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Original investigation

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Effectiveness of Text Messaging as an Adjuvant to Health Advice in Smoking Cessation Programs in Primary Care. A Randomized Clinical Trial

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Abstract

Introduction: Smoking remains a major risk factor for chronic diseases. Health advice is considered one of the most cost-effective interventions; however, changes produced by counseling tend not to persist over time, it is necessary to implement enforcement mechanisms.

Methods: Randomized clinical trial to evaluate the effectiveness of a combined program that includes health advice and text messaging to mobile phone (SMSalud®). Patients were randomized to one of two interventions: health advice (control group) or health advice and text messaging (intervention group). We included 320 smoker patients who met the inclusion criteria: being motivated, aged over 18 years, having a mobile phone, being able to read and send messages. Patients were excluded if they had a history of mental or behavioral disorders, or depression. The primary endpoint was the percentage of patients who had stopped smoking by 6 months and confirmed by CO breath test.

Results: By 6 months after the start of the program, 24.4% (39/160) of patients in the intervention group and 11.9% (19/160) of controls had stopped smoking (*OR*: 2.3; 95% CI: 1.3–4.3, $p = .007$). Patients with no dependence or mild dependence were more likely to stop (28.3%, 36/127 vs. 11.4%, 22/193; *OR*: 3.0, 95% CI: 1.7–5.5, $p < .001$). The rate of continuous abstinence at 12 months was 16.3% (26/160) in intervention group patients and 5.6% (9/160) in controls (*OR*: 3.2; 95% CI: 1.3–5.9).]

Conclusions: The combined program is effective for smoking cessation. Patients with less tobacco dependence have a higher probability of success.

Implications: Health advice is effective for promoting changes in lifestyle but these changes do not persist over time, so we have to use strengthening mechanisms, as e-health, and specifically, mobile phone based interventions. SMSalud® is an innovate program that includes text messaging and health advice, and it's effective for smoking cessation. The only feature that seems to affect the probability of smoking cessation is the degree of tobacco dependence.

Introduction

Tobacco smoking is still the leading preventable cause of death worldwide. Globally, it causes nearly 6 million deaths and is responsible for costs of billions of dollars every year.[1] It is recognized as an important risk factor for chronic diseases around the world, and in Spain, around 27% of the general population over 15 years of age are smokers.[2] As such, it represents a real problem for health services, being associated with high social and health care costs,[3] and hence, reducing consumption has been on the agenda of health systems in developed countries for some years.[4]

A large body of evidence supports the association between certain healthy lifestyles and lower rates of major chronic diseases and all-cause mortality. In the treatment of smoking, health advice is considered one of the most cost-effective interventions,[5] but the changes achieved by counseling tend not to last for a long time. Therefore, there is a need to identify effective mechanisms to reinforce such advice[6] and these include the use of information and communication technologies. Within information and communication technologies, m-Health refers to the practice of medicine and public health supported by mobile devices, such as mobile phones, with goals including educating, motivating, and connecting system users with healthcare professionals.[7]

Since the launch of commercial networks in the 1980s, the use of mobile phones has grown exponentially. The International Telecommunication Union[8] estimated that by the end of 2015 there would be 7 billion mobile phones worldwide, representing a penetration rate of 97%, and this makes these devices increasingly useful in terms of healthcare support. Short Message Service is a relatively simple technology with a great potential for contributing to healthcare improvement for various reasons: it is available on almost all types of mobiles, is relatively cheap, and can be used without special skills in this technology and applied to a wide range of circumstances.[9] Several studies have highlighted the great potential of this technology for producing changes in health-related behavior, from promoting safer sexual practices,[10] to remind patients about upcoming appointments and thus, increasing attendance rates[11] and performing following-up and monitoring of various medical conditions (including diabetes, lower back pain, and mental health).[12–14]

Additionally, interventions based on mobile phones or other electronic aids (internet sites and computer programs, among others) increase the likelihood of smoking cessation compared to no intervention or using general self-help materials (risk ratio [*RR*] 1.3 to 1.7, 95% CI [confidence interval]: 1.1 to 2.8).[15–17] Stead et al.[17] also found a dose-dependent relationship between the number of telephone calls and the likelihood of smoking cessation (*OR* [odds ratio] 1.4, 95% CI: 1.3 to 1.6). Indeed, in smoking cessation programs, mobile phones are increasingly being used as a complementary tool for providing support, since they can be used almost anytime and anywhere[9], as well as being cost-effective.[18]

Despite the consequences of smoking, around 27% of the population aged 15 years and over in Spain report smoking on a daily basis.[2] However, around 70% of smokers in this country indicate a willingness to quit smoking, 27.4% having attempted to do so in the previous year.[19] Nevertheless, it has been found that only 3% to 5% of smokers who attempt to quit without the support of health professionals achieve abstinence for as long as 6 to 12 months.[20]

Further, primary care offers among the best opportunities for identifying, treating, and monitoring smokers, given that 70% of smokers attend a primary care appointment at least once a year.[21] Indeed, the Program for Preventive Activities and Health Promotion (PAPPS) of the Spanish Society of Family and Community Medicine recommends systematically asking all adults seen in primary care about tobacco use every other year, as well as encouraging all smokers to give up their habit every time they attend an appointment.[22]

We believe that it is necessary to develop strategies focused on improving outcomes of smoking cessation programs that include reinforcement mechanisms to consolidate changes. With this in mind, we designed a study to assess the effectiveness of a smoking cessation program that combines health advice with reinforcement text messages (SMSalud®).

Methods

Study Design and Selection Criteria

We carried out a parallel-group randomized clinical trial with 320 patients registered (Figure 1) in one of two health centres (Lakuabizkarra and San Martín in Vitoria-Gasteiz) of the Basque public health system who were smokers aged 18 years or older, had a mobile phone, were able to receive and send text messages, and were motivated to start a smoking cessation program (based on a score of ≥5 on the Richmond test). We excluded patients who were on drug treatment for smoking cessation or had a history of mental or behavioral disorders or a diagnosis of depression (using the Goldberg scale; 23), as well as women who were pregnant.

Recruitment and Intervention

We estimated that we needed a sample of 320 patients (Figure 1) to detect a difference of at least 10% in the rate of smoking cessation between comparison groups. Patients were identified through the integrated electronic health record system (Osabide) of the Basque Health Service (Osakidetza) in relation to the aforementioned program, PAPPS, and received a letter from their doctor inviting them to participate in the study, and later, a telephone call from the research nurse. If patients showed interest, the nurse arranged an appointment to inform them about the potential benefits and risks of participating in the study and complete their assessment (Richmond test, Appendix I,[23] and Goldberg Depression Scale,[24] Appendix II). Patients were excluded from the study if they obtained a score of ≤4 on the Richmond test and/or were classified as having depression. All patients gave written informed consent before inclusion. The study was approved by the clinical trials committee of Araba University Hospital.

After inclusion, patients were randomly assigned to either usual clinical practice (health advice provided by a doctor or nurse) or to the combined smoking cessation program (health advice, as in the other group, plus reinforcement text messages to their mobile phones). The researchers involved were blind to the computer-generated sequence used for randomization until the moment of group allocation. Specifically, the Bioaraba Research Institute assigned patients to one of the two arms of the trial by balanced randomization (1:1 ratio), after receiving the patient randomization form, and hence research nurse did not know about the treatment group until patient allocation. The study was not blind given the nature of the intervention.

After their inclusion in the study, patients selected a day in the 1 month following their initial assessment on which to start the program. We considered it necessary to give patients this flexibility, to allow them time to tell friends and family and ask for their support, as well as identify a moment with minimal stress and social commitments.

The Fagerström Test for Nicotine Dependence was used to assess the intensity of participants' physical addition. Regarding their history of smoking, we asked participants how many cigarettes they

smoked a day, when they started smoking, whether they had any smoking-related health problems, and their reasons for wanting to quit, as well as assessing their family environment, previous cessation attempts and reasons for relapse.

The recruitment period was 1 year, from March 2013 to March 2014, and patients were then followed-up for 12 months. The primary endpoint (smoking cessation) was assessed at 6 months in all patients, and at 12 months in those who had stopped smoking by 6 months.

Intervention

Health Advice (Verbal and Written Information)

As early as the recruitment visit itself, we provided verbal and written information on the benefits of not smoking and recommended changes in eating habits. We also provided information regarding how to cope with withdrawal symptoms (Figure 1).

Reinforcement Text Messages

Patients on the combined program received two automatically-generated text messages a day (one in the morning and one in the evening) for the first 5 weeks and three messages a week from weeks 6 to 26 (Supplementary Table 1). The messages were motivational in intent, to encourage patients in their efforts to stop smoking, and also provided information about the health-related risks of smoking. The structure of this part of the intervention (SMSalud®) was based on text messaging support found to be effective in a previous trial.[25]

We also offered these patients the possibility of requesting support messages from the system in moments of crisis or anxiety. For this, they had to send a message free of charge with the word "anxiety" or "relapse" to a given phone number.

Both groups have followed the usual protocol (health advice) with its four visits (protocol according to recommendations of Spanish Society of Family and Community Medicine). Doctors and nurses have provided this advice, and the only difference between intervention and control group has been text messaging.

They were asked to attend appointments at 7 days, 4 weeks and 6 months after the start of the program. In addition, the nurse contacted patients by phone at week 12.

In the first three appointments, doctors and nurses reinforced patients. If they had been successful in not smoking up to that point, doctors and nurses congratulated them and addressed potential problems such as withdrawal symptoms, weight gain, and depression, with the aim of preventing a relapse. If they had not been successful, we explored why they had smoked.

Follow-up and Data Collection

At 6 months (end of the program), we assessed the primary endpoint (smoking cessation) by measuring the carbon monoxide (CO) levels in the breath of patients.

Patients classified as nonsmokers were given another appointment at 12 months to assess whether they continued to be abstinent and again measure their exhaled CO levels.

Assessment of the Response

The primary endpoint was the patients' exhaled CO levels at 6 months after the start of the program. To assess this, we used a breath CO monitor and mouth pieces (Bedfont Scientific Ltd), considering the result negative for levels of 0 to 6 ppm, and positive for higher levels.

Secondary endpoints were continuous abstinence, defined as the patient reporting not having smoked more than five cigarettes since the start of the follow-up period; level of agreement between patient-reported abstinence and exhaled CO levels; and level of satisfaction with the program using an ad-hoc questionnaire, all at 6 months after the start of the program, and additionally continuous abstinence, confirmed using exhaled CO levels, at 12 months.

Statistical Analysis

The primary endpoint (exhaled CO levels at 6 months) was analysed using first crude logistic regression and then logistic regression models adjusted for potential confounders identified in the bivariate analysis. Results are expressed as ORs with corresponding 95% CIs. The goodness-of-fit of the resulting model was assessed using the Hosmer and Lemeshow test, considering $p > .05$ to indicate a good fit.

This analysis was performed on an intention-to-treat basis in the whole sample of patients and using IBM SPSS statistics version 22.0. We assumed an alpha error of 5% and statistical power of 80%. The same approach was used to assess continuous abstinence at 12 months.

The Richmond and Fagerström test scores were categorized using cut-off points for distinguishing between individuals with low (≤4), moderate[5–6] or high (>6) levels of motivation to quit smoking, and low or none,[1–3] moderate[4–6] or high (>6) nicotine dependence.

The number of cigarettes smoked a day before the program was used to categorize patients as at higher or lower risk of relapse according to previous research (≤4/>5).[26] Similarly, age of smoking initiation was used to categorize patients as being more or less likely to be successful quitters (≤15 years, greater probability of success) according to previous research.[27]

Missing data for the primary and secondary endpoints of CO levels at 6 and 12 months were handled conservatively, assuming that patients who did not attend appointments still smoked. For the statistical analysis, these individuals were classified as smokers, and assigned a positive CO test result.

Results

To assess the efficacy of the smoking cessation program, we recruited 320 patients, of whom 148 (Figure 1) attended the 6-month follow-up and completed the exhaled CO testing. The other patients withdrew from the study or were lost to follow-up.

The mean age of the total sample was 45 years (*SD* 9.1); with means of 45.1 (*SD* 9.4) and 44.9 (*SD* 8.8) years in the intervention and control groups, respectively. We found no significant differences between the groups in baseline characteristics, except for whether they "often spent time with smokers or in places where others were smoking," the rate being higher in the control (41.5%; $n = 66$) than the intervention (27.5%; $n = 44$) group, and hence, this variable was included in the logistic regression model as a confounder (Table 1).

Smoking Status at 6 Months as Determined by Self-Report and Verified by CO Levels

There was a statistical difference in the levels of exhaled CO of patients that were in the intervention group compared to the control group ($p = 0004$). According to the findings, 24% of patients in the intervention group were defined as nonsmokers at the 6-month time compared to 12% of patients in the control group. Exploring the

association of the primary endpoint with each of the independent variables, the only significant association found was with nicotine dependence ($p < .001$). The success rate in the program was lower in patients with a moderate-to-high level of dependence (11.4%, 22/193) than those with no or mild dependence (28.3%, 36/127).

Considering abstinence reported by patients at 6 months, we found a significant difference between groups ($p = .001$), 25%[40] of intervention group patients and 10.7%[17] controls reporting that they did not smoke. There was a 78.5% agreement between exhaled CO test results and patient-reported abstinence at 6 months. In seven patients who reported smoking at 6 months, the exhaled CO test was negative. Examining the outcome of patients defined as non-smokers when combining the outcomes from the self-reports and the CO levels, there was still a statistical difference between the two groups (22.5% [36/160] in the intervention group vs. 9.5% [15/160] in controls; Supplementary Table 2).

Assessing the primary endpoint using logistic regression, we observed significant differences between the groups in the crude

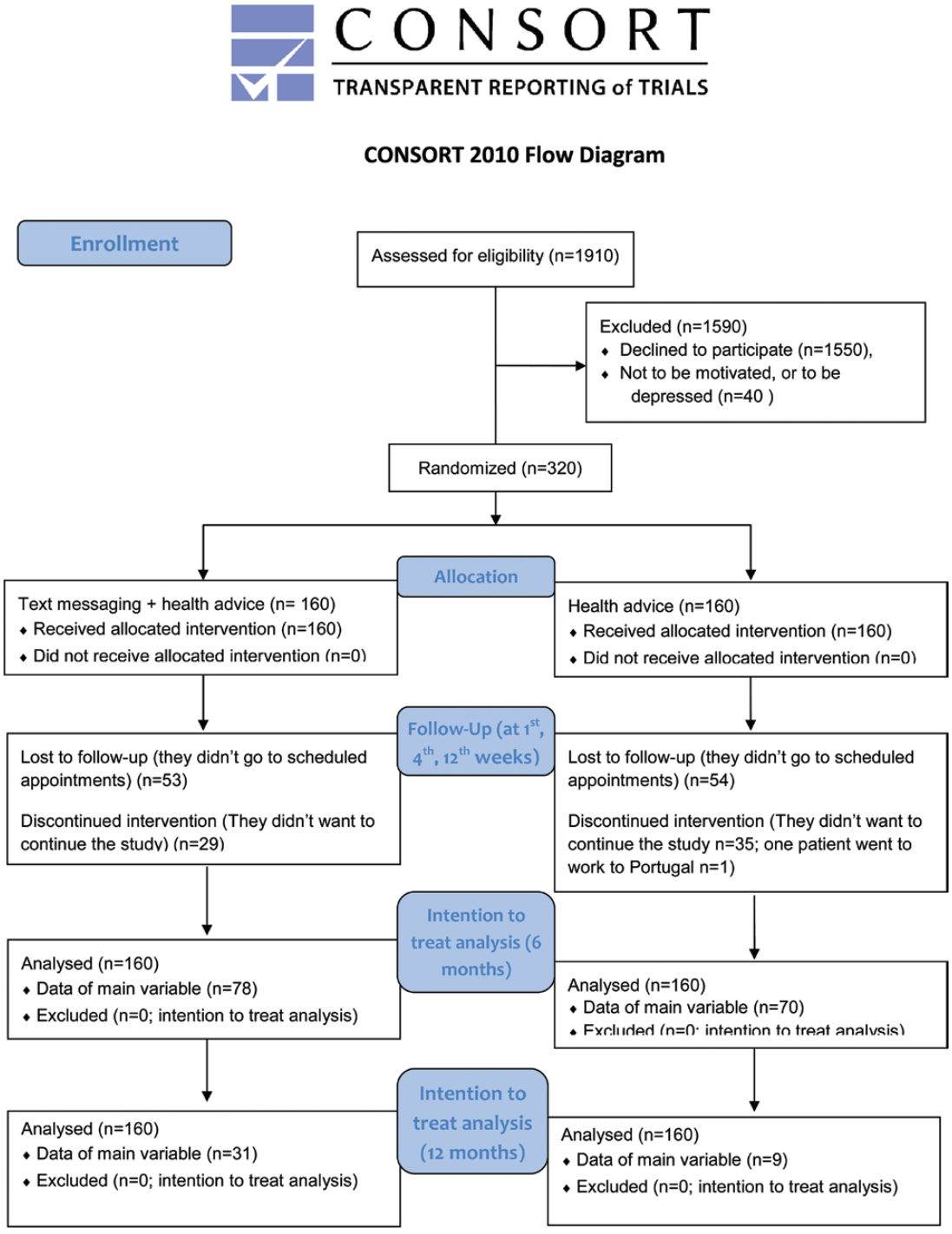

Figure 1. CONSORT 2010 flow diagram.

analysis (p = .004; *OR*: 2.4, 95% CI: 1.3 to 4.4). The probability of having a negative test result was 2.4-fold higher in intervention group patients than controls. We obtained similar results after adjusting for smoking dependence (Table 2).

Secondary Endpoints

Lastly, we explored the level of satisfaction with the smoking cessation program in the total sample (Supplementary Table 3) and in each group, not finding any significant differences (p > .05). The satisfaction ratings were very high on all items, more than 80% of patients stating that they were satisfied or totally satisfied.

The abstinence at 12 months was assessed in patients with negative CO test results at 6 months, that is, those with exhaled CO levels ≤6 ppm (nonsmokers). Of the 58 patients classified as nonsmokers at 6 months, only 40 attended appointments for testing at 12 months, 31 intervention group patients and 9 controls. We have observed significant differences between the groups in the crude analysis (26/160; 16.25% in the intervention group and 9/160; 5.6% in the control group; p = .002) and adjusted analysis (p = .006; *OR*: 3.2, 95% CI: 1.3 to 5.8). The probability of having a negative result in both tests was 3.2-fold higher in the intervention than control group (Table 3).

Discussion

Smoking remains one of the greatest threats to public health worldwide,[28] but various studies have shown that relatively few people understand the specific health risks of smoking,[28] and also that most smokers who do know about these risks would like to quit smoking. Health advice increases the likelihood of smoking cessation success, but this may not be sufficient, and hence, we need to explore strategies to increase the success rate of smoking cessation programs.

The objective of this study was to assess the effectiveness of a smoking cessation program that combines provision of health advice with the sending of support and reinforcement text messages to the mobile phone of patients who smoke. The intervention was more effective than usual practice (health advice alone) at 6 months (24.4 vs. 11.9%) and 12 months (16.3 vs. 5.6%). We also assessed patient-reported abstinence at 6 months, finding higher greater rates in the intervention than the control group (25 vs. 10.6%). The level of

Table 1. Baseline Characteristics of the Sample

Variable	Categories	Group			
		Control		Intervention	
Sex	Men	87	54.4%	92	57.5%
	Women	73	45.6%	68	42.5%
Age of smoking initiation, years	≤15	56	35.2%	72	45%
	>15	103	64.8	88	55%
Age, years		45 (*SD* 9.1)			
		44.9 (*SD* 8.8)		45.1 (*SD* 9.4)	
Type of smoker	Daily	159	99.4%	159	99.4%
	Occasional	1	0.6%	1	0.6%
Number of cigarettes smoked a day before the program	1–4	7	4.4%	8	5.0%
	≥5	151	95.6%	152	95.0%
Richmond test score	0–4 (not motivated)				
	5–6 (moderately motivated)	53	33.3%	51	32.3%
	≥7 (highly motivated)	106	66.7%	107	67.7%
Fagerström scale score	0	14	8.8%	13	8.1%
	1–3 (mild dependence)	45	28.1%	55	34.4%
	4–6 (moderate dependence)	70	43.8%	67	41.9%
	≥7 (high dependence)	31	19.4%	25	15.6%
Smoking-related diseases	No	140	87.5%	143	89.4%
	Yes	20	12.5%	17	10.6%
Often spent time with smokers or in places where others were smoking	No	93	58.5%	116	72.5%
	Yes	66	41.5%	44	27.5%
Had tried to quit smoking before	No	59	36.9%	66	41.3%
	Yes	101	63.1%	94	58.8%
Had anxiety	No	119	74.4%	120	75%
	Yes	41	25.6%	40	25%

Table 2. Patients Who Did Not Smoke at 6 Months (Negative CO Test). Adjusted analysis

				95% CI for the *OR*	
	B	Sig.	*OR**	Lower	Upper
Intervention group	0.845	0.007	2.329	1.263	4.296
Mild-to-moderate or no dependence	1.103	0.000	3.013	1.661	5.466
Constant	0.574	0.013	1.775		

CI = Confidence interval; *OR* = Odds ratio.

Table 3. Patients Who Did Not Smoke at 12 Months (2 Negative CO Test Results). Adjusted Analysis

				95% CI for the *OR*	
	B	Sig.	*OR*	Lower	Upper
Intervention group	1.148	0.005	3.153	1.415	7.026
Mild-to-moderate or no dependence	1.032	0.006	2.805	1.343	5.860
Constant	−3.315	0.000	0.036		

CI = Confidence interval; *OR* = Odds ratio.

satisfaction was high in both groups, with no significant differences in ratings for any of the items.

The design attempted to maximize the internal and external validity of the study. Participants were randomly allocated at the recruitment appointment using a computer-generated sequence hidden from researchers. In this way, all prognostic and potentially confounding characteristics were distributed in a balanced way between comparison groups.

The blinding of researchers to the randomization sequence until patient allocation minimized the risk of selection bias. On the other hand, another potential source of bias is the failure to blind researchers responsible for follow-up, as this could lead to systematic differences in the health advice provided, with clinicians placing more emphasis on intervention group patients or providing additional advice to controls with the intention of compensating them for the fact they were not receiving the intervention, differences which could affect the results of the study.[29] For future studies, a solution proposed by Sutton et al. is to record and then, compare the study's appointments, or at least some of them. This would enable us to detect, although not prevent, this type of performance bias. A lack of blinding can also lead to information bias, with the effect of the intervention being overestimated due to the observer effect. However, we have avoided this potential problem using a quantitative (objective) variable (concentration of CO in exhaled breath) as the primary measure of effectiveness.

The external validity is strengthened by the following: the research team was composed of highly-qualified health professionals, who are responsible in clinical practice for performing follow-up in smoking cessation programs. The sample of patients participating in the study was highly representative of the target population. Moreover, the health advice provided in terms of content, number of follow-up appointments, and the way to proceed at each stage of follow-up is based on the recommendations of the health promotion program, PAPPS, of the Spanish Society of Family and Community Medicine; this makes the intervention highly reproducible and generalizable to routine clinical practice in primary care.

The findings of this study are similar to those of other research groups. Whittaker et al.[9] found a combined measure of RR of quitting of 1.69 in a systematic review of 12 clinical trials assessing the effectiveness of mobile phone-based interventions. In a meta-analysis, Chen et al.[15] concluded that interventions based on internet, computer programs, mobile phones, or other electronic forms, increase the likelihood of cessation compared to no intervention or the use of generic self-help material. However, these systematic reviews assess the overall effectiveness of all types of interventions based on mobile phones (text messages and telephone counselling, internet-based programs, and Multimedia Message Service technology), allowing the simultaneous use of other strategies for smoking cessation at the time of patient randomization; in contrast, our study focused on isolating the effectiveness of text messaging. Further, in our study we only included smokers who were not on any drug treatment for smoking cessation at the time of recruitment, although 19 of them (9 in the intervention group and 10 controls) requested drug treatment at some point; nevertheless, only 5 stopped smoking, 4 in the intervention group and 1 control patient, and this supports our hypothesis of the effectiveness of text messages as a single adjuvant to counselling.

A clinical trial assessing the efficacy of a text message-based intervention versus self-help pamphlets for smoking cessation in 179 adolescent smokers[30] found significant differences in the rates of smoking reduction (66 vs. 35% in controls), although cessation rates were not reported.

With regards to the secondary endpoints of this study, the degree of nicotine dependence was the only prognostic variable considered that was found to be associated with the primary endpoint. In fact, dropout rates were higher among people with a lower degree of dependence. Similar trends have been found by other groups,[31–33] nicotine dependence having been identified as a predictor of success in smoking cessation programs.

As previously discussed, the main limitation of our study was the lack of blinding to the intervention, meaning that its effect might be over- or underestimated, and resulting in information bias. However, given the nature of the intervention, blinding was not feasible.[34]

The rate of losses to follow-up was very high (more than 50% at 6 months), despite having scheduled only a small number of appointments. In total, 148 participants (46.25%) completed the 6 months of follow-up (78 in the intervention group and 70 controls). The main explanation may be the type of recruitment, patients being first contacted through a written letter from their primary care doctor, and later a telephone call from the nurse running the study inviting them to an appointment, and this approach may have led unmotivated patients to participate. Another reason may be the nature of smoking cessation itself, the first attempt being unsuccessful in most cases[35,36] and the associated loss of motivation may reduce rates of attendance to appointments among patients who do not manage to stop smoking.

Another important limitation of this study is the half-life of CO in the body, which is around 5 hours, meaning that in 24 hours nearly all CO is cleared from the body. This may lead to false negatives if patients have gone a whole day without smoking. On the other hand, this problem applies to both groups, and hence, should not have affected the results.

Despite the aforementioned limitations, our study has also some strengths as a very acceptable sample size and a long-term follow-up, issues that were identified as limitations of other clinical trials, in a systematic review of m-Health interventions for smoking cessation programs in 2014.[37] For all the aforesaid, we can conclude that a smoking cessation program based on text messages to motivate patients and reinforce advice previously provided in face-to-face appointments is effective as an adjuvant to health advice, the level of satisfaction among patients being high in relation to the number and frequency of messages received, as well as their content.

We recommend wider use of this type of intervention in primary care, given its cost-effectiveness, and also the development of tailored combined strategies for patients with higher levels of nicotine dependence aiming to improve success rates in this population.

Supplementary Material

Supplementary Tables1, 2 and 3 can be found online at http://www.ntr.oxfordjournals.org

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Declaration of Interests

None declared.

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