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Text-message reminders increase uptake of routine breast screening appointments: a randomised controlled trial in a hard-to-reach population

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Background: There is a need for interventions to promote uptake of breast screening throughout Europe.

Methods: We performed a single-blind randomised controlled trial to test whether text-message reminders were effective. Two thousand two hundred and forty women receiving their first breast screening invitation were included in the study and randomly assigned in a 1 : 1 ratio to receive either a normal invitation only ($n = 1118$) or a normal invitation plus a text-message reminder 48 h before their appointment ($n = 1122$).

Results: In the intention-to-treat analysis, uptake of breast screening was 59.1% among women in the normal invitation group and 64.4% in the text-message reminder group ($\chi^2 = 6.47$, odds ratio (OR): 1.26, 95% confidence intervals (CI): 1.05–1.48, $P = 0.01$). Of the 1122 women assigned to the text-message reminder group, only 456 (41%) had a mobile number recorded by their GP and were thereby sent a text. In the per-protocol analysis, uptake by those in the control group who had a mobile number recorded on the GP system was 59.77% and by those in the intervention group who were sent a reminder 71.7% ($\chi^2 = 14.12$, OR = 1.71, 95% CI = 1.29–2.26, $P < 0.01$).

Conclusions: Sending women a text-message reminder before their first routine breast screening appointment significantly increased attendance. This information can be used to allocate resources efficiently to improve uptake without exacerbating social inequalities.

Breast cancer is a major public health concern in Europe, one accounting for 28.8% of all female cancer incidences (Ferlay *et al*, 2010), and 16.8% of all female cancer deaths (Ferlay *et al*, 2013). Survival is strongly contingent on a number of important genetic and clinical factors, among the most predictive of which are the stage and grade of the tumour upon diagnosis (Huang *et al*, 2003; Onitilo *et al*, 2009; American Cancer Society, 2012). As such, chances of survival are improved greatly when breast cancer is detected early, something which has been enabled through routine mammography screening (Independent UK Panel on Breast Cancer Screening, 2012).

The effectiveness of routine screening to improve breast cancer outcomes however depends not only on the ability of the screening test to detect early stage cancers, but also on the ability of the programme to attract the at-risk population (Lynge *et al*, 2012). European Guidelines for Quality Assurance in Breast Cancer

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Screening recommend that uptake should be at least 70%, and ideally >75% (Giordano *et al*, 2012); however, in a recent analysis of 26 European breast cancer screening programmes, only half of those studied achieved a level of uptake that was equal to or greater than the European benchmark for acceptable participation (Giordano *et al*, 2012). Suboptimal participation in breast cancer screening has been a topic of concern for some time, and, accordingly, there has been much interest in understanding the reasons underpinning low uptake, as well as in the development of novel interventions to promote participation and reduce missed appointment rates (Spadea *et al*, 2007; Walton, 2009; Jensen *et al*, 2012).

Detailed surveys issued to non-attenders and their health-care providers have identified the most prevalent patient-related factors for missing a breast screening appointment as: 'inadequate knowledge and understanding of the breast screening test' (Berner *et al*, 2001), 'feeling embarrassed about having the test', 'having a lack of breast cancer symptoms', 'residing in a deprived area', 'the profession of the health-care provider making the referral' and 'forgetting to go to the appointment' (Crump *et al*, 2000). 'Forgetting to go to the appointment' was the single most frequently cited reason for not attending a routine breast screen, accounting for 19–31% of missed appointments (Crump *et al*, 2000; Aro *et al*, 2001; Baysal and Gozum, 2011). Interventions that address 'forgetting to go to the appointment' then, such as reminders, might offer a potential solution for preventing a large number of missed appointments, thereby improving uptake without infringing upon a person's ability to make an informed choice.

Previous studies that have examined the use of reminders to prevent missed breast screening appointments report that both telephone and postal reminders are effective, but that neither are affordable nor sustainable (Taplin *et al*, 1999; Goelen *et al*, 2010). By comparison, text messaging (also referred to as short messaging service) offers a relatively inexpensive, instantaneous and ubiquitous modality for delivering reminders (Ofcom, 2012). In other areas of health care, text messages reminding the patient about the time, date and venue of their appointment have been shown not only to be an acceptable alternative for delivering reminders but also a preferable one (Cohen *et al*, 2007; Hanauer *et al*, 2009; Kharbanda *et al*, 2009). Thus, text messaging may offer an affordable and desirable solution for delivering reminders for routine breast screening appointments.

Although a recent meta-analysis of randomised controlled trials (RCTs) and observational studies found that text messages reminding patients of their appointments are effective in promoting clinic attendance (Guy *et al*, 2012), with no significant subgroup differences between the timing of the reminder at 24, 48 and 72 h (Guy *et al*, 2012), there have been no published RCTs evaluating the effectiveness of text-message reminders to promote the uptake of breast screening in an otherwise healthy population. We identified one RCT that investigated whether longer, more informative text messages were more effective than shorter, less informative text messages at promoting self-referral rates among previous non-attenders, but the study did not compare rates with receiving no reminder for routine appointments (Lakkis *et al*, 2011). Despite the lack of high-quality evidence, some Breast Cancer Screening Centres have opted to implement text messaging systems to deliver reminders for routine screening appointments (Lakkis *et al*, 2011); this, however, is not an evidence-based practice, and the resources invested in these services might be utilised better elsewhere.

In this study, we performed an RCT to evaluate the effectiveness (intention-to-treat analysis; ITT) and efficacy (per-protocol analysis; PP) of text messaging as a novel mechanism for delivering reminders for routine breast screening appointments, and to provide evidence to inform European Guidelines for Quality Assurance in Breast Cancer Screening on how best to invest the resources presently being spent on text-messaging services.

The primary aim was to establish whether text-message reminders improved uptake and reduced missed appointments for the prevalent breast screening round in a diverse setting, where uptake is below the National and European target.

MATERIALS AND METHODS

Study design and management. The text-message reminder study (TMRS) was a two-arm, single-blind, RCT. The study was undertaken in the London Borough of Hillingdon (LBH) by the Hillingdon Primary Care Trust and the West of London Breast Screening Service (WoLBSS) between November 2012 and October 2013.

Study setting. The setting of our study, the LBH, is one that routinely fails to reach the European target of 70%, and, as with the rest of London, the breast screening service has found it difficult to encourage attendance here (Giordano *et al*, 2012; NHS Cancer Screening Programmes, 2012). In the previous screening round (2011–2012), uptake in the LBH fell short of the European target for acceptable participation at 67%. Similar to many London settings, the LBH is ethnically diverse, with 52.2% of residents being of white British ethnicity, and serves patients from a range of socioeconomic areas (Office for National Statistics, 2012).

Participants. The only eligibility criterion was appearance on the list of women (ages 47–53 years) who were due to be invited for their first routine breast screen in the LBH during the trial period (November 2012–October 2013). All interval cancer cases, GP referrals, self-referrals, male appointments and other non-routine appointments were excluded from the trial. The study was designed to test for a one-tailed difference in attendance of 5%, with 80% power and a 5% margin of error. A sample size of 1117 participants per condition was derived using a standard test for comparing two proportions (the χ^2 test with Yates' continuity correction), giving a total sample size requirement of 2234 (Witte and Witte, 2013).

Procedures. Although this study represented only a minor variation on routine practice, and some UK breast screening centres are already offering text-message reminders for routine appointments, women entered into the trial were informed that they were participants in a study and given the option to withdraw. Women received an information letter about the trial, which included an opt-out request slip, with their breast screening invitation. The trial was approved by the East Midlands National Research Ethics Service and the review boards of the participating organisations, which included the Local Medical Committee for Hillingdon, the Hillingdon Clinical Commissioning Group and the West London NHS Research and Development Group. The study was carried out in accordance with Good Clinical Practice guidelines and the Declaration of Helsinki and registered with the ClinicalTrials.Gov RCT database for transparency.

Participants were randomised via computerised pseudorandom allocation methods to one of two trial arms in a 1 : 1 ratio. All women were sent the standard breast screening invitation letter normally used by the WoLBSS 3–4 weeks before their appointment. All women included in the trial received the study letter and opt-out request slip, irrespective of which arm of the trial they had been assigned to.

Women assigned to the 'control arm' (1) were invited to breast screening in a standard office hour appointment, without reminder, as per usual care. Women assigned to the intervention arm (2) were also invited to a standard office hour appointment; however, they additionally received a text-message reminder 48 h

before their appointment, which included the time, date and venue of their appointment, as well as information about rescheduling if unable to attend (see Supplementary Information).

Women who cancelled or who did not attend (DNA) and did not reschedule their breast screening appointment were sent a 'DNA letter' by the WoLBSS, again, as per usual care. The DNA letter extends an open invitation to the non-attender, offering them an 8-week window to book an appointment. Participants in the text-message reminder arm (2) who DNA their breast screening examination also received an additional 'DNA text message', which repeated key information from the DNA letter about booking a new appointment (see Supplementary Information). Women in the intervention group who went on to schedule a new appointment were also sent a text-message reminder for that appointment (again, this was sent 48 h before the appointment).

Text-message reminders were delivered via iPlato patient care messaging (PCM), a cloud-based communication platform specifically developed for health services (iPlato, 2013). iPlato PCM was integrated with the clinical system of the participating GP practices included in the breast screening round plan for the duration of the study, which enabled automated reminders to be sent remotely using the mobile telephone numbers stored on the online server. No attempts to obtain mobile numbers for participants who had none recorded on the GP clinical system at the time of the study were made so as to ensure the ecological validity of the ITT.

The primary study end point was attendance at first appointment offered. The secondary end point was attendance 60 days after the first appointment was offered, to test whether any differences in attendance between groups were sustained after non-attenders had a chance to schedule a new appointment in response to the DNA letter/DNA text message. The primary interest was the difference in uptake between the two study arms.

Data collection and analysis. Breast screening end codes available on the Breast Cancer Screening System were used to verify attendance at the initial appointment and again 60 days thereafter. At the end of the study, the data was analysed using the statistical analysis software package: 'IBM SPSS Statistics 22'. Differences in attendance rates between the control and intervention arms and other binary or ordinal data were examined using the χ^2 test; odds ratios (ORs) and 95% confidence intervals (CIs) were also calculated (Witte and Witte, 2013), with attendance at breast screening as the outcome variable and assigned study group as the exposure. To explore possible variations of the impact of the intervention in relation to age and social deprivation, a logistic regression was carried out (Vernon *et al*, 1990). For this purpose, a composite indicator of area-based socioeconomic deprivation for each postcode sector was derived using the 2010 Index of Multiple Deprivation. Ethnic background was not included in the regression analysis owing to sparseness in the data (ethnicity was only known for those women who went to their appointment and provided it).

RESULTS

Between November 2012 and October 2013, a total of 2294 women were enrolled into the TMRS. Fifty-four (2.35%) returned an opt-out request and were subsequently removed from the trial. This resulted in a total of 2240 women being included, of whom 1118 were randomly allocated to the control arm (1) and 1122 to the text-message reminder arm (2). Figure 1 shows the CONSORT diagram for the flow of the participants through the trial. Table 1 shows the basic attributes of the study participants. All women included in the study were aged 47–53 years and in the prevalent round for breast screening. Participants were from a range of socioeconomic areas (Table 1).

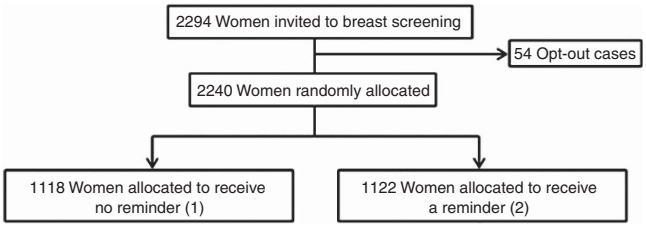

Figure 1. Basic design of the study and number of participants randomised.

Table 1. Description of the trial population

	n	%
Age (years)		
47–49	896	40
50–53	1344	60
Quintile of deprivation (IMD score)		
1 (0–9.87)	369	16.5
2 (9.88–14.60)	555	24.8
3 (14.61–21.61)	539	24.1
4 (21.62–33.49)	645	28.8
5 (33.50–100)	132	5.9
Mobile phone number recorded on GP system		
Mobile record on GP system	891	39.8

Intention-to-treat analysis. Attendance at first appointment offered was significantly higher among women assigned to the text-message reminder arm of the study than the no-reminder arm (64.35% *vs* 59.12%; $\chi^2 = 6.47$, OR = 1.26, 95% CI = 1.05–1.48, $P = 0.01$; Table 2A); attendance remained significantly higher at follow-up, 60 days after the initial appointment was offered (67.65% *vs* 62.88%; $\chi^2 = 5.61$, OR = 1.23, 95% CI = 1.04–1.47, $P = 0.02$; Table 2A). The number of women cancelling an appointment was also significantly higher in the text-message reminder arm of the trial than the no-reminder arm (5.44% *vs* 2.77%; $\chi^2 = 10.09$, OR = 2.02, 95% CI = 1.30–3.13, $P < 0.01$; Table 2A).

Accuracy and availability of patient mobile numbers (prevalence). Of the 1122 women assigned to the text-message reminder arm of the trial, only 456 (40.6%) had a mobile telephone number recorded on the GP clinical system (Table 3), of which 76 (17.6%) had expired and were no longer valid. The remaining 380 numbers were active, and only these women received a text-message reminder for their appointment. For the purposes of the per-protocol (PP) analysis, we compared uptake between women in the control arm of the trial who had a mobile number recorded on their GPs' clinical system, with women in the intervention arm who had a mobile number recorded on the GP clinical system. Because women in the control arm of the trial did not receive a text message as part of this study, we were unable to verify the validity of their mobile numbers, and consequently elected to include those in the intervention group who had an invalid mobile telephone number in the analysis, so as to avoid incurring any unnecessary bias.

Regression analysis: mobile prevalence among the study cohort. Overall, mobile prevalence of the TMRS cohort was 39.8% (Table 3). Mobile prevalence did not differ significantly between age groups (OR = 0.97, 95% CI = 0.82–1.16, $P = 0.74$; Table 3) nor between trial arms (OR = 1.08, 95% CI = 0.91–1.28, $P = 0.36$; Table 3), but was socioeconomically graded (OR = 1.25, 95% CI = 1.16–1.34, $P < 0.001$; Table 3), ranging from 48.0% in the least deprived quintile of areas (QoAs) to 31.1% in the most deprived.

Table 2A. Attendance at first appointment offered (primary end point), attendance within 60 days of first appointment offered (secondary end point) and per cent cancelling an appointment by trial arm: intention-to-treat analysis

Measure	Trial arm (1): routine invitation only ($n=1118$)	Trial arm (2): routine invitation with a text-message reminder ($n=1122$)	Difference χ^2
Primary end point: attendance (at first appointment offered)	59.12% (661)	64.35% (722)	6.47*
Secondary end point: attendance (within 60 days of first appointment offered)	62.88% (703)	67.65% (759)	5.61*
% Cancelled appointment	2.77% (31)	5.44% (61)	10.09*

*$P<0.05$.

Table 2B. Attendance at first appointment offered (primary end point), attendance within 60 days of first appointment offered (secondary end point) and per cent cancelling an appointment by trial arm: per-protocol analysis

Measure	Subgroup of the control population that had a mobile number recorded on the GP system ($n=435$)	Subgroup of the intervention population that had a mobile number recorded on the GP system ($n=456$)	Difference χ^2
Primary end point: attendance (at first appointment offered)	59.77% (260)	71.71% (327)	14.12**
Secondary end point: attendance (within 60 days of first appointment offered)	62.53% (272)	73.90% (337)	13.32**
% Cancelled appointment	2.30% (10)	6.80% (31)	10.27*

*$P<0.05$; **$P<0.001$.

Table 3. Mobile prevalence and logistic regression analysis

Comparisons	Mobile prevalence % (n)	OR (95% CI)	P-value
Overall prevalence	39.8% (891/2240)	—	—
Trial arm			
Control[a]	38.9% (435/1118)	—	—
Intervention	41% (456/1122)	1.08 (0.91–1.28)	0.36
Age group (years)			
47–49[a]	40.3% (361/896)	—	—
50–52	39.4% (530/1344)	0.97 (0.82–1.16)	0.74
Quintile of deprivation			
Quintile 1[a]	48.0% (177/369)	—	—
Quintile 2	44.5% (247/555)	0.85 (0.65–1.10)	0.34
Quintile 3	41.4% (223/539)	0.64 (0.43–0.96)	0.027
Quintile 4	31.6% (203/645)	0.56 (0.37–0.84)	0.004
Quintile 5	31.1% (41/132)	0.49 (0.32–0.74)	0.001

Abbreviations: CI = confidence interval; OR = odds ratio.
[a]Reference category.

Per-protocol analysis. In the PP analysis, attendance at the first appointment offered was significantly higher among women assigned to the text-message reminder arm of the study, who did have a mobile number recorded on their GPs' clinical system, than the no reminder arm (71.71% *vs* 59.77%; $\chi^2=14.12$, OR = 1.71, 95% CI = 1.29–2.26, $P<0.01$; Table 2B). In addition, attendance remained significantly higher at follow-up, 60 days after the initial appointment was offered (73.90% *vs* 62.53%; $\chi^2=13.32$, OR = 1.70, 95% CI = 1.28–2.26, $P<0.01$; Table 2B). The number of women cancelling an appointment was also significantly higher in the text-message reminder arm of the trial than the no-reminder arm (6.80% *vs* 2.30%; $\chi^2=10.27$, OR = 3.10, 95% CI = 1.50–6.40, $P<0.01$; Table 2B).

Regression analysis: attendance at first appointment. Overall, attendance at first appointment was 61.1% (Table 4). Attendance did not differ significantly between age groups (61% *vs* 62.2%; OR = 1.05, 95% CI = 0.884–1.25, $P=0.55$), but was, however, socially graded (OR = 0.80, 95% CI = 0.74–0.86, $P<0.001$), ranging from 70.2% among women living in the least deprived QoAs to 53.6% in the second most deprived (Table 4).

On an ITT basis, women living in the most deprived QoAs demonstrated the greatest benefits from receiving a text-message reminder before their first appointment, with an absolute increase in attendance at first appointment offered of 13.6%, a relative increase of 28% (Table 4), despite poor mobile records within this group (Table 3).

DISCUSSION

The results of this RCT are very clear. First, on an ITT basis, we found that sending women a text message reminding them of the time, day and venue of their first routine breast screening appointment, 48 h before the appointment, significantly increased attendance at the first appointment offered (64.35% *vs* 59.12%). Second, attendance remained significantly higher 60 days after non-attenders in both groups received a 'DNA letter', and in the text-message reminder group, an additional 'DNA text message' (67.65% *vs* 62.88%). On a PP basis, the benefits of receiving reminders for routine breast screening appointments by text message were even more apparent: 71.71% *vs* 59.77% at first appointment offered; 73.9% *vs* 62.5% within 60 days of the first appointment offered. From the PP analysis, we were able to identify that one of the major limitations of text-message reminders to promote the uptake of breast screening further as: 'suboptimal patient mobile telephone records'; out of 1122 participants assigned to the text-message reminder group, only 456 (40.6%) had a mobile telephone number recorded on their GPs' clinical system, and thereby sent a reminder.

Subgroup analyses by QoAs indicate that women living in the most deprived QoAs benefited the most from receiving a text-message reminder before their appointment, despite having the poorest mobile records. Among this group, attendance at the first appointment offered increased by 13.6% on an ITT basis (a relative increase of 28%). Increasing the attendance of women living in the most deprived areas is of particular importance, as these women are less likely to participate in screening, are more likely to engage in negative health behaviours (i.e. more likely to smoke, less likely to engage in regular exercise and more likely to eat less fruit and vegetables on average per day) and more likely to be diagnosed later with breast cancer with poorer prognosis for survival than

Table 4. Attendance and logistic regression analysis

Comparisons	Primary end point: attendance % (*n*)		OR (95% CI)	*P*-value
Overall attendance	61.7% (1383/2240)		—	—
Trial arm				
Control[a]	59.12% (661/1118)		—	—
Intervention	64.35% (722/1122)		1.25 (1.05–1.48)	0.01
Age group (years)				
47–49[a]	61.0% (547/896)		—	—
50–52	62.2% (836/1344)		1.05 (0.884–1.25)	0.55
Quintile of deprivation				
Quintile 1[a]	70.2% (259/369)		—	—
Quintile 2	67.4% (374/555)		0.88 (0.66–1.17)	0.37
Quintile 3	61.4% (331/539)		0.68 (0.51–0.90)	<0.01
Quintile 4	53.6% (346/645)		0.49 (0.37–0.64)	<0.01
Quintile 5	55.3% (73/132)		0.53 (0.35–0.80)	<0.01
Quintile of deprivation by trial arm				
	Control[a]	**Intervention**		
Quintile 1	73.4% (138/188)	66.9% (121/181)	0.73 (0.47–1.15)	0.18
Quintile 2	62.5% (173/277)	72.3% (201/278)	1.56 (1.09–2.23)	0.02
Quintile 3	59.6% (161/270)	63.2% (170/269)	1.16 (0.82–1.64)	0.42
Quintile 4	49.5% (157/317)	57.6% (189/328)	1.39 (1.02–1.89)	0.04
Quintile 5	48.5% (32/66)	62.1% (41/66)	1.75 (0.88–3.51)	0.11

Abbreviations: CI = confidence interval; OR = odds ratio.
[a]Reference category.

women from less deprived areas (Vernon *et al*, 1990; Sutton *et al*, 1994; Shohaimi *et al*, 2003, 2004; Bouchardy *et al*, 2006).

The findings of this study are comparable to those of previous trials investigating the use of more conventional and costly reminders to promote the uptake of breast screening (Taplin *et al*, 1999; Walton, 2009; Goelen *et al*, 2010). The finding that text-message reminders improve breast screening attendance is consistent with previous research investigating the use of text-message reminders to enhance attendance in other areas of health care, such as ophthalmology and paediatric dentistry (Guy *et al*, 2012); however, to our knowledge, the finding that reminders are particularly effective for increasing attendance among patients from deprived areas is completely novel (Guy *et al*, 2012), as is the finding that patients who receive a reminder by text message are more likely to telephone to cancel their appointment, rather than not attend.

Strengths and limitations. This is the first RCT examining the question of whether text-message reminders increase the uptake of breast cancer screening. As such, it is the first study to show that these are effective without being vulnerable to bias and confounding data present in previously published studies.

The setting of our study, the LBH, is one that routinely fails to reach the European target of 70%, serves an ethnically diverse population from a range of socioeconomic areas, and, as with the rest of London, the breast screening service has found it difficult to encourage attendance here. These results are likely to be generalisable to other London boroughs and international urban settings struggling to reach the 70% target.

By investigating the effectiveness of text-message reminders to improve the uptake of the first invitation population only, we are able to eliminate previous response to a breast screening invite as a confounding factor, as it has previously been described in the literature (Vernon *et al*, 1990). However, because we explored the effectiveness of text-message reminders to promote uptake of the first invitation population only, our results are not necessarily generalisable to the incident population. Having said this, previous research has demonstrated that women attending their first breast screening appointment are more likely to attend incident rounds of screening than women who DNA (Lakkis *et al*, 2011), thus enhancing uptake by the first invitation population is of particular interest and may have lasting benefit on participation throughout incident screening rounds.

The main limitation of this study is that it was not designed to test for differences in attendance between subgroups of the population. As such, the number of participants within each QoAs is too few for any definitive conclusions to be made, and such findings may not be robust. In addition, because participants were informed that they were being included in an experimental trial, the results may not be ecologically valid, as this information may have affected the participants' decision to attend mammography. To avoid any unnecessary demand characteristics arising in the intervention group, participants were told they were being included in an experimental trial, irrespective of whether they were assigned to receive a reminder or not.

Implications of results. The findings of this study have both national and international implications for the future practice of breast screening. Sending women a text message to remind them of the time, date and venue of their first breast screen could have a substantial impact on women's health through the early detection and treatment of benign and malignant breast disease, without impeding on the autonomy of the patient to make an informed choice. The study shows that text messages may be a promising intervention in increasing the uptake of women from deprived areas, thus reducing the social gradient. However, an RCT with a larger sample of participants with mobile numbers from varying quintiles is needed to test this hypothesis. Furthermore, text-message reminders could potentially save breast screening services money through improved efficiency (i.e. fewer missed appointments because of increased patient cancellations and increased uptake); however, a cost-effectiveness analysis is needed to confirm this. Text-message reminders are cheap, effective and easy to implement; improving GP practice records of patient mobile numbers would have benefits for screening as well as other clinic appointments, and it is plausible that text message reminders could be used to increase participation in other cancer screening programmes. Again, further research testing this hypothesis may be required.

CONCLUSION

Sending women a text message to remind them of the time, date and venue of their first routine breast screening appointment significantly

increased uptake without exacerbating social health inequalities. This information can be used to achieve an improved level of uptake, where uptake is below the National or International target.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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