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Prediction of initiation and cessation of breast feeding from late pregnancy to 16 weeks: The Feeding Your Baby (FYB) cohort study

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Key words: mobile phone, SMS text messaging, breastfeeding, prediction model, cohort

Abstract

Objective To derive prediction models for both initiation and cessation of breastfeeding using demographic, psychological and obstetric variables

Design A prospective cohort study

Setting Women delivering at Ninewells Hospital, Dundee, UK.

Data Sources Demographic data and psychological measures were obtained during pregnancy by questionnaire. Birth details, feeding method at birth and at hospital discharge were obtained from the Ninewells hospital database, Dundee, UK. Breastfeeding women were followed-up by text messages 2-weekly until 16 weeks or until breastfeeding was discontinued to ascertain feeding method and feeding intentions.

Participants
Pregnant women over 30 weeks gestation aged 16 years and above, living in Dundee, booked to deliver at Ninewells Hospital, Dundee and able to speak English.

Main outcome measure
Initiation and Cessation of breastfeeding

Results
From the total cohort of women at delivery (n = 344) 68% (95% CI 63% to 73%) of women had started breastfeeding at discharge. Significant predictors of initiating breastfeeding were older age, parity, greater intention to breastfeed from a Theory of Planned Behaviour (TPB)-based questionnaire, higher Iowa Infant Feeding Assessment Scale (IIFAS) score as well as living with a husband or partner. For the final model the AUROC was 0.967. For those who initiated breastfeeding (n = 233), the strongest predictors of stopping were low intention to breastfeed from TPB, low IIFAS score and non-managerial / professional occupations.

Conclusions
The findings from this study will be used to inform the protocol for an intervention study to encourage and support prolonged breastfeeding as intentions appear to be a key intervention focus for initiation. The predictive models could be used to identify women at high risk of not initiating and also women at high risk of stopping for interventions to improve longevity of breastfeeding.

Article Summary

Article Focus

- To identify antenatal factors which predict women who will initiate breastfeeding;
- Assess the critical time points for the discontinuation of breastfeeding;
- To identify the key antenatal and postnatal attributes and beliefs associated with continuation / cessation and develop predictive models

Key Messages

- Comprehensive assessment of intentions and breastfeeding via novel SMS text messaging facilitated accurate prediction of breast feeding initiation and cessation
- Psychological factors as well as previous experience were shown to be important predictors of cessation before 16 weeks in predictive algorithms indicating the potential for early intervention
- These findings challenge the current interpretation of the UNICEF guidelines and suggest that a full discussion about infant feeding options in the antenatal period, including asking about intentions, could be used to identify women at risk of early cessation of breastfeeding.

Strengths and Limitations of this study

A key strength was the accurate, validated, real-time and efficient measurement of method of infant feeding through SMS messaging. The study incorporated intentions and psychological factors based on the Theory of Planned Behaviour as predictors of initiation and cessation. This allowed the development of predictive algorithms and points to targeting the development and trialling of interventions. This was based on a relatively large cohort covering the antenatal period to 16 weeks postnatal. One limitation may be the lack of ethnic diversity in the study population which is reflected in the ethnic structure of Tayside.

Introduction

The short and long-term health benefits of breast feeding for both mother and child are well documented.[1-4] Consequently the current WHO recommendation is that infants should be exclusively breastfed for the first six months.[5] Most developed countries report that a minority of infants are exclusively breastfeeding at 6 months (40% Netherlands; 13% USA) and in the UK exclusive breastfeeding continued after 6 months in less than 1%.[6] There has been some success in the UK in improving the number of women who start breastfeeding: initiation rates of breastfeeding rose in Scotland from 63% in 2000 to 74% in 2010.[7] However targets to improve the rate of exclusive feeding at 6 – 8 weeks have proved more challenging. The Scottish Government aimed to increase exclusive breastfeeding at 6 – 8 weeks over a 4 year period to 33.3% by 2010/11[8], however in 2010/11 the rate remained unchanged at 26.5%.[9] Given the rapid decline in breastfeeding in the immediate postnatal period, the failure to meet government targets and follow WHO recommendations, more detailed information about current practices and attitudes and the potential for intervention is required.

Maternal demographics and previous breastfeeding experience are known to be associated with both initiation as well as duration of breastfeeding[9-10] however these variables are not amenable to behavioural change interventions. The measurement of attitudinal factors such as the Iowa Infant Feeding Assessment Scale (IIFAS)[11] has shown promise as a way of improving the accuracy of prediction of the initiation of breastfeeding behaviour. The IIFAS has been found to predict breastfeeding initiation in a variety of settings including USA[11], Australia[12], Scotland[13-14], Northern Ireland[15] and Romania.[16] However these studies have either only measured feeding at birth[14] , until discharge from hospital [14,15] or by retrospective maternal report.[16] The only study which prospectively followed women over a prolonged period was carried out in an area of high breastfeeding (94% initiation rate) and was biased by recruitment of women and measurement of baseline variables in the first 3 days after birth (rather than during pregnancy) by which time attitudes to infant feeding are likely to have been affected by experiences since birth.[12]

Hence there is little evidence for interventions based on psychological and attitudinal variables to improve breastfeeding outcomes. However a World Health Organisation programme (The Baby Friendly Initiative, BFI) to protect and support the initiation and continuation of breastfeeding by the implementation of evidence-based care in maternity hospitals is well-established.[17] Many hospitals and community settings strive to achieve 'UNICEF Baby Friendly Status' and there is some evidence that BFI accreditation can improve breastfeeding rates.[18-20] Guidance from UNICEF for Step 3 of BFI accreditation, in the context of information provision, 'strongly recommends that pregnant women are not merely asked a closed question about how they plan to feed their baby.' (UNICEF 2011, page 13).[21] This is to encourage a more open discussion to take place and to allow women to make a final decision about feeding method after delivery. While the recommendation does not explicitly preclude a discussion about feeding intentions in the antenatal period, the guidelines suggest that the documentation of antenatal feeding intention should be avoided. In practice this has been interpreted more stringently; intentions are not discussed at all.

Building on past research we designed an exploratory longitudinal study using mixed methodology, including use of the IIFAS[11] and psychological variables guided by the Theory of Planned Behaviour[22] captured during the antenatal period, to understand and predict women's initiation and duration of breastfeeding in an area of low breastfeeding commencement. Use of the MRC framework[23] informed the qualitative and quantitative components of the study enabling us to advance our understanding of women's intentions and attitudes towards infant feeding. The study used SMS text messaging, a novel method of data collection, to follow up women after delivery. The validity and reliability of the method of SMS text messaging has already been reported elsewhere[24] as well as some of the qualitative results.[25]

This paper reports the identification of i) antenatal factors which predict women who will initiate breastfeeding; ii) the critical time points for the discontinuation of breastfeeding; and iii) the key antenatal and postnatal attributes and beliefs associated with continuation / cessation

From these data a predictive model was derived to identify those at high risk of stopping breastfeeding. The findings from this study will inform the recruitment protocol and design of an intervention to encourage breastfeeding in a future RCT testing the intervention efficacy.

Methods

Design

A prospective cohort study of the method of infant feeding following delivery.

Participants

Pregnant women over 30 weeks gestation aged 16 years and above, living in Dundee, booked to deliver at Ninewells Hospital and able to speak English.

Measures

Five data collection points were used:

1. Baseline data - self-completed questionnaire, third trimester of pregnancy:

Background demographic:

- Age, cohabitation and residency status, years since leaving school and occupation. Socio-economic status derived from postcode and corresponding SIMD scores.

Obstetric measures:

- Expected Date of Delivery (EDD)
- Parity
- Previous infant feeding.

Psychological measures:

- *Iowa Infant Feeding Attitude Scale* (IIFAS)[11] a 17-item questionnaire with 5-point Likert scale response format from strongly agree to strongly disagree. Scores range from 17 – 85: higher score = more positive attitude to breastfeeding.
- *Theory of Planned Behaviour (TPB) questionnair*e study-specific 13 item questionnaire informed by the theories of planned behaviour and self-efficacy[22] assessed Attitude to breastfeeding (4 items), Social norm (2 items), Perceived Behavioural Control (PBC) (3 items) and Intention (4 items) each recorded on a 5-point scale from strongly agree to strongly disagree.

2. Delivery data - obtained through hospital records:

- Date of delivery, method of delivery, sex and weight of baby, method of infant feeding recorded at birth and at discharge from the hospital

Outcome variables:

3. Infant feeding collected by validated SMS text messages[24]:

Method(s) of infant feeding and future intentions, assessed after hospital discharge every 2 weeks using 2 text questions until response 'F' received to SMS1:

- SMS1. 'In the past 2 weeks how have you been feeding your baby?' (Answer options – only breast milk (O), both breast and formula milk (B), only formula milk (F)).
- SMS2. If 'only breast milk' or 'both breast and formula milk' – 'For how many more weeks do you plan to give your baby breast milk?'

4. Exit data (4 weeks after final SMS message):

- Method of infant feeding at study exit, problems with infant feeding, satisfaction with (breast) feeding support and satisfaction with feeding method(s) using 5-point Likert scale response format.

5. Focus groups and interviews with various sub-groups of women

Procedure

Women were approached in the last trimester of pregnancy at clinics by a Community Midwife (CM) or a Research Assistant (RA). Consent was obtained for contact details to be passed to the study team in the form of returned postcards; women were given a baseline questionnaire and consent form. These were returned to the study team following a recruitment phone call by the RAs. Study incentives were used to motivate and encourage CMs to recruit.

The hospital database was checked weekly and as participants delivered, their delivery and discharge details were sent to the RAs. Starting from 2 weeks after delivery RAs used standard web-based messaging tools to contact all participants by text to find out current feeding practices

and intentions (Figure 1). Web-based messaging services sent automated texts via computer and used a text number for responses. Contact continued by text message every 2 weeks until the baby was 16 weeks old, or until the response 'F' was received. Women with no mobile phone or who preferred not to receive text messages were contacted by the RA on their home phone.

The 'end' point for gathering text data was 2 weeks after delivery for women who started or who changed to formula feeding before 2 weeks; and on discontinuation of any breastfeeding or when the baby was 16 weeks old for the rest. Four weeks after the 'end' point women were phoned to gather final data (using an exit phone questionnaire). After the exit interview women were sent a letter thanking them and a £10 gift voucher.

During the exit interview participants were invited to take part in a focus group or interview. These were organised with sub-groups of women representing a range of feeding experiences. Groups were kept as homogenous as possible and were held in a central location in Dundee. One to one interviews were carried out in the participant's home or in University premises. Focus groups and interviews continued until data saturation had been reached (topic guide - Appendix 1). Expenses and a 'thank you' gift voucher were given for participation in this phase. Results are reported elsewhere.

Statistical Analysis

Data were analysed using SAS version 9.2. Descriptive data are presented as % (frequency) for categorical variables, and mean (95% CI) for continuous variables.

The total IIFAS Score and the sub-scores for the TPB variables were calculated from the questionnaires. Non-normally distributed variables were converted to categorical variables when there was no viable transformation.

Baseline data were tested for correlations with duration of breastfeeding. ANOVA and Chi-Square tests were performed to test for significant associations of baseline variables with duration of breastfeeding and intention to breastfeed, and to examine differences between groups.

The reliability of the text message responses (method of feeding) was checked by repeat-texting a random subset of 50 participants the next day. Validity was checked by phoning a random subset of 50 participants on the same day as their text response and asking them the same questions verbally. The results, previously reported, demonstrated excellent reliability and validity.[24]

Logistic regression modelling was implemented to assess predictors of initiating breastfeeding and the results expressed as Odds Ratios (OR) and their 95% CI.

For those who initiated breastfeeding univariate associations between the duration of any and exclusive breastfeeding with baseline variables were performed using the logrank test for each of the baseline variables. Variables with a univariate significance level of at least 0.3 were chosen for potential inclusion in model building.

Cox Proportional Hazards models were then built for all combinations of variables, utilizing both a forward and stepwise selection model including all variables. Models were then assessed for goodness of fit using the AIC and the best-fit model chosen. These models were utilised to predict the outcome of any breastfeeding and exclusive breastfeeding.

Model performance was assessed by estimation of the c-statistic, a measure of discrimination as well as the Integrated Discrimination Index[26] to demonstrate the most important variables determining discrimination utilising the SAS macro %rocplus (http://mayoresearch.mayo.edu/mayo/research/biostat/sasmacros.cfm). Assessment of calibration was also carried out using methods suitable for censored data. Analyses were implemented in SPSS (version 18) and SAS v 9.2 (SAS Institute, Cary, NC, USA).

Sample size, Recruitment and Attrition

The study aimed to recruit 350 women over an 8 month period, giving a recruitment rate of 35%. Of these approximately 224 (64%) would start breastfeeding (local Maternity Database figures from 2007), and 133 (38%) will still be breastfeeding at 6 - 8 weeks.[9] In considering predictors of maintaining breast feeding at 6 - 8 weeks from birth, and approximately 130 events, there would be 80% power to detect Hazard Ratio ≥ 1.6 in a Cox regression model.

Between November 2009 and June 2010 a total of 639 postcards were received by the study team. From these, 355 women were fully consented and included in the study (55.6% of postcards received), which exceeded our target of 350 women (Figure 1). The SIMD profile of consented women broadly tracked the profile of all women who delivered in Dundee in 2009. A total of 292 women were followed up to the exit questionnaire (82.3% of consented women).

At exit 152 women were asked about participating in a focus group or interview and 138 expressed an interest (91%) Of these, 38 took part in one of seven focus groups and 40 were interviewed individually (78 in total, 56% of those interested, 22% of total sample). The results of the qualitative analysis are reported elsewhere[25].

SMS messages for collection of data about feeding method

To manage the high number of automated SMS messages a computer schedule was created for the study (Figure 2). A total of 2738 text message responses were received via this automated SMS message scheduler. Data from 42 women were gathered by phone call on 114 occasions when the SMS system was unavailable. The SMS messaging service package incurred a small cost to participants: some participants may have been unable to respond if they had no credit on their phone. Two women were contacted on their home phone only: one had no mobile phone while the other preferred not to receive text messages.

Baseline Characteristics

Three hundred and fifty five women were included in the study at baseline. Of these 344 (96.9%) had information on feeding status at delivery and prediction of initiating breast feeding was based on this cohort (Table 1). Baseline psychological measures (IIFAS score and TPB) are included in Table 1.

Prediction of Initiating Breastfeeding

At delivery 67.7% (95% CI 62.8% to 72.6%) of women had started breastfeeding out of those with feeding data (n = 344). Significant independent predictors of initiating breastfeeding were older age, parity, greater intention to breastfeed from the TPB questionnaire, higher IIFAS score as well as living with a husband or partner as shown in table 2. For the final logistic model the AUROC was 0.982 (95% CI 0.971 to 0.993) and calibration was good with Hosmer-Lemeshow test of p = 0.354. A score for estimation of the probability of initiation can be easily constructed using this final equation as shown in Appendix 1. This score can be utilised as a Clinical Prediction Rule (CPR) to identify women with low probability of initiating breastfeeding and interventions can be developed that are focussed on this group. Estimation of the IDI showed that Intention to Breastfeed with an IDI of 0.212 (p< 0.001) was the strongest contributor to discrimination of initiating breastfeeding and entered the model first, followed by the IIFAS score with IDI = 0.024 (p = 0.034).

Duration of breastfeeding

For those with feeding data (n = 344) Kaplan-Meier curves were fitted for exclusive breastfeeding (response 'only breast milk' to text question) and any breast milk (response 'both breast and formula milk' to text question) for each of the three subgroups defined by previous breastfeeding and parity. The duration of breastfeeding at various time points were derived (Figures 3a and b). These show that parous women who have previous experience of breastfeeding are most likely to start breastfeeding, more likely to continue to breastfeed exclusively and are slowest to discontinue any breastfeeding. In this experienced group, at 16 weeks 52.6% recorded any breastfeeding (33.0% exclusive). In contrast, parous women with no previous breastfeeding experience are least likely to start breastfeeding with a baseline of approximately 20%. In this group at 16 weeks only 5.0% were continuing with any breastfeeding (3.9% exclusive).

Prediction of stopping breastfeeding

This analysis considered only those who initiated breastfeeding (n = 233) and what factors predicted cessation. As in Figure 3 analyses were carried out for both exclusive breastfeeding and any breastfeeding. The final model was chosen using the AIC and the best fit model comprised the variables: Previous breastfeeding, Intention to breastfeed, Total IIFAS score and Major occupational group. Neither Age nor SIMD were included in the final model as these are strongly correlated with occupation and previous breastfeeding. Those women who initiated breastfeeding and had higher IIFAS scores were highly significantly less likely to stop breastfeeding whether 'exclusive' or 'any' breastfeeding (Table 4). Those with higher intention scores had much greater duration than those with lower intention scores and were significantly associated with lower risk of stopping 'exclusive' or 'any' breastfeeding, with a 29% and 43% lower risk respectively.
In the final model there was also a trend across the occupations with lower breastfeeding in the routine and manual occupations. Parity was not such a strong predictor once intentions and IOWA score were included. The two most significant predictors of not stopping (for both exclusive and any breastfeeding) were high intention score and high IIFAS score (Table 4). The c-statistics for both models were c = 0.649 (95% CI 0.605 to 0.693) and c = 0.689 (95% CI 0.641 to 0.875) for 'exclusive' and 'any' breastfeeding respectively. In these models the IDI was highest for the IIFAS with IDI=0.077 for 'exclusive' and IDI=0.074 for 'any' breastfeeding respectively. In contrast, although a statistically significant predictor, the IDI was negligible for intentions from the TPB questionnaire.

Discussion

As far as can be established this is the first study of infant feeding in the weeks following birth using antenatal data gathered prospectively in real time in a large cohort. In order to achieve this, a novel method of collecting data via SMS text messaging was successfully developed, validated and utilised. This data collection method was demonstrated to have excellent reliability and validity.[24]

A sample with a broadly similar overall SIMD profile to pregnant women in Dundee in 2009 was recruited with good representation from deprived areas which is often a problem in studying breastfeeding. Excellent follow-up through each phase of the study was achieved, and the quantitative phase was complemented by a large amount of qualitative data gathered from a diverse sample of participants with a range of feeding experiences.[25]

Our cohort's figures for breastfeeding are broadly consistent with national and local rates of breastfeeding. 68% of the sample started breastfeeding compared to local figures 59% (local maternity database, 2009). Over the 6 – 8 weeks period 29.1% – 33.9% were exclusively breastfeeding and 44.1% – 48.3% were offering some breast milk. In comparison, Dundee City figures were: exclusive = 23.3%, and any = 33.4%; while the exclusive breastfeeding figure at 6-8 weeks for Scotland was 26.5%.[27] The generally higher rates at all time-points may be accounted for by the slightly higher numbers of women in our study from more affluent areas, while the national Infant Feeding Survey data is based on retrospective reports.[7] It is also possible that our figures are more accurate as they are based on prospective real-time texts from the women. Overall, the consistency with known official statistics lends added validity to our results.

The mean score on the IIFAS (58.8, SD 9.36) was similar to that reported by de la Mora (1999)[11] The dichotomous nature of the 'Intentions' variable suggests that in the latter stages of pregnancy most women are clear about how they plan to feed their baby, with only a few being undecided. As in previous studies of breastfeeding using the TPB, intentions were explained by PBC, attitudes and the IOWA score with demographic variables accounting for less of the variance.[11, 28,29]

The Kaplan-Meier plots show the expected pattern of breastfeeding cessation, with the steepest drop-off occurring in the first couple of weeks after birth in all women for exclusive breastfeeding. However, large differences in the duration of breastfeeding could be observed between groups. In particular parous women with no previous breastfeeding experience stopped very quickly after birth, while primiparous women showed a similar pattern of duration to those parous women who did have previous breastfeeding experience so prior experience of breastfeeding is a strong predictor. This is similar to the findings of the recent Scottish Infant Feeding Survey data from 2010.[7]

In the prediction models, while demographic measures were important, the measures of intention (TPB) and attitude to breastfeeding (IIFAS score) were the strongest predictors of both initiation and stopping breastfeeding. However, intention was stronger for initiating breastfeeding, while attitude was stronger for persevering with breastfeeding. This has important clinical implications. We suggest that the current interpretation of the UNICEF Baby Friendly guidelines should be revisited. Our findings indicate that a discussion with women about their intentions, in combination with an exploration of their attitude to formula feeding and breastfeeding (perhaps through use of the IIFAS) could be a powerful way of identifying those women who might need more help and support with both initiating and persevering with breastfeeding. The findings also lend weight to the targeting of younger women and women from lower socioeconomic backgrounds both for extra encouragement to breastfeed and for additional breastfeeding support.

Importance to NHS and possible implementation

Breastfeeding is known to have significant short and long-term health benefits for both mother and infant. Increasing the number of breastfed babies through targeted interventions has potential to prevent future ill-health, save the NHS money and is congruent with Government policy.[30-32] The findings of this study can be used both to identify women who need additional support and to inform the design of interventions to promote and support breastfeeding. Antenatal and public health interventions should aim to improve attitudes to breastfeeding generally and improve women's confidence in their ability to breastfeed. There is a need to target primigravidae during pregnancy and in the early postnatal days and weeks: as success with breastfeeding in the first pregnancy is likely to lead to more chance of feeding successfully in subsequent pregnancies. Parous women with no previous breastfeeding experience need the most support as they are most likely to give up quickly. The use of antenatal measures of intention and attitude to breastfeeding might be useful to identify women who are likely to need more support in the early days and weeks after delivery. Increased levels of support, perhaps from other women who have successfully breastfed might be an effective intervention strategy.

Future research

This study has followed phase 1 of the MRC process, that is, collection of initial data and determining predictors of outcome.[23] The next stage will be to develop a complex interventions based on these findings both to improve rates of initiation of breastfeeding and to provide targeted support to those who commence breastfeeding. In addition, the discriminative ability for initiation was excellent but only moderate for stopping breastfeeding, while intention (TPB) was most important for initiating and attitude (IIFAS) most important for persevering with breastfeeding. This suggests there may be further factors in stopping that could be explored.

This study demonstrated the benefits of SMS messaging to collect data and so can easily be used in other studies to collect similar data. In addition text messaging may have potential as a cost-effective and convenient way to provide health information and support messages as part of a complex intervention. These suggestions could apply to breastfeeding, as well as having application in many other health arenas.

Conclusions

This landmark study used SMS text messaging to gather real-time data on infant feeding from birth to 16 weeks postnatal. It provides the most detailed and comprehensive data on the form and method of infant feeding. The results are consistent with Scottish national figures, hence enhancing the validity of our findings.

The construct of 'Intentions' (from the TPB) and a measure of attitude to breastfeeding (the IIFAS score) have been shown to be important in predicting future infant feeding behaviour, as well as socioeconomic background. Primigravidae and parous women with no previous breastfeeding experience are likely to need the most support as these groups are least likely to commence breastfeeding, and most likely to stop early.

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Contributors: PTD designed the study, supervised the statistical analysis, drafted the final paper and approved the final version; JD designed the study, involved in design of collection tools, commented on drafts and approved the final version; AS designed the study, contributed to collection tools, commented on drafts and approved the final version; PR carried out the statistical analysis, contributed to drafts and approved the final version; EM-H involved in design of collection tools, collected data, commented on drafts and approved the final version; GK involved in design of collection tools, collected data, commented on drafts and approved the final version; JW designed the study, supervision of the data collection, commented on drafts and approved the final version; HMW designed the study, involved in design of data collection tools, supervised the study as PI, commented on drafts and approved the final version.

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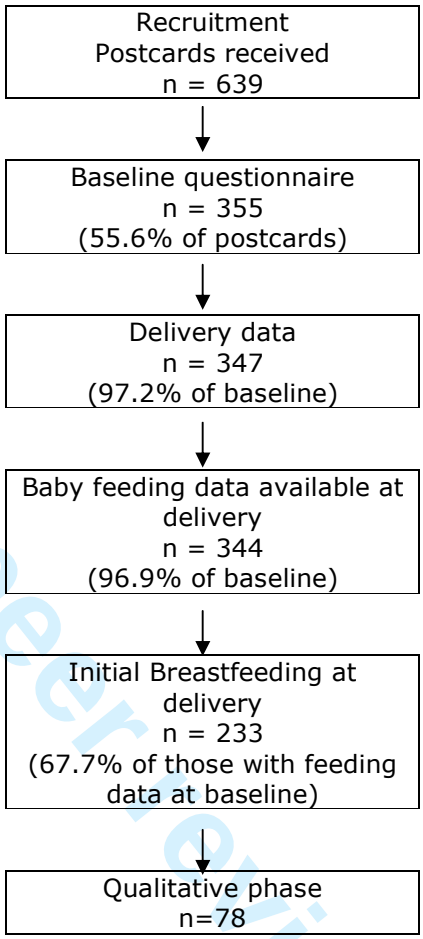

Figure 1: Flow chart of participant recruitment

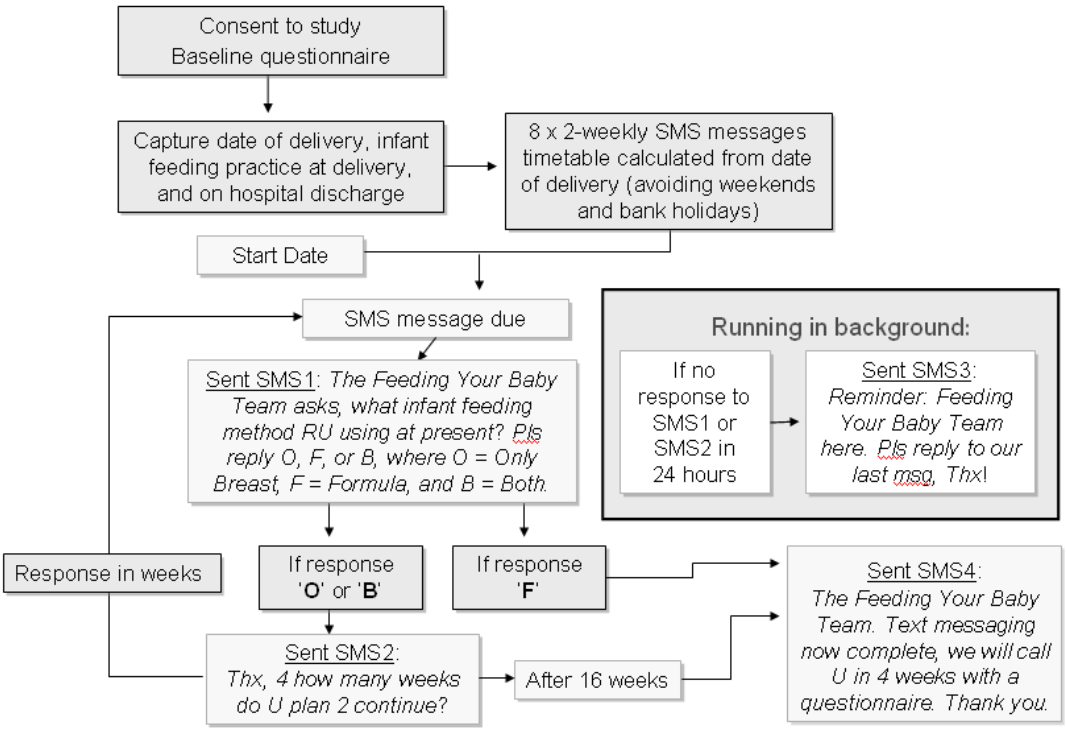

Figure 2: Schedule of SMS messages

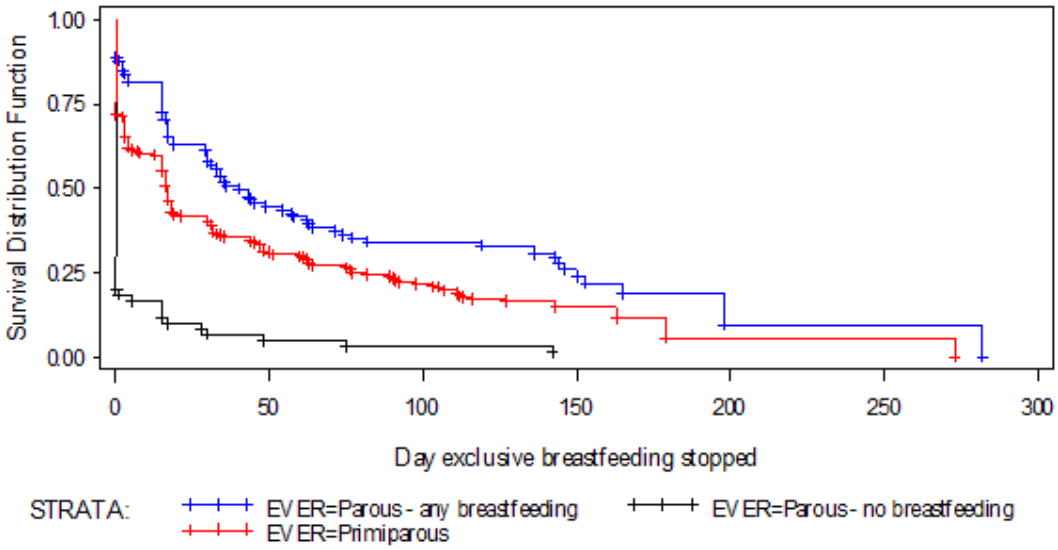

Figure 3a: Time to end of exclusive breastfeeding (WHO) in all women

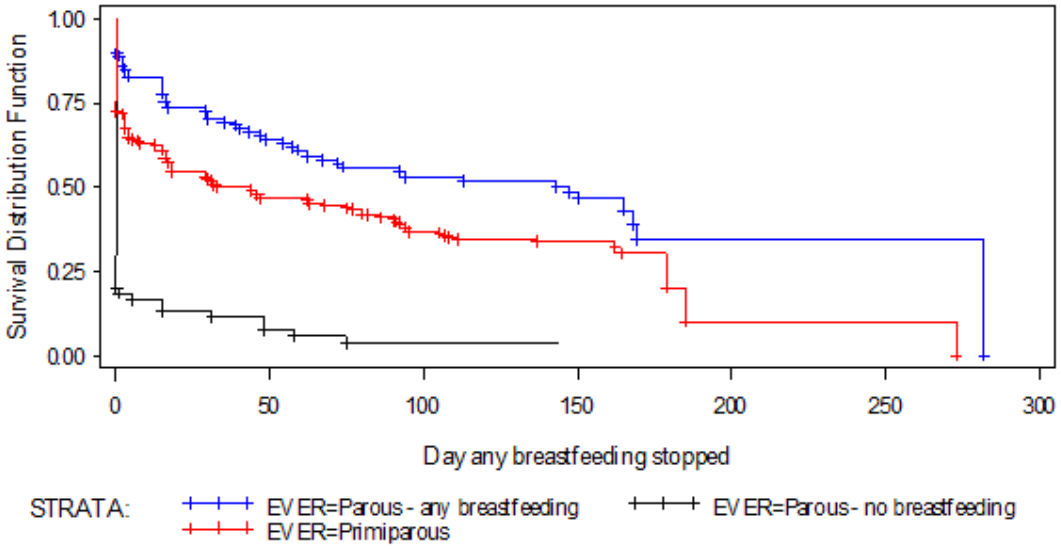

Figure 3b: Time to end of any breastfeeding in all women

Table 1: Characteristics of Women by feeding method at Baseline delivery (n = 344)

	Women who did not initiate breastfeeding (n = 111) *Mean (SD) or **% (N)	Women who initiated breastfeeding (n = 233) Mean (SD) or % (N)
Gestation at baseline (weeks)*	32.5 (5.28)	31.7 (5.91)
Age (years)*	26.6 (6.21)	29.6 (5.42)
Years since leaving school*	15.9 (2.83)	17.9 (1.83)
Relationship status**		
Single	22.5 (25)	5.2 (12)
Married	29.7 (33)	55.8 (130)
With partner	46.8 (52)	38.6 (90)
Other	0.0 (0)	0.4 (1)
Missing	0.9 (1)	0.0 (0)
Living status**		
On own	17.1 (19)	2.6 (6)
With husband or partner	58.6 (65)	89.3 (208)
With parents	15.3 (17)	5.2 (12)
Other	6.3 (7)	1.3 (3)
Missing	2.7 (3)	1.7 (4)
Parity**		
First child	45.0 (50)	54.5 (127)
Second child	30.6 (34)	29.2 (68)
Third child or more	21.6 (24)	12.5 (29)
Missing	2.7 (3)	3.9 (9)
Previous breastfeeding experience		
Primiparous	47.7 (53)	58.4 (136)
Parous – no previous breastfeeding experience	43.2 (48)	5.2 (12)
Parous – previous breastfeeding experience	9.0 (10)	36.5 (85)
Missing	0.0 (0)	0.0 (0)
SIMD Quintile**		
Quintile 1 (most deprived)	47.7 (53)	30.5 (71)
Quintile 2	20.7 (23)	10.3 (24)
Quintile 3	8.1 (9)	12.4 (29)
Quintile 4	15.3 (17)	30.9 (72)
Quintile 5 (most affluent)	7.2 (8)	15.9 (37)
Missing	0.9 (1)	0.0 (0)
Occupations**		
Higher managerial, administrative and professional occupations	24.3 (27)	60.1 (140)
Intermediate occupations	16.2 (18)	12.0 (28)
Routine and manual occupations	18.9 (21)	11.6 (27)
Not in paid employment	34.2 (38)	15.5 (36)
Missing	6.3 (7)	0.9 (2)
Total IIFAS score	49.8 (6.29)	62.8 (7.46)

	Women who did not initiate breastfeeding (n = 111) *Mean (SD) or **% (N)	Women who initiated breastfeeding (n = 233) Mean (SD) or % (N)
TPB score 1: Attitude to breastfeeding	2.6 (0.76)	4.2 (0.68)
TPB score 2: Subjective norm	2.2 (0.3)	3.3 (1.0)
TPB score 3: Perceived behavioural control	2.6 (0.84)	3.8 (0.76)
TPB score 4: Intention to breastfeed	1.7 (0.96)	4.4 (0.96)
TPB score 4: Intention to breastfeed categorical (% (number)		
No breastfeeding intended	60.4 (67)	3.0 (7)
Undecided	38.7 (43)	45.1 (105)
Definite breastfeeding intended	0.0 (0)	51.9 (121)
Missing	0.9 (1)	0.0 (0)

Table 2 Results of Multiple Logistic Regression of factors associated with initiating breast feeding (n = 344)

Variable	OR (95% CI)	Chi Squared	p-value
Age (years)	1.114 [1.003 to 1.237]	4.077	0.044
Parity			
Parous - no breastfeeding vs Primiparous	0.212 [0.052 to 0.863]	7.798	0.005
Parous - any breastfeeding vs Primiparous	2.015 [0.547 to 7.426]	5.294	0.021
TPB score 4: Intention to breastfeed	4.668 [2.909 to 7.491]	40.759	<.0001
Total IIFAS Score	1.173 [1.058 to 1.300]	9.238	0.002
Living Status			
With husband or partner vs On own	13.862 [2.241 to 85.722]	10.806	0.001
With parents vs On own	3.545 [0.379 to 33.171]	0.381	0.537
Other vs On own	0.554 [0.021 to 14.686]	1.542	0.214

Table 3: Predicted breastfeeding rates at different timepoints according to parity and any breastfeeding of previous children (from SMS data n = 344)

		Exclusive Breastfeeding		Any Breastfeeding	
	Time	%	CI	%	CI
All	Baseline	67.6	[0.62 to 0.72]	68.2	[0.63 to 0.73]
	6 weeks	33.9	[0.29 to 0.39]	48.3	[0.43 to 0.53]
	8 weeks	29.1	[0.24 to 0.34]	44.1	[0.39 to 0.49]
	16 weeks	20.4	[0.16 to 0.25]	34.5	[0.29 to 0.40]
	Exit Interview	3.3	[0.00 to 0.12]	8.5	[0.01 to 0.27]
Primiparous	Baseline	71.7	[0.65 to 0.78]	72.3	[0.65 to 0.78]
	6 weeks	34.3	[0.28 to 0.41]	50.1	[0.43 to 0.57]
	8 weeks	29.3	[0.23 to 0.36]	46.7	[0.39 to 0.54]
	16 weeks	18.8	[0.14 to 0.25]	34.5	[0.28 to 0.41]
	Exit Interview	5.8	[0.01 to 0.18]	10.1	[0.01 to 0.32]
Parous - no previous breastfeeding	Baseline	20.0	[0.11 to 0.31]	18.3	[0.10 to 0.29]
	6 weeks	5.0	[0.01 to 0.13]	11.7	[0.05 to 0.21]
	8 weeks	5.0	[0.01 to 0.13]	5.8	[0.02 to 0.14]
	16 weeks	3.9	[0.01 to 0.13]	5.0	[0.01 to 0.12]
	Exit Interview	1.7	[0.00 to 0.08]	3.9	[0.01 to 0.12]
Parous - with previous breastfeeding experience	Baseline	88.8	[0.81 to 0.94]	89.8	[0.82 to 0.94]
	6 weeks	46.6	[0.36 to 0.56]	67.2	[0.57 to 0.76]
	8 weeks	41.4	[0.32 to 0.51]	62.0	[0.52 to 0.71]
	16 weeks	33.0	[0.24 to 0.42]	52.6	[0.42 to 0.62]
	Exit Interview	9.3	[0.01 to 0.28]	34.6	[0.21 to 0.49]

Table 4a: Final model using Cox Regression to predict stopping 'Exclusive' breastfeeding (n = 233)

Variable	Hazard Ratio	CI	p-value
Parous - any breastfeeding	0.873	[0.63 to 1.21]	0.4103
Parous - no breastfeeding	0.809	[0.41 to 1.58]	0.5367
Primiparous	1.000		
Higher managerial, administrative and professional occupations	0.726	[0.46 to 1.15]	0.1716
Intermediate occupations	0.789	[0.44 to 1.41]	0.4246
Routine and manual occupations	0.880	[0.50 to 1.56]	0.6601
Not in paid employment	1.000		
TPB score 4: Intention to breastfeed (High vs low)	0.715	[0.53 to 0.97]	0.0317
Total IIFAS Score (+ 10 units)	0.553	[0.43 to 0.71]	<.0001

Table 4b: Final model using Cox Regression to predict stopping 'Any' breastfeeding (n=233)

Variable	Hazard Ratio	CI	p-value
Parous - any breastfeeding	0.829	[0.56 to 1.22]	0.3426
Parous - no breastfeeding	1.079	[0.51 to 2.26]	0.8403
Primiparous	1.000		
Higher managerial, administrative and professional occupations	0.602	[0.37 to 0.99]	0.0457
Intermediate occupations	0.622	[0.32 to 1.21]	0.1619
Routine and manual occupations	0.714	[0.37 to 1.39]	0.3215
Not in paid employment	1.000		
TPB score 4: Intention to breastfeed (High vs Low)	0.569	[0.39 to 0.82]	0.0026
Total IIFAS Score (+ 10 units)	0.549	[0.41 to 0.74]	<.0001

Appendix 1

Logistic model for prediction of initiation of breastfeeding

The probability of initiating breastfeeding can be derived from the model in Table 2, where:
Prob = 1 / (1 + exp (-βx)).

Estimate the linear predictor βx =
-17.1114
+ 0.1078 x age
-1.2663 x Ever (Parous-no breastfeeding=1)
+ 0.9835 x Ever (Parous – any breastfeeding=1)
+ 1.8032 x Living (with husband or partner=1)
+ 0.4395 x Living (with parents=1)
-1.4168 x Living (with other=1)
+ 0.1597 x IIFAS
+ 1.5407 x Intentions

Calculate exp (-βx),
Then Prob. = 1 / (1 +exp (-βx))

Final Model: Initiation of Breastfeeding

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	p-value
Intercept		1	-17.1114	3.4021	25.2967	<0.0001
Age		1	0.1078	0.0534	4.0770	0.0435
Parity	Parous - no breastfeeding	1	-1.2663	0.4535	7.7977	0.0052
	Parous - any breastfeeding	1	0.9835	0.4274	5.2943	0.0214
Living	With husband or partner	1	1.8032	0.5485	10.8058	0.0010
	With parents	1	0.4395	0.7121	0.3809	0.5371
	Other	1	-1.4168	1.1411	1.5417	0.2144
IIFAS		1	0.1597	0.0525	9.2383	0.0024
Intentions		1	1.5407	0.2413	40.7592	<0.0001

Derivation of points from the final model (n=344) for clinical use. Each question is based on the factors in the prediction model; Intentions (TPB), IIFAS score, living arrangements, parity and age. ($B^* = 0.1078$)

Variable		B	$\beta (W_{ij} - W_{iREF})$	Points = $\beta (W_{ij} - W_{iREF})/B^*$
Intercept		-17.1114		-159
Intentions (TPB)	+1	1.5407		14
IIFAS score	+1	0.1597		1.5
Age	+1 year	0.1078		1
Parous – no breastfeeding		-1.2663	-1.2663	-12
Parous – any breastfeeding		0.9835	0.9835	9
Primiparous		0	0	0

Living with husband or partner	**1.8032**	**1.8032**	**17**
Living with parents	**0.4395**	**0.4395**	**4**
Living with Other	**-1.4168**	**-1.4168**	**-13**
On own	**0**	**0**	**0**

*Sullivan LM, Massaro JM, D'Agostino RB Sr. Presentation of multivariate data for clinical use: The Framingham Study risk score function Statist Med 2004; 23: 1631-1660.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **YES**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **YES**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **YES**
Objectives	3	State specific objectives, including any prespecified hypotheses **YES**
Methods		
Study design	4	Present key elements of study design early in the paper **YES**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **YES**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up **YES**
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed **NA**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **YES**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **YES**
Bias	9	Describe any efforts to address potential sources of bias **YES**
Study size	10	Explain how the study size was arrived at **YES**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **YES**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **YES**
		(*b*) Describe any methods used to examine subgroups and interactions **YES**
		(*c*) Explain how missing data were addressed **NA**
		(*d*) If applicable, explain how loss to follow-up was addressed **NA**
		(*e*) Describe any sensitivity analyses **NA**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **YES**
		(b) Give reasons for non-participation at each stage **YES**
		(c) Consider use of a flow diagram **Yes**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **YES**
		(b) Indicate number of participants with missing data for each variable of interest **NA**
		(c) Summarise follow-up time (eg, average and total amount) **YES**
Outcome data	15*	Report numbers of outcome events or summary measures over time **YES**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were

		adjusted for and why they were included **YES**
		(*b*) Report category boundaries when continuous variables were categorized **YES**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **YES**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **YES**
Discussion		
Key results	18	Summarise key results with reference to study objectives **YES**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **YES**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **YES**
Generalisability	21	Discuss the generalisability (external validity) of the study results **YES**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **YES**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Prediction of initiation and cessation of breast feeding from late pregnancy to 16 weeks: The Feeding Your Baby (FYB) cohort study

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Prediction of initiation and cessation of breast feeding from late pregnancy to 16 weeks: The Feeding Your Baby (FYB) cohort study

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Key words: mobile phone, SMS text messaging, breastfeeding, prediction model, cohort

Abstract

Objective To derive prediction models for both initiation and cessation of breastfeeding using demographic, psychological and obstetric variables

Design A prospective cohort study

Setting Women delivering at Ninewells Hospital, Dundee, UK.

Data Sources Demographic data and psychological measures were obtained during pregnancy by questionnaire. Birth details, feeding method at birth and at hospital discharge were obtained from the Ninewells hospital database, Dundee, UK. Breastfeeding women were followed-up by text messages 2-weekly until 16 weeks or until breastfeeding was discontinued to ascertain feeding method and feeding intentions.

Participants
Pregnant women over 30 weeks gestation aged 16 years and above, living in Dundee, booked to deliver at Ninewells Hospital, Dundee and able to speak English.

Main outcome measure
Initiation and Cessation of breastfeeding

Results
From the total cohort of women at delivery (n = 344) 68% (95% CI 63% to 73%) of women had started breastfeeding at discharge. Significant predictors of initiating breastfeeding were older age, parity, greater intention to breastfeed from a Theory of Planned Behaviour (TPB)-based questionnaire, higher Iowa Infant Feeding Assessment Scale (IIFAS) score as well as living with a husband or partner. For the final model the AUROC was 0.967. For those who initiated breastfeeding (n = 233), the strongest predictors of stopping were low intention to breastfeed from TPB, low IIFAS score and non-managerial / professional occupations.

Conclusions
The findings from this study will be used to inform the protocol for an intervention study to encourage and support prolonged breastfeeding as intentions appear to be a key intervention focus for initiation. The predictive models could be used to identify women at high risk of not initiating and also women at high risk of stopping for interventions to improve longevity of breastfeeding.

Article Summary

Article Focus

- To identify antenatal factors which predict women who will initiate breastfeeding;
- Assess the critical time points for the discontinuation of breastfeeding;
- To identify the key antenatal and postnatal attributes and beliefs associated with continuation / cessation and develop predictive models

Key Messages

- Comprehensive assessment of intentions and breastfeeding via novel SMS text messaging facilitated accurate prediction of breast feeding initiation and cessation
- Psychological factors as well as previous experience were shown to be important predictors of cessation before 16 weeks in predictive algorithms indicating the potential for early intervention
- These findings challenge the current interpretation of the UNICEF guidelines and suggest that a full discussion about infant feeding options in the antenatal period, including asking about intentions, could be used to identify women at risk of early cessation of breastfeeding.

Strengths and Limitations of this study

A key strength was the accurate, validated, real-time and efficient measurement of method of infant feeding through SMS messaging. The study incorporated intentions and psychological factors based on the Theory of Planned Behaviour as predictors of initiation and cessation. This allowed the development of predictive algorithms and could allow the development and trialling of targeted interventions. This was based on a relatively large cohort covering the antenatal period to 16 weeks postnatal. One limitation may be the lack of ethnic diversity in the study population which is reflected in the ethnic structure of Tayside.

Introduction

The short and long-term health benefits of breast feeding for both mother and child are well documented.[1-4] Consequently the current WHO recommendation is that infants should be exclusively breastfed for the first six months.[5] Most developed countries report that a minority of infants are exclusively breastfeeding at 6 months (40% Netherlands; 13% USA) and in the UK exclusive breastfeeding continued after 6 months in less than 1%.[6] There has been some success in the UK in improving the number of women who start breastfeeding: initiation rates of breastfeeding rose in Scotland from 63% in 2000 to 74% in 2010.[7] However targets to improve the rate of exclusive feeding at 6 – 8 weeks have proved more challenging. The Scottish Government aimed to increase exclusive breastfeeding at 6 – 8 weeks over a 4 year period to 33.3% by 2010/11[8], however in 2010/11 the rate remained unchanged at 26.5%.[9] Given the rapid decline in breastfeeding in the immediate postnatal period, the failure to meet government targets and follow WHO recommendations, more detailed information about current practices and attitudes and the potential for intervention is required.

Maternal demographics and previous breastfeeding experience are known to be associated with both initiation as well as duration of breastfeeding[9-10] however these variables are not amenable to behavioural change interventions. The measurement of attitudinal factors such as the Iowa Infant Feeding Assessment Scale (IIFAS)[11] has shown promise as a way of improving the accuracy of prediction of the initiation of breastfeeding behaviour. The IIFAS has been found to predict breastfeeding initiation in a variety of settings including USA[11], Australia[12], Scotland[13-14], Northern Ireland[15] and Romania.[16] However these studies have either only measured feeding at birth[14] , until discharge from hospital [14,15] or by retrospective maternal report.[16] The only study which prospectively followed women over a prolonged period was carried out in an area of high breastfeeding (94% initiation rate) and was biased by recruitment of women and measurement of baseline variables in the first 3 days after birth (rather than during pregnancy) by which time attitudes to infant feeding are likely to have been affected by experiences since birth.[12]

Hence there is little evidence for interventions based on psychological and attitudinal variables to improve breastfeeding outcomes. However a World Health Organisation programme (The Baby Friendly Initiative, BFI) to protect and support the initiation and continuation of breastfeeding by the implementation of evidence-based care in maternity hospitals is well-established.[17] Many hospitals and community settings strive to achieve 'UNICEF Baby Friendly Status' and there is some evidence that BFI accreditation can improve initiation and continuation rates .[18-20] Guidance from UNICEF for Step 3 of BFI accreditation, in the context of information provision, 'strongly recommends that pregnant women are not merely asked a closed question about how they plan to feed their baby.' (UNICEF 2011, page 13).[21] This is to encourage a more open discussion to take place and to allow women to make a final decision about feeding method after delivery. While the recommendation does not explicitly preclude a discussion about feeding intentions in the antenatal period, the guidelines suggest that the documentation of antenatal feeding intention should be avoided. In practice this has been interpreted more stringently; intentions are not discussed at all.

Building on past research we designed an exploratory longitudinal study using mixed methodology, including use of the IIFAS[11] and psychological variables guided by the Theory of Planned Behaviour[22] captured during the antenatal period, to understand and predict women's initiation and duration of breastfeeding in an area of low breastfeeding commencement. Use of the MRC framework[23] informed the qualitative and quantitative components of the study enabling us to advance our understanding of women's intentions and attitudes towards infant feeding. The study used SMS text messaging, a novel method of data collection, to follow up women after delivery. The validity and reliability of the method of SMS text messaging has already been reported elsewhere[24] as well as some of the qualitative results.[25]

This paper reports the identification of i) antenatal factors which predict women who will initiate breastfeeding; ii) the critical time points for the discontinuation of breastfeeding; and iii) the key antenatal and postnatal attributes and beliefs associated with continuation / cessation

From these data a predictive model was derived to identify those at high risk of stopping breastfeeding. The findings from this study will inform the recruitment protocol and design of an intervention to encourage breastfeeding in a future RCT testing the intervention efficacy.

Methods

Design

A prospective cohort study of the method of infant feeding following delivery.

Participants

Pregnant women over 30 weeks gestation aged 16 years and above, living in Dundee, booked to deliver at Ninewells Hospital and able to speak English. There were no exclusions based on feeding intention or maternal history. The detailed reasons for exclusion are shown in appendix 2.

Measures

Five data collection points were used:

1. Baseline data - self-completed questionnaire, third trimester of pregnancy:

Background demographic:

- Age, cohabitation and residency status, years since leaving school and occupation based on Standard Occupational Classification, ONS, 2010.[26] Socio-economic status derived from postcode and corresponding SIMD scores.

Obstetric measures:

- Expected Date of Delivery (EDD)
- Parity
- Previous infant feeding.

Psychological measures:

- *Iowa Infant Feeding Attitude Scale* (IIFAS)[11] a 17-item questionnaire with 5-point Likert scale response format from strongly agree to strongly disagree. Scores range from 17 – 85: higher score = more positive attitude to breastfeeding.
- *Theory of Planned Behaviour (TPB) questionnair*e study-specific 13 item questionnaire informed by the theories of planned behaviour and self-efficacy[22] assessed Attitude to breastfeeding (4 items), Social norm (2 items), Perceived Behavioural Control (PBC) (3 items) and Intention (4 items) each recorded on a 5-point scale (See appendix 3).

2. Delivery data - obtained through hospital records:

- Date of delivery, method of delivery, sex and weight of baby, method of infant feeding recorded at birth and at discharge from the hospital

Outcome variables:

3. Infant feeding collected by validated SMS text messages[24]:

Method(s) of infant feeding and future intentions, assessed after hospital discharge every 2 weeks using 2 text questions until response 'F' received to SMS1:

- SMS1. 'In the past 2 weeks how have you been feeding your baby?' (Answer options – only breast milk (O), both breast and formula milk (B), only formula milk (F)).
- SMS2. If 'only breast milk' or 'both breast and formula milk' – 'For how many more weeks do you plan to give your baby breast milk?'

4. Exit data (4 weeks after final SMS message):

- Method of infant feeding at study exit, problems with infant feeding, satisfaction with (breast) feeding support and satisfaction with feeding method(s) using 5-point Likert scale response format.

5. Focus groups and interviews with various sub-groups of women

Procedure

Women were approached in the last trimester of pregnancy at clinics by a Community Midwife (CM) or a Research Assistant (RA). Consent was obtained for contact details to be passed to the study team in the form of returned postcards; women were given a baseline questionnaire and consent form. These were returned to the study team following a recruitment phone call by the RAs. Study incentives were used to motivate and encourage CMs to recruit.

The hospital database was checked weekly and as participants delivered, their delivery and discharge details were sent to the RAs. Starting from 2 weeks after delivery RAs used standard

web-based messaging tools to contact all participants by text to find out current feeding practices and intentions (Figure 1). Web-based messaging services sent automated texts via computer and used a text number for responses. Contact continued by text message every 2 weeks until the baby was 16 weeks old, or until the response 'F' was received. Women with no mobile phone or who preferred not to receive text messages were contacted by the RA on their home phone.

The 'end' point for gathering text data was 2 weeks after delivery for women who started or who changed to formula feeding before 2 weeks; and on discontinuation of any breastfeeding or when the baby was 16 weeks old for the rest. Four weeks after the 'end' point women were phoned to gather final data (using an exit phone questionnaire). After the exit interview women were sent a letter thanking them and a £10 gift voucher.

During the exit interview participants were invited to take part in a focus group or interview. Results are reported elsewhere.

Statistical Analysis

Data were analysed using SAS version 9.2. Descriptive data are presented as % (frequency) for categorical variables, and mean (95% CI) for continuous variables.

The total IIFAS Score and the sub-scores for the TPB variables were calculated from the questionnaires. Non-normally distributed variables were converted to categorical variables when there was no viable transformation.

Baseline data were tested for correlations with duration of breastfeeding. ANOVA and Chi-Square tests were performed to test for significant associations of baseline variables with duration of breastfeeding and intention to breastfeed, and to examine differences between groups.

The reliability of the text message responses (method of feeding) was checked by repeat-texting a random subset of 50 participants the next day. Validity was checked by phoning a random subset of 50 participants on the same day as their text response and asking them the same questions verbally and by comparison with data collected by the health visitor. The results, previously reported, demonstrated excellent reliability and validity.[24]

Logistic regression modelling was implemented to assess predictors of initiating breastfeeding and the results expressed as Relative Risks (RR) and their 95% CIs.

For those who initiated breastfeeding univariate associations between the duration of any and exclusive breastfeeding with baseline variables were performed using the logrank test for each of the baseline variables. Variables with a univariate significance level of at least 0.3 were chosen for potential inclusion in model building.

Cox Proportional Hazards models were then built for all combinations of variables, utilizing both a forward and stepwise selection model including all variables. Models were then assessed for goodness of fit using the AIC and the best-fit model chosen. These models were utilised to predict the outcome of any breastfeeding and exclusive breastfeeding.

Model performance was assessed by estimation of the c-statistic, a measure of discrimination as well as the Integrated Discrimination Index[27] to demonstrate the most important variables determining discrimination utilising the SAS macro %rocplus (http://mayoresearch.mayo.edu/mayo/research/biostat/sasmacros.cfm). Assessment of calibration was also carried out using methods suitable for censored data. Analyses were implemented in SPSS (version 18) and SAS v 9.2 (SAS Institute, Cary, NC, USA).

Sample size, Recruitment and Attrition

The study aimed to recruit 350 women over an 8 month period, giving a recruitment rate of 35%. Of these approximately 224 (64%) would start breastfeeding (local Maternity Database figures from 2007), and 133 (38%) will still be breastfeeding at 6 - 8 weeks.[9] In considering predictors of

maintaining breast feeding at 6 - 8 weeks from birth, and approximately 130 events, there would be 80% power to detect Hazard Ratio ≥ 1.6 in a Cox regression model.

Between November 2009 and June 2010 a total of 639 postcards were received by the study team. From these, 355 women were fully consented and included in the study (55.6% of postcards received), which exceeded our target of 350 women (Figure 1 and full details in appendix 2). The SIMD profile of consented women broadly tracked the profile of all women who delivered in Dundee in 2009. A total of 292 women were followed up to the exit questionnaire (82.3% of consented women). Some of this follow up was protracted due to difficulties in contacting several participants.

At exit 152 women were asked about participating in a focus group or interview and 138 expressed an interest (91%) Of these, 38 took part in one of seven focus groups and 40 were interviewed individually (78 in total, 56% of those interested, 22% of total sample). The results of the qualitative analysis are reported elsewhere[25].

SMS messages for collection of data about feeding method

To manage the high number of automated SMS messages a computer schedule was created for the study (Figure 2). A total of 2738 text message responses were received via this automated SMS message scheduler. Data from 42 women were gathered by phone call on 114 occasions when the SMS system was unavailable. The SMS messaging service package incurred a small cost to participants: some participants may have been unable to respond if they had no credit on their phone. Two women were contacted on their home phone only: one had no mobile phone while the other preferred not to receive text messages.

Results

Baseline Characteristics

Three hundred and fifty five women were included in the study at baseline. Of these 344 (96.9%) had information on feeding status at delivery and prediction of initiating breast feeding was based on this cohort (Table 1). Baseline psychological measures (IIFAS score and TPB) are included in Table 1.

Prediction of Initiating Breastfeeding

At delivery 67.7% (95% CI 62.8% to 72.6%) of women had started breastfeeding out of those with feeding data (n = 344). Significant independent predictors of initiating breastfeeding were older age, parity, greater intention to breastfeed from the TPB questionnaire, higher IIFAS score as well as living with a husband or partner as shown in table 2. For the final logistic model the AUROC was 0.982 (95% CI 0.971 to 0.993) and calibration was good with Hosmer-Lemeshow test of p = 0.354. A score for estimation of the probability of initiation can be easily constructed using this final equation as shown in Appendix 1. This score can be utilised as a Clinical Prediction Rule (CPR) to identify women with low probability of initiating breastfeeding and interventions can be developed that are focussed on this group. Estimation of the IDI showed that Intention to Breastfeed with an IDI of 0.212 (p< 0.001) was the strongest contributor to discrimination of initiating breastfeeding and entered the model first, followed by the IIFAS score with IDI = 0.024 (p = 0.034).

Duration of breastfeeding

For those with feeding data (n = 344) Kaplan-Meier curves were fitted for exclusive breastfeeding (response 'only breast milk' to text question) and any breast milk (response 'both breast and formula milk' to text question) for each of the three subgroups defined by previous breastfeeding and parity. The duration of breastfeeding at various time points were derived (Figures 3a and b). These show that parous women who have previous experience of breastfeeding are most likely to start breastfeeding, more likely to continue to breastfeed exclusively and are slowest to discontinue any breastfeeding. In this experienced group, at 16 weeks 52.6% recorded any breastfeeding (33.0% exclusive). In contrast, parous women with no previous breastfeeding experience are least likely to start breastfeeding with a baseline of approximately 20%. In this group at 16 weeks only 5.0% were continuing with any breastfeeding (3.9% exclusive).

Prediction of stopping breastfeeding

This analysis considered only those who initiated breastfeeding (n = 233) and what factors predicted cessation. As in Figure 3 analyses were carried out for both exclusive breastfeeding and any breastfeeding. The final model was chosen using the AIC and the best fit model comprised the variables: Previous breastfeeding, Intention to breastfeed, Total IIFAS score and Major occupational group based on ONS groups reclassified into four broad groupings. Neither Age nor SIMD were included in the final model as these are strongly correlated with occupation and previous breastfeeding. Those women who initiated breastfeeding and had higher IIFAS scores were highly significantly less likely to stop breastfeeding whether 'exclusive' or 'any' breastfeeding (Table 4). Those with higher intention scores had much greater duration than those with lower intention scores and were significantly associated with lower risk of stopping 'exclusive' or 'any' breastfeeding, with a 29% and 43% lower risk respectively.
In the final model there was also a trend across the occupations with lower breastfeeding in the routine and manual occupations. Parity was not such a strong predictor once intentions and IOWA score were included. The two most significant predictors of not stopping (for both exclusive and any breastfeeding) were high intention score and high IIFAS score (Table 4). The c-statistics for both models were c = 0.649 (95% CI 0.605 to 0.693) and c = 0.689 (95% CI 0.641 to 0.875) for 'exclusive' and 'any' breastfeeding respectively. In these models the IDI was highest for the IIFAS with IDI=0.077 for 'exclusive' and IDI=0.074 for 'any' breastfeeding respectively. In contrast, although a statistically significant predictor, the IDI was negligible for intentions from the TPB questionnaire.

Discussion

As far as can be established this is the first study of infant feeding in the weeks following birth using antenatal data gathered prospectively in real time in a large cohort. In order to achieve this, a novel method of collecting data via SMS text messaging was successfully developed, validated and utilised. This data collection method was demonstrated to have excellent reliability and validity.[24]

A sample with a broadly similar overall SIMD profile to pregnant women in Dundee in 2009 was recruited with good representation from deprived areas which is often a problem in studying breastfeeding. Excellent follow-up through each phase of the study was achieved, and the quantitative phase was complemented by a large amount of qualitative data gathered from a diverse sample of participants with a range of feeding experiences.[25]

Our cohort's figures for breastfeeding are broadly consistent with national and local rates of breastfeeding. 68% of the sample started breastfeeding compared to local figures 59% (local maternity database, 2009). Over the 6 – 8 weeks period 29.1% – 33.9% were exclusively breastfeeding and 44.1% – 48.3% were offering some breast milk. In comparison, Dundee City figures were: exclusive = 23.3%, and any = 33.4%; while the exclusive breastfeeding figure at 6-8 weeks for Scotland was 26.5%.[27] The generally higher rates at all time-points may be accounted for by the slightly higher numbers of women in our study from more affluent areas, while the national Infant Feeding Survey data is based on retrospective reports.[7] The texting in itself may have acted as an intervention to encourage continuation of breastfeeding. It is also possible that our figures are more accurate as they are based on prospective real-time texts from the women. Overall, the consistency with known official statistics lends added validity to our results.

The mean score on the IIFAS (58.8, SD 9.36) was similar to that reported by de la Mora (1999)[11] The dichotomous nature of the 'Intentions' variable suggests that in the latter stages of pregnancy most women are clear about how they plan to feed their baby, with only a few being undecided. As in previous studies of breastfeeding using the TPB, intentions were explained by PBC, attitudes and the IOWA score with demographic variables accounting for less of the variance.[11, 29,30]

The Kaplan-Meier plots show the expected pattern of breastfeeding cessation, with the steepest drop-off occurring in the first couple of weeks after birth in all women for exclusive breastfeeding. However, large differences in the duration of breastfeeding could be observed between groups. In particular parous women with no previous breastfeeding experience stopped very quickly after birth, while primiparous women showed a similar pattern of duration to those parous women who did have previous breastfeeding experience so prior experience of breastfeeding is a strong

predictor. This is similar to the findings of the recent Scottish Infant Feeding Survey data from 2010.[7]

In the prediction models, as others have found, [31] while demographic measures were important, the measures of intention (TPB) and attitude to breastfeeding (IIFAS score) were the strongest predictors of both initiation and stopping breastfeeding. However, intention was stronger for initiating breastfeeding, while attitude was stronger for persevering with breastfeeding. This has important clinical implications. We suggest that the current interpretation of the UNICEF Baby Friendly guidelines should be revisited. Our findings indicate that a discussion with women about their intentions, in combination with an exploration of their attitude to formula feeding and breastfeeding (perhaps through use of the IIFAS) could be a powerful way of identifying those women who might need more help and support with both initiating and persevering with breastfeeding. The findings also lend weight to the targeting of younger women and women from lower socioeconomic backgrounds both for extra encouragement to breastfeed and for additional breastfeeding support. Similar to other studies that have measured PBC in pregnancy, PBC was not a significant independent predictor of breastfeeding initiation.[31,32] However, unlike McMillan et al[31] we found that PBC was a weaker predictor of continuation than attitudes. Questions remain about the best time to measure PBC in relation to breastfeeding and the measures that should be used.

Importance to NHS and possible implementation

Breastfeeding is known to have significant short and long-term health benefits for both mother and infant. Increasing the number of breastfed babies through targeted interventions has potential to prevent future ill-health, save the NHS money and is congruent with Government policy.[33-35] The findings of this study can be used both to identify women who need additional support and to inform the design of interventions to promote and support breastfeeding using a prediction model. Antenatal and public health interventions should aim to improve attitudes to breastfeeding generally and improve women's confidence in their ability to breastfeed. There is a need to target primigravidae during pregnancy and in the early postnatal days and weeks: as success with breastfeeding in the first pregnancy is likely to lead to more chance of feeding successfully in subsequent pregnancies. Parous women with no previous breastfeeding experience need the most support as they are most likely to give up quickly. The use of antenatal measures of intention and attitude to breastfeeding might be useful to identify women who are likely to need more support in the early days and weeks after delivery. Increased levels of support, perhaps from other women who have successfully breastfed might be an effective intervention strategy.

Future research

This study has followed phase 1 of the MRC process, that is, collection of initial data and determining predictors of outcome.[23] The next stage will be to develop a complex interventions based on these findings both to improve rates of initiation of breastfeeding and to provide targeted support to those who commence breastfeeding. In addition, the discriminative ability for initiation was excellent but only moderate for stopping breastfeeding, while intention (TPB) was most important for initiating and attitude (IIFAS) most important for persevering with breastfeeding. This suggests there may be further factors in stopping that could be investigated; future studies could explore this issue.

This study demonstrated the benefits of SMS messaging to collect data and so can easily be used in other studies to collect similar data. In addition text messaging may have potential as a cost-effective and convenient way to provide health information and support messages as part of a complex intervention. These suggestions could apply to breastfeeding, as well as having application in many other health arenas.

Conclusions

This landmark study used SMS text messaging to gather real-time data on infant feeding from birth to 16 weeks postnatal. It provides the most detailed and comprehensive data on the form and

method of infant feeding. The results are consistent with Scottish national figures, hence enhancing the validity of our findings.

The construct of 'Intentions' (from the TPB) and a measure of attitude to breastfeeding (the IIFAS score) have been shown to be important in predicting future infant feeding behaviour, as well as socioeconomic background. Primigravidae and parous women with no previous breastfeeding experience are likely to need the most support as these groups are least likely to commence breastfeeding, and most likely to stop early.

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Contributors: PTD designed the study, supervised the statistical analysis, drafted the final paper and approved the final version; JD designed the study, involved in design of collection tools, commented on drafts and approved the final version; AS designed the study, contributed to collection tools, commented on drafts and approved the final version; PR carried out the statistical analysis, contributed to drafts and approved the final version; EM-H involved in design of collection tools, collected data, commented on drafts and approved the final version; GK involved in design of collection tools, collected data, commented on drafts and approved the final version; JW designed the study, supervision of the data collection, commented on drafts and approved the final version; HMW designed the study, involved in design of data collection tools, supervised the study as PI, commented on drafts and approved the final version.

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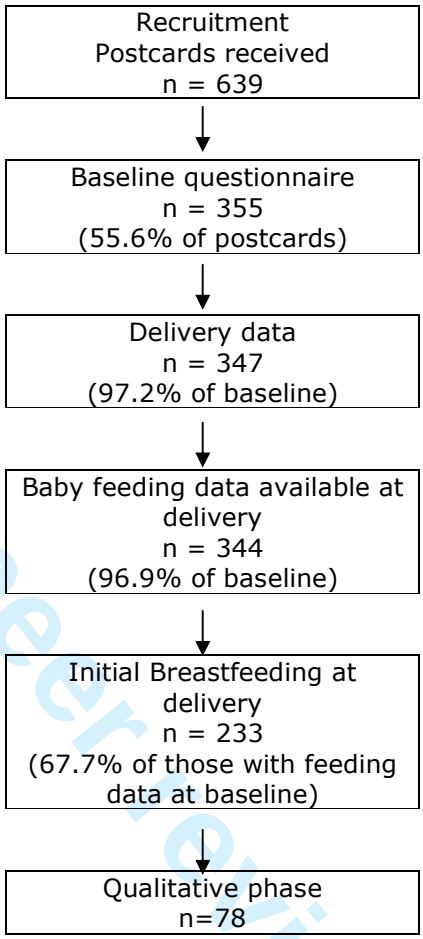

Figure 1: Flow chart of participant recruitment

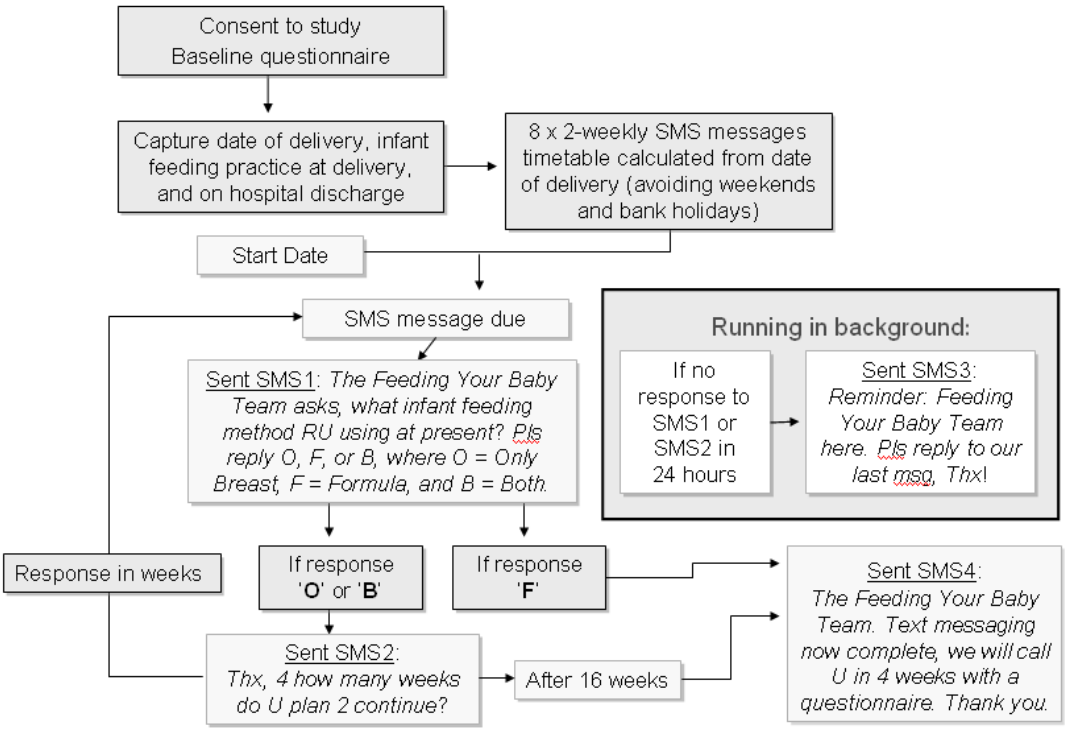

Figure 2: Schedule of SMS messages

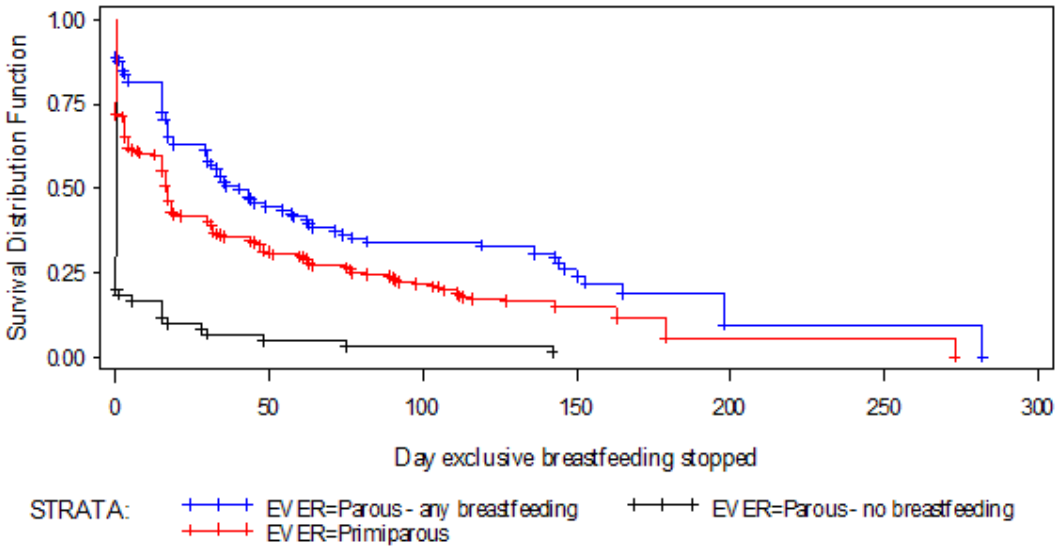

Figure 3a: Time to end of exclusive breastfeeding (WHO) in all women

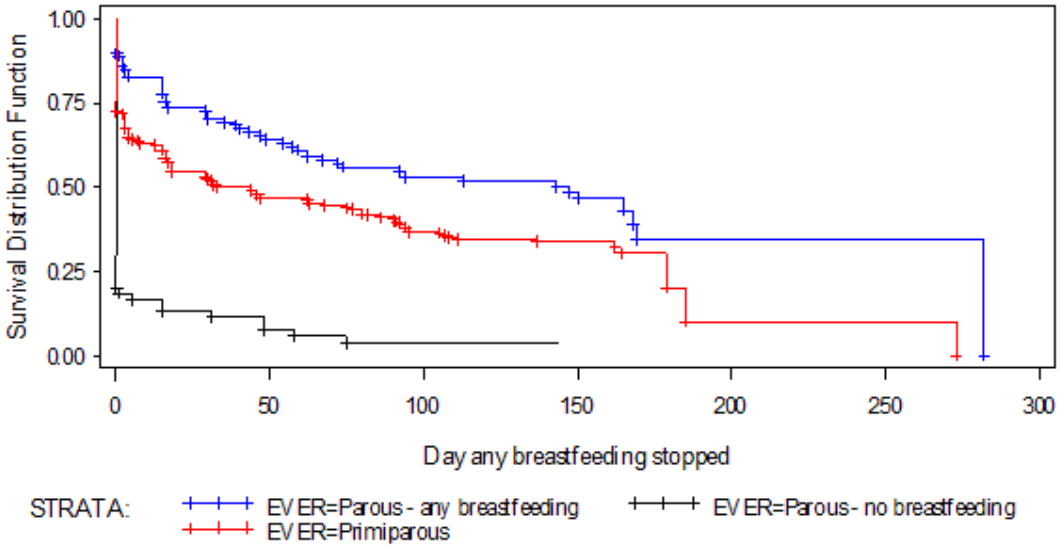

Figure 3b: Time to end of any breastfeeding in all women

Table 1: Characteristics of Women by feeding method at Baseline delivery (n = 344)

	Women who did not initiate breastfeeding (n = 111) *Mean (SD) or **% (N)	Women who initiated breastfeeding (n = 233) Mean (SD) or % (N)
Gestation at baseline (weeks)*	32.5 (5.3)	31.7 (5.9)
Age (years)*	26.6 (6.2)	29.6 (5.4)
Years since leaving school*	15.9 (2.8)	17.9 (1.8)
Relationship status**		
Single	22.5 (25)	5.2 (12)
Married	29.7 (33)	55.8 (130)
With partner	46.8 (52)	38.6 (90)
Other	0.0 (0)	0.4 (1)
Missing	0.9 (1)	0.0 (0)
Living status**		
On own	17.1 (19)	2.6 (6)
With husband or partner	58.6 (65)	89.3 (208)
With parents	15.3 (17)	5.2 (12)
Other	6.3 (7)	1.3 (3)
Missing	2.7 (3)	1.7 (4)
Parity**		
First child	45.0 (50)	54.5 (127)
Second child	30.6 (34)	29.2 (68)
Third child or more	21.6 (24)	12.5 (29)
Missing	2.7 (3)	3.9 (9)
Previous breastfeeding experience		
Primiparous	47.7 (53)	58.4 (136)
Parous – no previous breastfeeding experience	43.2 (48)	5.2 (12)
Parous – previous breastfeeding experience	9.0 (10)	36.5 (85)
Missing	0.0 (0)	0.0 (0)
SIMD Quintile**		
Quintile 1 (most deprived)	47.7 (53)	30.5 (71)
Quintile 2	20.7 (23)	10.3 (24)
Quintile 3	8.1 (9)	12.4 (29)
Quintile 4	15.3 (17)	30.9 (72)
Quintile 5 (most affluent)	7.2 (8)	15.9 (37)
Missing	0.9 (1)	0.0 (0)
Occupations**		
Higher managerial, administrative and professional occupations	24.3 (27)	60.1 (140)
Intermediate occupations	16.2 (18)	12.0 (28)
Routine and manual occupations	18.9 (21)	11.6 (27)
Not in paid employment	34.2 (38)	15.5 (36)
Missing	6.3 (7)	0.9 (2)
Total IIFAS score	49.8 (6.29)	62.8 (7.46)

	Women who did not initiate breastfeeding (n = 111) *Mean (SD) or **% (N)	Women who initiated breastfeeding (n = 233) Mean (SD) or % (N)
TPB score 1: Attitude to breastfeeding	2.6 (0.76)	4.2 (0.68)
TPB score 2: Subjective norm	2.2 (0.3)	3.3 (1.0)
TPB score 3: Perceived behavioural control	2.6 (0.84)	3.8 (0.76)
TPB score 4: Intention to breastfeed†	1.7 (0.96)	4.4 (0.96)
TPB score 4: Intention to breastfeed categorical (% (number)∞		
No breastfeeding intended	60.4 (67)	3.0 (7)
Undecided	38.7 (43)	45.1 (105)
Definite breastfeeding intended	0.0 (0)	51.9 (121)
Missing	0.9 (1)	0.0 (0)

†: on a scale of 1 – 5
∞: 1 = No breastfeeding intended; 2 – 4 = Undecided; 5 = Definite breastfeeding intended

Table 2 Results of Multiple Logistic Regression of factors associated with initiating breast feeding (n = 344)

Variable	RR (95% CI)	Chi Squared	p-value
Age (years)	1.11 [1.00 to 1.24]	4.077	0.044
Parity			
Parous - no breastfeeding vs Primiparous	0.28 [0.12 to 0.69]	7.798	0.005
Parous - any breastfeeding vs Primiparous	2.67 [1.15 to 6.18]	5.294	0.021
TPB score 4: Intention to breastfeed	4.67 [2.91 to 7.49]	40.759	<.0001
Total IIFAS Score	1.17 [1.06 to 1.30]	9.238	0.002
Living Status			
With husband or partner vs On own	6.07 [2.07 to 17.78]	10.806	0.001
With parents vs On own	1.55 [0.38 to 6.27]	0.381	0.537
Other vs On own	0.24 [0.03 to 2.27]	1.542	0.214

Table 3: Predicted breastfeeding rates at different timepoints according to parity and any breastfeeding of previous children (from SMS data n = 344)

		Exclusive Breastfeeding		Any Breastfeeding	
	Time	%	CI	%	CI
All	Baseline	67.6	[62 to 72]	68.2	[63 to 73]
	6 weeks	33.9	[29 to 39]	48.3	[43 to 53]
	8 weeks	29.1	[24 to 34]	44.1	[39 to 49]
	16 weeks	20.4	[16 to 25]	34.5	[29 to 40]
	Exit Interview	3.3	[0 to 12]	8.5	[1 to 27]
Primiparous	Baseline	71.7	[65 to 78]	72.3	[65 to 78]
	6 weeks	34.3	[28 to 41]	50.1	[43 to 57]
	8 weeks	29.3	[23 to 36]	46.7	[39 to 54]
	16 weeks	18.8	[14 to 25]	34.5	[28 to 41]
	Exit Interview	5.8	[1 to 18]	10.1	[1 to 32]
Parous - no previous breastfeeding	Baseline	20.0	[11 to 31]	18.3	[10 to 29]
	6 weeks	5.0	[1 to 13]	11.7	[5 to 21]
	8 weeks	5.0	[1 to 13]	5.8	[2 to 14]
	16 weeks	3.9	[1 to 13]	5.0	[1 to 12]
	Exit Interview	1.7	[0 to 8]	3.9	[1 to 12]
Parous - with previous breastfeeding experience	Baseline	88.8	[81 to 94]	89.8	[82 to 94]
	6 weeks	46.6	[36 to 56]	67.2	[57 to 76]
	8 weeks	41.4	[32 to 51]	62.0	[52 to 71]
	16 weeks	33.0	[24 to 42]	52.6	[42 to 62]
	Exit Interview	9.3	[01 to 28]	34.6	[21 to 49]

Table 4a: Final model using Cox Regression to predict stopping 'Exclusive' breastfeeding (n = 233)

Variable	Hazard Ratio	CI	p-value
Parous - any breastfeeding	0.873	[0.63 to 1.21]	0.4103
Parous - no breastfeeding	0.809	[0.41 to 1.58]	0.5367
Primiparous	1.000		
Higher managerial, administrative and professional occupations	0.726	[0.46 to 1.15]	0.1716
Intermediate occupations	0.789	[0.44 to 1.41]	0.4246
Routine and manual occupations	0.880	[0.50 to 1.56]	0.6601
Not in paid employment	1.000		
TPB score 4: Intention to breastfeed (High vs low)	0.715	[0.53 to 0.97]	0.0317
Total IIFAS Score (+ 10 units)	0.553	[0.43 to 0.71]	<.0001

Table 4b: Final model using Cox Regression to predict stopping 'Any' breastfeeding (n=233)

Variable	Hazard Ratio	CI	p-value
Parous - any breastfeeding	0.829	[0.56 to 1.22]	0.3426
Parous - no breastfeeding	1.079	[0.51 to 2.26]	0.8403
Primiparous	1.000		
Higher managerial, administrative and professional occupations	0.602	[0.37 to 0.99]	0.0457
Intermediate occupations	0.622	[0.32 to 1.21]	0.1619
Routine and manual occupations	0.714	[0.37 to 1.39]	0.3215
Not in paid employment	1.000		
TPB score 4: Intention to breastfeed (High vs Low)	0.569	[0.39 to 0.82]	0.0026
Total IIFAS Score (+ 10 units)	0.549	[0.41 to 0.74]	<.0001

Appendix 1

Logistic model for prediction of initiation of breastfeeding

The probability of initiating breastfeeding can be derived from the model in Table 2, where:
Prob = 1 / (1 + exp (-βx)).

Estimate the linear predictor βx =
-17.1114
+ 0.1078 x age
-1.2663 x Ever (Parous-no breastfeeding=1)
+ 0.9835 x Ever (Parous – any breastfeeding=1)
+ 1.8032 x Living (with husband or partner=1)
+ 0.4395 x Living (with parents=1)
-1.4168 x Living (with other=1)
+ 0.1597 x IIFAS
+ 1.5407 x Intentions

Calculate exp (-βx),
Then Prob. = 1 / (1 +exp (-βx))

Final Model: Initiation of Breastfeeding

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	p-value
Intercept		1	-17.1114	3.4021	25.2967	<0.0001
Age		1	0.1078	0.0534	4.0770	0.0435
Parity	Parous - no breastfeeding	1	-1.2663	0.4535	7.7977	0.0052
	Parous - any breastfeeding	1	0.9835	0.4274	5.2943	0.0214
Living	With husband or partner	1	1.8032	0.5485	10.8058	0.0010
	With parents	1	0.4395	0.7121	0.3809	0.5371
	Other	1	-1.4168	1.1411	1.5417	0.2144
IIFAS		1	0.1597	0.0525	9.2383	0.0024
Intentions		1	1.5407	0.2413	40.7592	<0.0001

Derivation of points from the final model (n=344) for clinical use. Each question is based on the factors in the prediction model; Intentions (TPB), IIFAS score, living arrangements, parity and age. ($B^* = 0.1078$)

Variable		B	$\beta (W_{ij} - W_{iREF})$	Points = $\beta (W_{ij} - W_{iREF})/B^*$
Intercept		-17.1114		-159
Intentions (TPB)	+1	1.5407		14
IIFAS score	+1	0.1597		1.5
Age	+1 year	0.1078		1
Parous – no breastfeeding		-1.2663	-1.2663	-12
Parous – any breastfeeding		0.9835	0.9835	9
Primiparous		0	0	0

Living with husband or partner	**1.8032**	**1.8032**	**17**
Living with parents	**0.4395**	**0.4395**	**4**
Living with Other	**-1.4168**	**-1.4168**	**-13**
On own	**0**	**0**	**0**

*Sullivan LM, Massaro JM, D'Agostino RB Sr. Presentation of multivariate data for clinical use: The Framingham Study risk score function Statist Med 2004; 23: 1631-1660.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **YES**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **YES**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **YES**
Objectives	3	State specific objectives, including any prespecified hypotheses **YES**
Methods		
Study design	4	Present key elements of study design early in the paper **YES**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **YES**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up **YES**
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed **NA**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **YES**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **YES**
Bias	9	Describe any efforts to address potential sources of bias **YES**
Study size	10	Explain how the study size was arrived at **YES**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **YES**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **YES**
		(*b*) Describe any methods used to examine subgroups and interactions **YES**
		(*c*) Explain how missing data were addressed **NA**
		(*d*) If applicable, explain how loss to follow-up was addressed **NA**
		(*e*) Describe any sensitivity analyses **NA**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **YES**
		(b) Give reasons for non-participation at each stage **YES**
		(c) Consider use of a flow diagram **Yes**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **YES**
		(b) Indicate number of participants with missing data for each variable of interest **NA**
		(c) Summarise follow-up time (eg, average and total amount) **YES**
Outcome data	15*	Report numbers of outcome events or summary measures over time **YES**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were

		adjusted for and why they were included **YES**
		(*b*) Report category boundaries when continuous variables were categorized **YES**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **YES**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **YES**
Discussion		
Key results	18	Summarise key results with reference to study objectives **YES**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **YES**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **YES**
Generalisability	21	Discuss the generalisability (external validity) of the study results **YES**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **YES**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

Prediction of initiation and cessation of breast feeding from late pregnancy to 16 weeks: The Feeding Your Baby (FYB) cohort study

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Key words: mobile phone, SMS text messaging, breastfeeding, prediction model, cohort

Abstract

Objective To derive prediction models for both initiation and cessation of breastfeeding using demographic, psychological and obstetric variables

Design A prospective cohort study

Setting Women delivering at Ninewells Hospital, Dundee, UK.

Data Sources Demographic data and psychological measures were obtained during pregnancy by questionnaire. Birth details, feeding method at birth and at hospital discharge were obtained from the Ninewells hospital database, Dundee, UK. Breastfeeding women were followed-up by text messages 2-weekly until 16 weeks or until breastfeeding was discontinued to ascertain feeding method and feeding intentions.

Participants
Pregnant women over 30 weeks gestation aged 16 years and above, living in Dundee, booked to deliver at Ninewells Hospital, Dundee and able to speak English.

Main outcome measure
Initiation and Cessation of breastfeeding

Results
From the total cohort of women at delivery (n = 344) 68% (95% CI 63% to 73%) of women had started breastfeeding at discharge. Significant predictors of initiating breastfeeding were older age, parity, greater intention to breastfeed from a Theory of Planned Behaviour (TPB)-based questionnaire, higher Iowa Infant Feeding Assessment Scale (IIFAS) score as well as living with a husband or partner. For the final model the AUROC was 0.967. For those who initiated breastfeeding (n = 233), the strongest predictors of stopping were low intention to breastfeed from TPB, low IIFAS score and non-managerial / professional occupations.

Conclusions
The findings from this study will be used to inform the protocol for an intervention study to encourage and support prolonged breastfeeding as intentions appear to be a key intervention focus for initiation. The predictive models could be used to identify women at high risk of not initiating and also women at high risk of stopping for interventions to improve longevity of breastfeeding.

Article Summary

Article Focus

- To identify antenatal factors which predict women who will initiate breastfeeding;
- Assess the critical time points for the discontinuation of breastfeeding;
- To identify the key antenatal and postnatal attributes and beliefs associated with continuation / cessation and develop predictive models

Key Messages

- Comprehensive assessment of intentions and breastfeeding via novel SMS text messaging facilitated accurate prediction of breast feeding initiation and cessation
- Psychological factors as well as previous experience were shown to be important predictors of cessation before 16 weeks in predictive algorithms indicating the potential for early intervention
- These findings challenge the current interpretation of the UNICEF guidelines and suggest that a full discussion about infant feeding options in the antenatal period, including asking about intentions, could be used to identify women at risk of early cessation of breastfeeding.

Strengths and Limitations of this study

A key strength was the accurate, validated, real-time and efficient measurement of method of infant feeding through SMS messaging. The study incorporated intentions and psychological factors based on the Theory of Planned Behaviour as predictors of initiation and cessation. This allowed the development of predictive algorithms and ~~points to targeting~~ could allow the development and trialling of targeted interventions. This was based on a relatively large cohort covering the antenatal period to 16 weeks postnatal. One limitation may be the lack of ethnic diversity in the study population which is reflected in the ethnic structure of Tayside.

Introduction

The short and long-term health benefits of breast feeding for both mother and child are well documented.[1-4] Consequently the current WHO recommendation is that infants should be exclusively breastfed for the first six months.[5] Most developed countries report that a minority of infants are exclusively breastfeeding at 6 months (40% Netherlands; 13% USA) and in the UK exclusive breastfeeding continued after 6 months in less than 1%.[6] There has been some success in the UK in improving the number of women who start breastfeeding: initiation rates of breastfeeding rose in Scotland from 63% in 2000 to 74% in 2010.[7] However targets to improve the rate of exclusive feeding at 6 – 8 weeks have proved more challenging. The Scottish Government aimed to increase exclusive breastfeeding at 6 – 8 weeks over a 4 year period to 33.3% by 2010/11[8], however in 2010/11 the rate remained unchanged at 26.5%.[9] Given the rapid decline in breastfeeding in the immediate postnatal period, the failure to meet government targets and follow WHO recommendations, more detailed information about current practices and attitudes and the potential for intervention is required.

Maternal demographics and previous breastfeeding experience are known to be associated with both initiation as well as duration of breastfeeding[9-10] however these variables are not amenable to behavioural change interventions. The measurement of attitudinal factors such as the Iowa Infant Feeding Assessment Scale (IIFAS)[11] has shown promise as a way of improving the accuracy of prediction of the initiation of breastfeeding behaviour. The IIFAS has been found to predict breastfeeding initiation in a variety of settings including USA[11], Australia[12], Scotland[13-14], Northern Ireland[15] and Romania.[16] However these studies have either only measured feeding at birth[14] , until discharge from hospital [14,15] or by retrospective maternal report.[16] The only study which prospectively followed women over a prolonged period was carried out in an area of high breastfeeding (94% initiation rate) and was biased by recruitment of women and measurement of baseline variables in the first 3 days after birth (rather than during pregnancy) by which time attitudes to infant feeding are likely to have been affected by experiences since birth.[12]

Hence there is little evidence for interventions based on psychological and attitudinal variables to improve breastfeeding outcomes. However a World Health Organisation programme (The Baby Friendly Initiative, BFI) to protect and support the initiation and continuation of breastfeeding by the implementation of evidence-based care in maternity hospitals is well-established.[17] Many hospitals and community settings strive to achieve 'UNICEF Baby Friendly Status' and there is some evidence that BFI accreditation can improve initiation and continuation rates ~~breastfeeding rates~~.[18-20] Guidance from UNICEF for Step 3 of BFI accreditation, in the context of information provision, 'strongly recommends that pregnant women are not merely asked a closed question about how they plan to feed their baby.' (UNICEF 2011, page 13).[21] This is to encourage a more open discussion to take place and to allow women to make a final decision about feeding method after delivery. While the recommendation does not explicitly preclude a discussion about feeding intentions in the antenatal period, the guidelines suggest that the documentation of antenatal feeding intention should be avoided. In practice this has been interpreted more stringently; intentions are not discussed at all.

Building on past research we designed an exploratory longitudinal study using mixed methodology, including use of the IIFAS[11] and psychological variables guided by the Theory of Planned Behaviour[22] captured during the antenatal period, to understand and predict women's initiation and duration of breastfeeding in an area of low breastfeeding commencement. Use of the MRC framework[23] informed the qualitative and quantitative components of the study enabling us to advance our understanding of women's intentions and attitudes towards infant feeding. The study used SMS text messaging, a novel method of data collection, to follow up women after delivery. The validity and reliability of the method of SMS text messaging has already been reported elsewhere[24] as well as some of the qualitative results.[25]

This paper reports the identification of i) antenatal factors which predict women who will initiate breastfeeding; ii) the critical time points for the discontinuation of breastfeeding; and iii) the key antenatal and postnatal attributes and beliefs associated with continuation / cessation

From these data a predictive model was derived to identify those at high risk of stopping breastfeeding. The findings from this study will inform the recruitment protocol and design of an intervention to encourage breastfeeding in a future RCT testing the intervention efficacy.

Methods

Design

A prospective cohort study of the method of infant feeding following delivery.

Participants

Pregnant women over 30 weeks gestation aged 16 years and above, living in Dundee, booked to deliver at Ninewells Hospital and able to speak English. There were no exclusions based on feeding intention or maternal history. The detailed reasons for exclusion are shown in appendix 2.

Measures

Five data collection points were used:

1. Baseline data - self-completed questionnaire, third trimester of pregnancy:

Background demographic:

- Age, cohabitation and residency status, years since leaving school and occupation based on Standard Occupational Classification, ONS, 2010.[26] Socio-economic status derived from postcode and corresponding SIMD scores.

Obstetric measures:

- Expected Date of Delivery (EDD)
- Parity
- Previous infant feeding.

Psychological measures:

- *Iowa Infant Feeding Attitude Scale* (IIFAS)[11] a 17-item questionnaire with 5-point Likert scale response format from strongly agree to strongly disagree. Scores range from 17 – 85: higher score = more positive attitude to breastfeeding.
- *Theory of Planned Behaviour (TPB) questionnair*e study-specific 13 item questionnaire informed by the theories of planned behaviour and self-efficacy[22] assessed Attitude to breastfeeding (4 items), Social norm (2 items), Perceived Behavioural Control (PBC) (3 items) and Intention (4 items) each recorded on a 5-point scale ~~from strongly agree to strongly disagree.~~ (See appendix 3).

2. Delivery data - obtained through hospital records:

- Date of delivery, method of delivery, sex and weight of baby, method of infant feeding recorded at birth and at discharge from the hospital

Outcome variables:

3. Infant feeding collected by validated SMS text messages[24]:

Method(s) of infant feeding and future intentions, assessed after hospital discharge every 2 weeks using 2 text questions until response 'F' received to SMS1:

- SMS1. 'In the past 2 weeks how have you been feeding your baby?' (Answer options – only breast milk (O), both breast and formula milk (B), only formula milk (F)).
- SMS2. If 'only breast milk' or 'both breast and formula milk' – 'For how many more weeks do you plan to give your baby breast milk?'

4. Exit data (4 weeks after final SMS message):

- Method of infant feeding at study exit, problems with infant feeding, satisfaction with (breast) feeding support and satisfaction with feeding method(s) using 5-point Likert scale response format.

5. Focus groups and interviews with various sub-groups of women

Procedure

Women were approached in the last trimester of pregnancy at clinics by a Community Midwife (CM) or a Research Assistant (RA). Consent was obtained for contact details to be passed to the study team in the form of returned postcards; women were given a baseline questionnaire and consent form. These were returned to the study team following a recruitment phone call by the RAs. Study incentives were used to motivate and encourage CMs to recruit.

The hospital database was checked weekly and as participants delivered, their delivery and discharge details were sent to the RAs. Starting from 2 weeks after delivery RAs used standard web-based messaging tools to contact all participants by text to find out current feeding practices and intentions (Figure 1). Web-based messaging services sent automated texts via computer and used a text number for responses. Contact continued by text message every 2 weeks until the baby was 16 weeks old, or until the response 'F' was received. Women with no mobile phone or who preferred not to receive text messages were contacted by the RA on their home phone.

The 'end' point for gathering text data was 2 weeks after delivery for women who started or who changed to formula feeding before 2 weeks; and on discontinuation of any breastfeeding or when the baby was 16 weeks old for the rest. Four weeks after the 'end' point women were phoned to gather final data (using an exit phone questionnaire). After the exit interview women were sent a letter thanking them and a £10 gift voucher.

During the exit interview participants were invited to take part in a focus group or interview. ~~These were organised with sub-groups of women representing a range of feeding experiences. Groups were kept as homogenous as possible and were held in a central location in Dundee. One to one interviews were carried out in the participant's home or in University premises. Focus groups and interviews continued until data saturation had been reached (topic guide – Appendix 1). Expenses and a 'thank you' gift voucher were given for participation in this phase.~~ Results are reported elsewhere.

Statistical Analysis

Data were analysed using SAS version 9.2. Descriptive data are presented as % (frequency) for categorical variables, and mean (95% CI) for continuous variables.

The total IIFAS Score and the sub-scores for the TPB variables were calculated from the questionnaires. Non-normally distributed variables were converted to categorical variables when there was no viable transformation.

Baseline data were tested for correlations with duration of breastfeeding. ANOVA and Chi-Square tests were performed to test for significant associations of baseline variables with duration of breastfeeding and intention to breastfeed, and to examine differences between groups.

The reliability of the text message responses (method of feeding) was checked by repeat-texting a random subset of 50 participants the next day. Validity was checked by phoning a random subset of 50 participants on the same day as their text response and asking them the same questions verbally and by comparison with data collected by the health visitor. The results, previously reported, demonstrated excellent reliability and validity.[24]

Logistic regression modelling was implemented to assess predictors of initiating breastfeeding and the results expressed as Relative Risks~~Odds Ratios~~ (RO~~R~~) and their 95% CIs.

For those who initiated breastfeeding univariate associations between the duration of any and exclusive breastfeeding with baseline variables were performed using the logrank test for each of the baseline variables. Variables with a univariate significance level of at least 0.3 were chosen for potential inclusion in model building.

Cox Proportional Hazards models were then built for all combinations of variables, utilizing both a forward and stepwise selection model including all variables. Models were then assessed for goodness of fit using the AIC and the best-fit model chosen. These models were utilised to predict the outcome of any breastfeeding and exclusive breastfeeding.

Model performance was assessed by estimation of the c-statistic, a measure of discrimination as well as the Integrated Discrimination Index[27~~6~~] to demonstrate the most important variables determining discrimination utilising the SAS macro %rocplus (http://mayoresearch.mayo.edu/mayo/research/biostat/sasmacros.cfm). Assessment of calibration

was also carried out using methods suitable for censored data. Analyses were implemented in SPSS (version 18) and SAS v 9.2 (SAS Institute, Cary, NC, USA).

Sample size, Recruitment and Attrition

The study aimed to recruit 350 women over an 8 month period, giving a recruitment rate of 35%. Of these approximately 224 (64%) would start breastfeeding (local Maternity Database figures from 2007), and 133 (38%) will still be breastfeeding at 6 - 8 weeks.[9] In considering predictors of maintaining breast feeding at 6 - 8 weeks from birth, and approximately 130 events, there would be 80% power to detect Hazard Ratio ≥ 1.6 in a Cox regression model.

Between November 2009 and June 2010 a total of 639 postcards were received by the study team. From these, 355 women were fully consented and included in the study (55.6% of postcards received), which exceeded our target of 350 women (Figure 1 and full details in appendix 2). The SIMD profile of consented women broadly tracked the profile of all women who delivered in Dundee in 2009. A total of 292 women were followed up to the exit questionnaire (82.3% of consented women). Some of this follow up was protracted due to difficulties in contacting several participants.

At exit 152 women were asked about participating in a focus group or interview and 138 expressed an interest (91%) Of these, 38 took part in one of seven focus groups and 40 were interviewed individually (78 in total, 56% of those interested, 22% of total sample). The results of the qualitative analysis are reported elsewhere[25].

SMS messages for collection of data about feeding method

To manage the high number of automated SMS messages a computer schedule was created for the study (Figure 2). A total of 2738 text message responses were received via this automated SMS message scheduler. Data from 42 women were gathered by phone call on 114 occasions when the SMS system was unavailable. The SMS messaging service package incurred a small cost to participants: some participants may have been unable to respond if they had no credit on their phone. Two women were contacted on their home phone only: one had no mobile phone while the other preferred not to receive text messages.

Results

Baseline Characteristics

Three hundred and fifty five women were included in the study at baseline. Of these 344 (96.9%) had information on feeding status at delivery and prediction of initiating breast feeding was based on this cohort (Table 1). Baseline psychological measures (IIFAS score and TPB) are included in Table 1.

Prediction of Initiating Breastfeeding

At delivery 67.7% (95% CI 62.8% to 72.6%) of women had started breastfeeding out of those with feeding data (n = 344). Significant independent predictors of initiating breastfeeding were older age, parity, greater intention to breastfeed from the TPB questionnaire, higher IIFAS score as well as living with a husband or partner as shown in table 2. For the final logistic model the AUROC was 0.982 (95% CI 0.971 to 0.993) and calibration was good with Hosmer-Lemeshow test of p = 0.354. A score for estimation of the probability of initiation can be easily constructed using this final equation as shown in Appendix 1. This score can be utilised as a Clinical Prediction Rule (CPR) to identify women with low probability of initiating breastfeeding and interventions can be developed that are focussed on this group. Estimation of the IDI showed that Intention to Breastfeed with an IDI of 0.212 (p< 0.001) was the strongest contributor to discrimination of initiating breastfeeding and entered the model first, followed by the IIFAS score with IDI = 0.024 (p = 0.034).

Duration of breastfeeding

For those with feeding data (n = 344) Kaplan-Meier curves were fitted for exclusive breastfeeding (response 'only breast milk' to text question) and any breast milk (response 'both breast and formula milk' to text question) for each of the three subgroups defined by previous breastfeeding and parity. The duration of breastfeeding at various time points were derived (Figures 3a and b). These show that parous women who have previous experience of breastfeeding are most likely to

start breastfeeding, more likely to continue to breastfeed exclusively and are slowest to discontinue any breastfeeding. In this experienced group, at 16 weeks 52.6% recorded any breastfeeding (33.0% exclusive). In contrast, parous women with no previous breastfeeding experience are least likely to start breastfeeding with a baseline of approximately 20%. In this group at 16 weeks only 5.0% were continuing with any breastfeeding (3.9% exclusive).

Prediction of stopping breastfeeding

This analysis considered only those who initiated breastfeeding (n = 233) and what factors predicted cessation. As in Figure 3 analyses were carried out for both exclusive breastfeeding and any breastfeeding. The final model was chosen using the AIC and the best fit model comprised the variables: Previous breastfeeding, Intention to breastfeed, Total IIFAS score and Major occupational group based on ONS groups reclassified into four broad groupings. Neither Age nor SIMD were included in the final model as these are strongly correlated with occupation and previous breastfeeding. Those women who initiated breastfeeding and had higher IIFAS scores were highly significantly less likely to stop breastfeeding whether 'exclusive' or 'any' breastfeeding (Table 4). Those with higher intention scores had much greater duration than those with lower intention scores and were significantly associated with lower risk of stopping 'exclusive' or 'any' breastfeeding, with a 29% and 43% lower risk respectively.

In the final model there was also a trend across the occupations with lower breastfeeding in the routine and manual occupations. Parity was not such a strong predictor once intentions and IOWA score were included. The two most significant predictors of not stopping (for both exclusive and any breastfeeding) were high intention score and high IIFAS score (Table 4). The c-statistics for both models were c = 0.649 (95% CI 0.605 to 0.693) and c = 0.689 (95% CI 0.641 to 0.875) for 'exclusive' and 'any' breastfeeding respectively. In these models the IDI was highest for the IIFAS with IDI=0.077 for 'exclusive' and IDI=0.074 for 'any' breastfeeding respectively. In contrast, although a statistically significant predictor, the IDI was negligible for intentions from the TPB questionnaire.

Discussion

As far as can be established this is the first study of infant feeding in the weeks following birth using antenatal data gathered prospectively in real time in a large cohort. In order to achieve this, a novel method of collecting data via SMS text messaging was successfully developed, validated and utilised. This data collection method was demonstrated to have excellent reliability and validity.[24]

A sample with a broadly similar overall SIMD profile to pregnant women in Dundee in 2009 was recruited with good representation from deprived areas which is often a problem in studying breastfeeding. Excellent follow-up through each phase of the study was achieved, and the quantitative phase was complemented by a large amount of qualitative data gathered from a diverse sample of participants with a range of feeding experiences.[25]

Our cohort's figures for breastfeeding are broadly consistent with national and local rates of breastfeeding. 68% of the sample started breastfeeding compared to local figures 59% (local maternity database, 2009). Over the 6 – 8 weeks period 29.1% – 33.9% were exclusively breastfeeding and 44.1% – 48.3% were offering some breast milk. In comparison, Dundee City figures were: exclusive = 23.3%, and any = 33.4%; while the exclusive breastfeeding figure at 6-8 weeks for Scotland was 26.5%.[27] The generally higher rates at all time-points may be accounted for by the slightly higher numbers of women in our study from more affluent areas, while the national Infant Feeding Survey data is based on retrospective reports.[7] The texting in itself may have acted as an intervention to encourage continuation of breastfeeding. It is also possible that our figures are more accurate as they are based on prospective real-time texts from the women. Overall, the consistency with known official statistics lends added validity to our results.

The mean score on the IIFAS (58.8, SD 9.36) was similar to that reported by de la Mora (1999)[11] The dichotomous nature of the 'Intentions' variable suggests that in the latter stages of pregnancy most women are clear about how they plan to feed their baby, with only a few being undecided. As in previous studies of breastfeeding using the TPB, intentions were explained by PBC, attitudes and the IOWA score with demographic variables accounting for less of the variance.[11, 28,29,30]

The Kaplan-Meier plots show the expected pattern of breastfeeding cessation, with the steepest drop-off occurring in the first couple of weeks after birth in all women for exclusive breastfeeding. However, large differences in the duration of breastfeeding could be observed between groups. In particular parous women with no previous breastfeeding experience stopped very quickly after birth, while primiparous women showed a similar pattern of duration to those parous women who did have previous breastfeeding experience so prior experience of breastfeeding is a strong predictor. This is similar to the findings of the recent Scottish Infant Feeding Survey data from 2010.[7]

In the prediction models, as others have found, [31] while demographic measures were important, the measures of intention (TPB) and attitude to breastfeeding (IIFAS score) were the strongest predictors of both initiation and stopping breastfeeding. However, intention was stronger for initiating breastfeeding, while attitude was stronger for persevering with breastfeeding. This has important clinical implications. We suggest that the current interpretation of the UNICEF Baby Friendly guidelines should be revisited. Our findings indicate that a discussion with women about their intentions, in combination with an exploration of their attitude to formula feeding and breastfeeding (perhaps through use of the IIFAS) could be a powerful way of identifying those women who might need more help and support with both initiating and persevering with breastfeeding. The findings also lend weight to the targeting of younger women and women from lower socioeconomic backgrounds both for extra encouragement to breastfeed and for additional breastfeeding support. Similar to other studies that have measured PBC in pregnancy, PBC was not a significant independent predictor of breastfeeding initiation.[31,32] However, unlike McMillan et al[31] we found that PBC was a weaker predictor of continuation than attitudes. Questions remain about the best time to measure PBC in relation to breastfeeding and the measures that should be used.

Importance to NHS and possible implementation

Breastfeeding is known to have significant short and long-term health benefits for both mother and infant. Increasing the number of breastfed babies through targeted interventions has potential to prevent future ill-health, save the NHS money and is congruent with Government policy.[3,3-3,5] The findings of this study can be used both to identify women who need additional support and to inform the design of interventions to promote and support breastfeeding using a prediction model. Antenatal and public health interventions should aim to improve attitudes to breastfeeding generally and improve women's confidence in their ability to breastfeed. There is a need to target primigravidae during pregnancy and in the early postnatal days and weeks: as success with breastfeeding in the first pregnancy is likely to lead to more chance of feeding successfully in subsequent pregnancies. Parous women with no previous breastfeeding experience need the most support as they are most likely to give up quickly. The use of antenatal measures of intention and attitude to breastfeeding might be useful to identify women who are likely to need more support in the early days and weeks after delivery. Increased levels of support, perhaps from other women who have successfully breastfed might be an effective intervention strategy.

Future research

This study has followed phase 1 of the MRC process, that is, collection of initial data and determining predictors of outcome.[23] The next stage will be to develop a complex interventions based on these findings both to improve rates of initiation of breastfeeding and to provide targeted support to those who commence breastfeeding. In addition, the discriminative ability for initiation was excellent but only moderate for stopping breastfeeding, while intention (TPB) was most important for initiating and attitude (IIFAS) most important for persevering with breastfeeding. This suggests there may be further factors in stopping that could be investigated; future studies could explore this issue.

This study demonstrated the benefits of SMS messaging to collect data and so can easily be used in other studies to collect similar data. In addition text messaging may have potential as a cost-effective and convenient way to provide health information and support messages as part of a

complex intervention. These suggestions could apply to breastfeeding, as well as having application in many other health arenas.

Conclusions

This landmark study used SMS text messaging to gather real-time data on infant feeding from birth to 16 weeks postnatal. It provides the most detailed and comprehensive data on the form and method of infant feeding. The results are consistent with Scottish national figures, hence enhancing the validity of our findings.

The construct of 'Intentions' (from the TPB) and a measure of attitude to breastfeeding (the IIFAS score) have been shown to be important in predicting future infant feeding behaviour, as well as socioeconomic background. Primigravidae and parous women with no previous breastfeeding experience are likely to need the most support as these groups are least likely to commence breastfeeding, and most likely to stop early.

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Contributors: PTD designed the study, supervised the statistical analysis, drafted the final paper and approved the final version; JD designed the study, involved in design of collection tools, commented on drafts and approved the final version; AS designed the study, contributed to collection tools, commented on drafts and approved the final version; PR carried out the statistical analysis, contributed to drafts and approved the final version; EM-H involved in design of collection tools, collected data, commented on drafts and approved the final version; GK involved in design of collection tools, collected data, commented on drafts and approved the final version; JW designed the study, supervision of the data collection, commented on drafts and approved the final version; HMW designed the study, involved in design of data collection tools, supervised the study as PI, commented on drafts and approved the final version.

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Data sharing: No additional data are available.

Contribution to third party material where-ever it may be located; and, vi) licence any third party to do any or all of the above."

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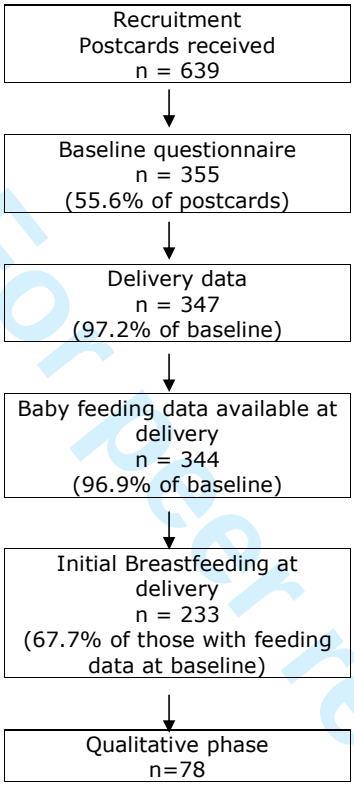

Figure 1: Flow chart of participant recruitment

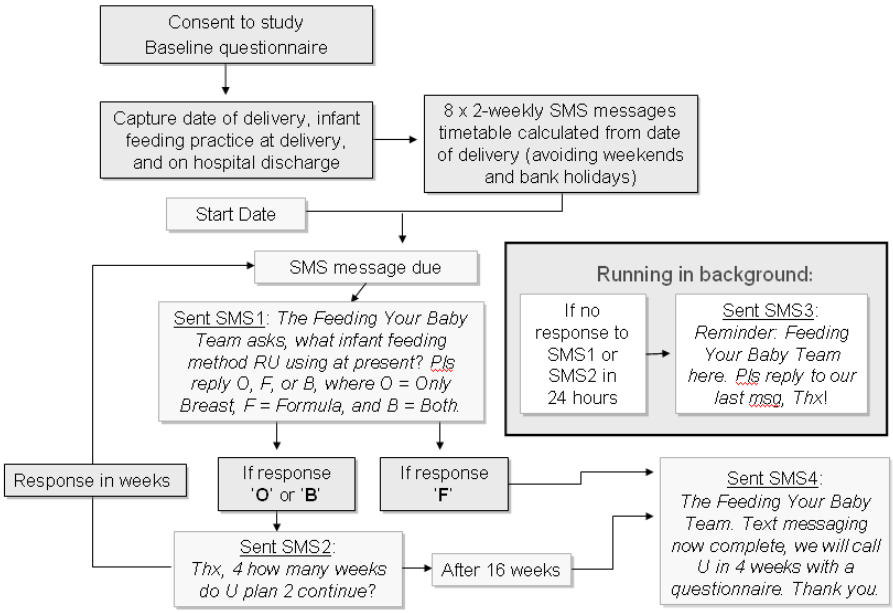

Figure 2: Schedule of SMS messages

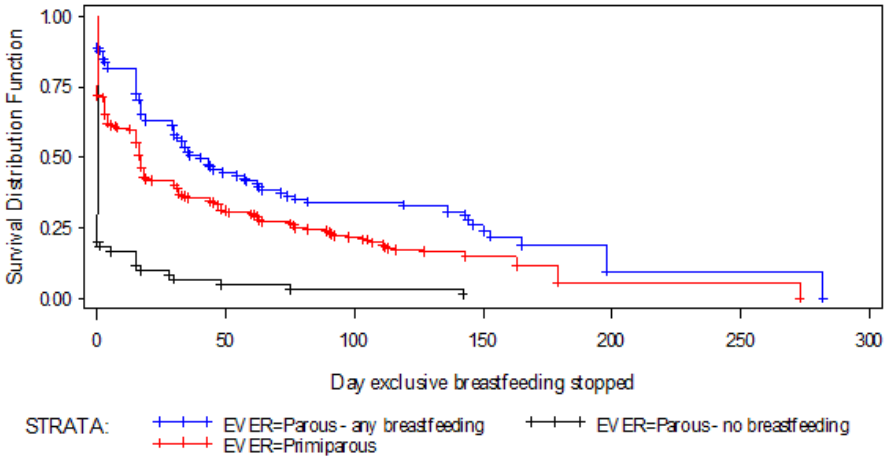

Figure 3a: Time to end of exclusive breastfeeding (WHO) in all women

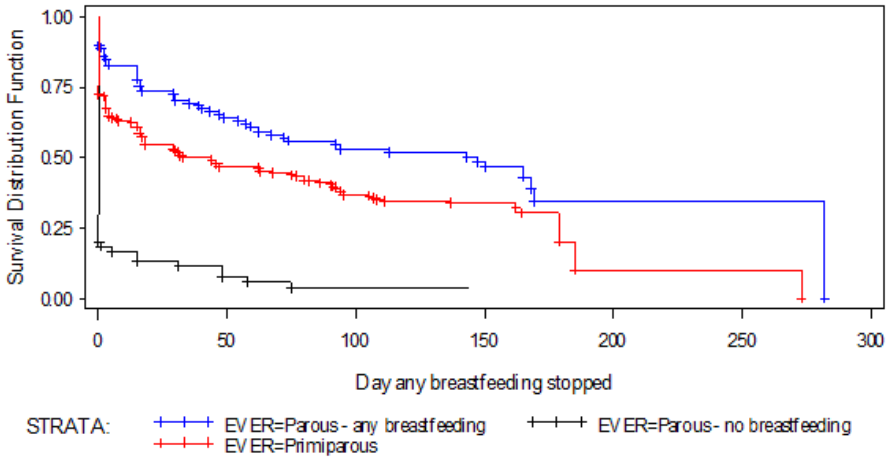

Figure 3b: Time to end of any breastfeeding in all women

Table 1: Characteristics of Women by feeding method at Baseline delivery (n = 344)

	Women who did not initiate breastfeeding (n = 111) *Mean (SD) or **% (N)	Women who initiated breastfeeding (n = 233) Mean (SD) or % (N)
Gestation at baseline (weeks)*	32.5 (5.328)	31.7 (5.91)
Age (years)*	26.6 (6.21)	29.6 (5.42)
Years since leaving school*	15.9 (2.83)	17.9 (1.83)
Relationship status**		
Single	22.5 (25)	5.2 (12)
Married	29.7 (33)	55.8 (130)
With partner	46.8 (52)	38.6 (90)
Other	0.0 (0)	0.4 (1)
Missing	0.9 (1)	0.0 (0)
Living status**		
On own	17.1 (19)	2.6 (6)
With husband or partner	58.6 (65)	89.3 (208)
With parents	15.3 (17)	5.2 (12)
Other	6.3 (7)	1.3 (3)
Missing	2.7 (3)	1.7 (4)
Parity**		
First child	45.0 (50)	54.5 (127)
Second child	30.6 (34)	29.2 (68)
Third child or more	21.6 (24)	12.5 (29)
Missing	2.7 (3)	3.9 (9)
Previous breastfeeding experience		
Primiparous	47.7 (53)	58.4 (136)
Parous – no previous breastfeeding experience	43.2 (48)	5.2 (12)
Parous – previous breastfeeding experience	9.0 (10)	36.5 (85)
Missing	0.0 (0)	0.0 (0)
SIMD Quintile**		
Quintile 1 (most deprived)	47.7 (53)	30.5 (71)
Quintile 2	20.7 (23)	10.3 (24)
Quintile 3	8.1 (9)	12.4 (29)
Quintile 4	15.3 (17)	30.9 (72)
Quintile 5 (most affluent)	7.2 (8)	15.9 (37)
Missing	0.9 (1)	0.0 (0)
Occupations**		
Higher managerial, administrative and professional occupations	24.3 (27)	60.1 (140)
Intermediate occupations	16.2 (18)	12.0 (28)
Routine and manual occupations	18.9 (21)	11.6 (27)
Not in paid employment	34.2 (38)	15.5 (36)
Missing	6.3 (7)	0.9 (2)
Total IIFAS score	49.8 (6.29)	62.8 (7.46)

	Women who did not initiate breastfeeding (n = 111) *Mean (SD) or **% (N)	Women who initiated breastfeeding (n = 233) Mean (SD) or % (N)
TPB score 1: Attitude to breastfeeding	2.6 (0.76)	4.2 (0.68)
TPB score 2: Subjective norm	2.2 (0.3)	3.3 (1.0)
TPB score 3: Perceived behavioural control	2.6 (0.84)	3.8 (0.76)
TPB score 4: Intention to breastfeed†	1.7 (0.96)	4.4 (0.96)
TPB score 4: Intention to breastfeed categorical (% (number)∞		
No breastfeeding intended	60.4 (67)	3.0 (7)
Undecided	38.7 (43)	45.1 (105)
Definite breastfeeding intended	0.0 (0)	51.9 (121)
Missing	0.9 (1)	0.0 (0)

†: on a scale of 1 – 5
∞: 1 = No breastfeeding intended; 2 – 4 = Undecided; 5 = Definite breastfeeding intended

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Table 2 Results of Multiple Logistic Regression of factors associated with initiating breast feeding (n = 344)

Variable	~~O~~RR (95% CI)	Chi Squared	p-value
Age (years)	1.11~~4~~ [1.00~~3~~ to 1.24~~37~~]	4.077	0.044
Parity			
Parous - no breastfeeding vs Primiparous	0.2~~18~~2 [0.12~~052~~ to 0.~~863~~69]	7.798	0.005
Parous - any breastfeeding vs Primiparous	2.67~~015~~ [~~0~~1.15~~47~~ to ~~7~~6.184~~26~~]	5.294	0.021
TPB score 4: Intention to breastfeed	4.67~~68~~ [2.91~~09~~ to 7.49~~1~~]	40.759	<.0001
Total IIFAS Score	1.17~~3~~ [1.06~~58~~ to 1.30~~0~~]	9.238	0.002
Living Status			
With husband or partner vs On own	~~13~~6.07~~862~~ [2.07~~241~~ to ~~85~~17.72~~28~~]	10.806	0.001
With parents vs On own	~~3~~1.55~~45~~ [0.38~~79~~ to ~~33~~6.27~~171~~]	0.381	0.537
Other vs On own	0.24~~554~~ [0.03~~21~~ to ~~14~~2.27~~686~~]	1.542	0.214

Table 3: Predicted breastfeeding rates at different timepoints according to parity and any breastfeeding of previous children (from SMS data n = 344)

		Exclusive Breastfeeding		Any Breastfeeding	
	Time	%	CI	%	CI
All	Baseline	67.6	[0.62 to 0.72]	68.2	[0.63 to 0.73]
	6 weeks	33.9	[0.29 to 0.39]	48.3	[0.43 to 0.53]
	8 weeks	29.1	[0.24 to 0.34]	44.1	[0.39 to 0.49]
	16 weeks	20.4	[0.16 to 0.25]	34.5	[0.29 to 0.40]
	Exit Interview	3.3	[0.00 to 0.12]	8.5	[0.01 to 0.27]
Primiparous	Baseline	71.7	[0.65 to 0.78]	72.3	[0.65 to 0.78]
	6 weeks	34.3	[0.28 to 0.41]	50.1	[0.43 to 0.57]
	8 weeks	29.3	[0.23 to 0.36]	46.7	[0.39 to 0.54]
	16 weeks	18.8	[0.14 to 0.25]	34.5	[0.28 to 0.41]
	Exit Interview	5.8	[0.01 to 0.18]	10.1	[0.01 to 0.32]
Parous - no previous breastfeeding	Baseline	20.0	[0.11 to 0.31]	18.3	[0.10 to 0.29]
	6 weeks	5.0	[0.01 to 0.13]	11.7	[0.05 to 0.21]
	8 weeks	5.0	[0.01 to 0.13]	5.8	[0.02 to 0.14]
	16 weeks	3.9	[0.01 to 0.13]	5.0	[0.01 to 0.12]
	Exit Interview	1.7	[0.00 to 0.08]	3.9	[0.01 to 0.12]
Parous - with previous breastfeeding experience	Baseline	88.8	[0.81 to 0.94]	89.8	[0.82 to 0.94]
	6 weeks	46.6	[0.36 to 0.56]	67.2	[0.57 to 0.76]
	8 weeks	41.4	[0.32 to 0.51]	62.0	[0.52 to 0.71]
	16 weeks	33.0	[0.24 to 0.42]	52.6	[0.42 to 0.62]
	Exit Interview	9.3	[0.01 to 0.28]	34.6	[0.21 to 0.49]

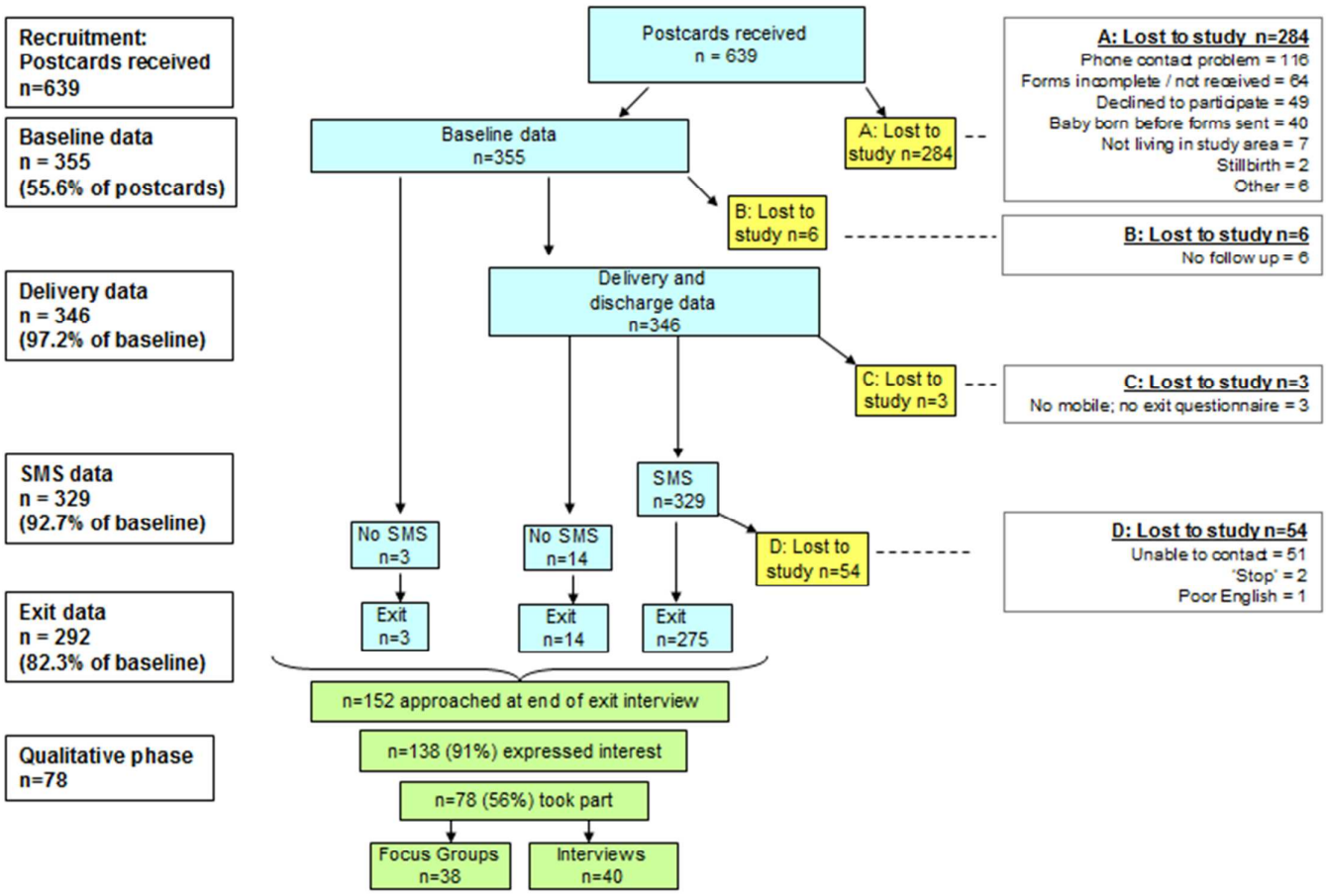
Table 4a: Final model using Cox Regression to predict stopping 'Exclusive' breastfeeding (n = 233)

Variable	Hazard Ratio	CI	p-value
Parous - any breastfeeding	0.873	[0.63 to 1.21]	0.4103
Parous - no breastfeeding	0.809	[0.41 to 1.58]	0.5367
Primiparous	1.000		
Higher managerial, administrative and professional occupations	0.726	[0.46 to 1.15]	0.1716
Intermediate occupations	0.789	[0.44 to 1.41]	0.4246
Routine and manual occupations	0.880	[0.50 to 1.56]	0.6601
Not in paid employment	1.000		
TPB score 4: Intention to breastfeed (High vs low)	0.715	[0.53 to 0.97]	0.0317
Total IIFAS Score (+ 10 units)	0.553	[0.43 to 0.71]	<.0001

Table 4b: Final model using Cox Regression to predict stopping 'Any' breastfeeding (n=233)

Variable	Hazard Ratio	CI	p-value
Parous - any breastfeeding	0.829	[0.56 to 1.22]	0.3426
Parous - no breastfeeding	1.079	[0.51 to 2.26]	0.8403
Primiparous	1.000		
Higher managerial, administrative and professional occupations	0.602	[0.37 to 0.99]	0.0457
Intermediate occupations	0.622	[0.32 to 1.21]	0.1619
Routine and manual occupations	0.714	[0.37 to 1.39]	0.3215
Not in paid employment	1.000		
TPB score 4: Intention to breastfeed (High vs Low)	0.569	[0.39 to 0.82]	0.0026
Total IIFAS Score (+ 10 units)	0.549	[0.41 to 0.74]	<.0001

Appendix 2: Flowchart of recruitment and attrition to study



Appendix 3: Theory of Planned Behaviour Variables

All variables measured on a scale of 1 – 5.

Attitude:

1. How beneficial do you think it would be to exclusively breastfeed your baby for 16 weeks? ('not at all' to 'extremely')
2. How beneficial do you think it would be to introduce your baby to other forms of feeding during the first 16 weeks? ('not at all' to 'extremely')
3. How much you would like to breastfeed until your baby is 16 weeks old? ('definitely would like' to 'definitely would not like')
4. How much do you care about whether you breast feed until the baby is 16 weeks old? ('not very much' to 'much as possible')

Social Norm:

5. How much would you try to breast feed until the baby is 16 weeks old over the next month in order to please your partner/ relative? ('not very much' to 'much as possible')
6. Do you think your partner/family feels you should breast feed until your baby is 16 weeks old? ('definitely should' to 'definitely should not')

Perceived behavioural control

7. How confident are you that you will breastfeed until your baby is 16 weeks old? ('not at all confident' to 'extremely confident')
8. How difficult will it be for you to breastfeed until your baby is 16 weeks old? ('not at all difficult' to 'extremely difficult')
9. How much control do you feel you have over whether you will breastfeed until your baby is 16 weeks old? ('no control at all' to 'complete control')

Intention

10. Do you intend to try to breast feed until the baby is 16 weeks old? ('definitely yes' to 'definitely no')
11. Do you plan to breast feed until the baby is 16 weeks old? ('definitely yes' to 'definitely no')
12. At this moment are you likely to breast feed until the baby is 16 weeks old? ('definitely yes' to 'definitely no')
13. Are you likely to breast feed until the baby is 16 weeks old? ('definitely yes' to 'definitely no')