successful than the greater number who used an intervention in the intervention groups is evidence that our strategy has not over-controlled for potential bias.

The overall increase in success among those offered help was approximately 3%; however, the estimated effect among those taking up one of the interventions was approximately 6%. This means that approximately 33 people need to be offered such an intervention to gain one additional quitter, while it takes only approximately 16 to actually use an intervention to achieve the same goal.

Once computer-based, automated interventions have been developed they cost very little to maintain, and can be provided at an ever-decreasing net cost per user. Ongoing delivery costs are negligible in the case of the QuitCoach (but base costs are higher, as it is more complex and thus more difficult to maintain), and are calculated for onQ to be less than A$20 per user. As text-messaging costs decline, and/or they become effectively free (i.e. within paid-for data download limits), the cost-effectiveness of this service will become even more attractive, particularly if it is used by large numbers. For inexpensive (per smoker reached) interventions of this kind, any benefit is likely to be of considerable public health importance.

This study highlights some of the challenges of studying the effects of cognitive–behavioural interventions. The types of behavioural interventions used here can work [3,8], but their effectiveness is, to a large extent, dependent upon how potential users engage with them. The challenges are even greater, as in this case, where the interventions are delivered without face-to-face contact and in a context where alternative equally or more effective interventions are available. Because double-blinded trials are not possible with interventions with a psychological component, we believe there is a need for a mix of studies such as this one, where no expectancies are set up of between-group differences in what is received and studies that make participation conditional on taking up the offer provided, where between-group expectancies cannot be avoided. However, if this is to be supported by the scientific community, methods are needed for comparing the results equitably. In this paper we suggest one way of adjusting the effect estimates for 'offer' type studies.

Not unexpectedly, higher success rates were found in the more motivated information-seeker sample in all groups, including the control, but the magnitude of the effect was surprising. This study highlights the importance of considering the nature of the population from which samples are drawn in comparing studies, as the overall success rate can vary markedly as a function of where and how the sample is recruited. We found that there was little difference by sample in the marginal success rate, but the ORs for success were markedly different, as there was a more than 10-fold difference in the base quit rate. We think it is important to estimate the marginal improvement in success rates, for which number-needed-to-treat is a useful measure.

We conclude that smokers interested in quitting who were assigned randomly to an offer of either the QuitCoach internet-based support program and/or the onQ text-messaging program had non-significantly greater odds of quitting for at least 6 months than those randomized to an offer of a simple information website. Taken in conjunction with other research, this study provides modest additional evidence for the effectiveness of both forms of intervention, but not for additive effects. Among smokers prepared to use them, the effect sizes are likely to be greater. Offering such programs widely has the potential to have a modest population-level impact on smoking cessation, especially if more smokers can be encouraged to use them.

Clinical trial registration

The trial was registered with the Australian New Zealand Clinical Trials Registry, registration number 0082854.

Declarations of interest

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. The QuitCoach program: features of and structure of the advice provided.

Appendix S2. Implementation of the interactive automated text-messaging program (onQ) intervention.

