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To What Extent Does Maternal Body Mass Index (BMI) Predict Intentions, Attitudes or Practices of Early Infant Feeding?

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Abstract

Background: Public health guidelines recommend women establish and maintain exclusive breastfeeding to six months postpartum. Women with a Body Mass Index (BMI kg/m^2) in the overweight or obese range are less likely to initiate and continue breastfeeding than healthy weight women. Evidence for psychological mechanisms of this association using validated methods of measurement is limited, but factors such as attitudes and intentions for infant feeding are implicated. This study aimed to investigate the associations between maternal BMI, antenatal attitudes and intentions for infant feeding, and subsequent breastfeeding practices. *Methods:* A total of $N = 128$ women completed an online questionnaire antenatally and $n = 48$ were followed-up in the first month postpartum. Validated measures of Intentions (IFIS) and Attitudes (IIFAS) for infant feeding were used. One-way analysis of variance (ANOVA) and multivariate regression analyses assessed study objectives. *Results:* Infant feeding attitudes ($p = .327$) and intentions ($p = .254$) were similar among healthy weight, overweight, and obese women and did not differ significantly. In adjusted regression models, only intentions significantly predicted early breastfeeding behaviour ($p = .036$; $AR^2 = .301$). Missing data analysis revealed no significant differences in the profile of completing versus non-completing women. *Discussion:* Evidence suggests postnatal factors contribute significantly to lower breastfeeding rates in cohorts of women with overweight or obese BMIs. Further investigations should consider using theory and methods from behavioural science to longitudinally investigate modifiable mechanisms of action responsible for lower breastfeeding rates among overweight and obese women to inform practices that support prolonged breastfeeding.

Keywords: Infant Feeding; Breastfeeding; Maternal Obesity; Maternal BMI; Infant Feeding Intentions; Attitudes

Title: To What Extent Does Maternal Body Mass Index (BMI) Predict Intentions, Attitudes or Practices of Early Infant Feeding?

Background

The WHO (2013) currently recommends infants are exclusively breastfed for the first six months of life due to the multiple nutritional and wider health benefits for both mothers and infants (Horta, Bahl, Martines & Victora, 2007; Victora et al., 2016). Despite the recognized benefits, breastfeeding rates worldwide remain low with only 37% of infants being exclusively breastfed to six months (Victora et al., 2016). Research from the UK indicates that although initiation rates are relatively high (81%), at 6-8 weeks postpartum only 42.7% of women are still breastfeeding (Public Health England [PHE], 2018), and at six months postpartum less than 1% of women are breastfeeding exclusively (McAndrew et al., 2012).

Recent evidence suggests women with a pre-pregnancy Body Mass Index (BMI) (kg/m^2) in the overweight (25-29.9kg/m^2) or obese (≥30kg/m^2) range are less likely to initiate and continue breastfeeding to the same extent as women who have a healthy BMI (18.5-24.9 kg/m^2) (Amir & Donath, 2007; Mäkelä et al., 2014; Turcksin, Bel, Galjaard & Devlieger, 2012; Wojcicki, 2011). Meta-analytic evidence estimates women with pre-pregnancy BMI in the overweight or obese range are up to 60% more likely (95% CI [1.47, 1.74]) to cease exclusive breastfeeding in the first six months postpartum than women with BMI in the healthy range (Flores, Mielke, Wendt, Nunes & Bertoldi, 2018). The aetiology of the association between increased maternal BMI and poorer breastfeeding outcomes is yet to be fully understood, although evidence available suggests multifactorial mechanisms.

Biological factors such as delayed lactogenesis (Amir & Donath, 2007; Nommsen-Rivers, Chantry, Peerson, Cohen & Dewey, 2010) and metabolic imbalances, and

physiological challenges latching and positioning infants (Babendure et al., 2015; Garner, Ratcliff, Devine, Thornburg & Rasmussen, 2014) are implicated, alongside psychosocial factors. Emerging evidence indicates women with a pre-pregnancy BMI ≥30kg/m^2 have greater perceived insufficient milk supply (Jarlenski et al., 2014), less vicarious breastfeeding experience (Hauff, Leonard & Rasmussen, 2014; Mok et al., 2008), more discomfort nursing in social situations (Newby & Davies, 2016), lower body confidence in the context of breastfeeding (Garner et al., 2014) and different support-seeking behaviours (Molyneaux, Poston, Ashurt-Williams & Howard, 2014). These factors may, in part, contribute to lower rates of breastfeeding initiation and reduced duration.

In attempts to identify malleable targets for breastfeeding promotion interventions, infant feeding research has frequently employed the theoretical framework of the Theory of Planned Behaviour (TPB) (Azjen, 1991; 2002) to examine sociocultural and psychological factors associated with breastfeeding practices. The TPB proposes intention is the predominant determinant of behaviour, and that intentions are predicted by three constructs: attitudes (positive and/or negative appraisal of the behaviour), perceived behavioural control (perception of how much control an individual has to perform the behaviour), and subjective norms (appraisal of societal expectations about performing the behaviour) (Azjen, 1991; 2002). Theoretically, more positive attitudes, greater perceived behavioural control, and greater or more positive subjective norms predict greater behavioural intentions, and subsequently increase the likelihood of performing the behaviour.

Evidence from cross-sectional and prospective cohort studies using the TPB to predict breastfeeding behaviour indicate women with greater breastfeeding intentions (Bai, Middlestadt, Peng & Fly, 2010; Donnan et al., 2013; Martinez-Brockman, Shebl, Harari, & Pérez-Escamilla, 2017; McMillan, 2008), greater self-efficacy/perceived behavioural control (Ismail, Muda & Bakar, 2016; Martinez-Brockman et al., 2017), and more breastfeeding-

positive beliefs and attitudes (Dodgson, Henly, Dcukettt & Tarrent, 2003; Lawton, Ashley, Dawson, Waiblinger & Connor, 2012) are more likely to start and continue breastfeeding. Evidence for the associations between subjective norm, intentions and breastfeeding behaviours is limited and conflicting (Ismail, Muda & Bakar, 2013; Kloeblen, Thompson & Miner, 1999; McMillan et al., 2009), perhaps because a validated questionnaire measure of subjective norms is not currently available. Evidence using the TPB to predict breastfeeding is limited methodologically as studies often do not measure breastfeeding behaviours performed (Bai et al., 2010; McMillan et al., 2009), and only capture perceptions during the postnatal period (Dodgson et al., 2003). As such, there is a question about the extent to which variables in the TPB measured antenatally accurately predict breastfeeding behaviours, with a paucity of evidence for this among cohorts of women who are overweight and obese.

Recent systematic review evidence suggests women with obesity are significantly less likely to intend to breastfeed (Lyons, Currie, Peters, Lavendar & Smith, 2018), and argues such reduced intentions contribute to lower breastfeeding rates in this cohort compared to healthy weight counterparts (Turcksin et al., 2012). Although this association is theoretically supported by the conceptual framework of the TPB (Azjen, 1991; 2002), the methodological quality in the measurement of infant feeding intention is consistently poor (Lyons et al., 2018) with studies frequently using dichotomous or unvalidated scales, meaning associations are likely to be tenuous. For example, a national longitudinal cohort study using a categorical measurement of intention found no differences in intentions for infant feeding according to maternal pre-pregnancy BMI status (Hauff et al., 2014). Among studies comparing perceptions and practices of breastfeeding among obese and non-obese women, attitudes for breastfeeding are typically measured using scales that are not psychometrically validated (Hauff et al., 2014; Hilson, Rasmussen & Kjolhede, 2004), or theoretically informed (Jarlenski et al.,2014; O'Sullivan, Perrine & Rasmussen, 2015). Furthermore, longitudinal

evidence examining the influence of psychological factors on early feeding practices among cohorts of women who are overweight or obese is lacking, making it difficult to identify causal factors.

Infants whose mothers are overweight or obese at pregnancy commencement are significantly more likely to be overweight or obese in childhood and are at increased risk of associated diseases (e.g. metabolic syndrome, diabetes and hypertension) (Godfrey et al., 2016; O'Reilly & Reynolds, 2012; Poston, 2012). Breastfeeding significantly reduces the risk of childhood obesity (Victora et al., 2016; Yan, Liu, Zhu, Huang & Wang, 2014) and associated health morbidities (Horta, Loret de Mola & Victora, 2015; Martin, Gunnell & Davey Smith, 2005). As the proportion of women who are obese pre-pregnancy is rising (Poston et al., 2016), it is important to investigate modifiable factors associated with breastfeeding practices among cohorts of women who are overweight and obese in order to provide targeted interventions strategies aimed at improving the lifespan health of women and their infants. Investigating breastfeeding practices in this cohort using the theoretical guidance of the TPB and psychometrically validated measurement tools available, could provide direction for theoretically informed support strategies. This study therefore aimed to use validated measurement scales informed by the Theory of Planned Behaviour (Azjen, 1991; 2002) to explore whether psychological constructs of attitudes and intentions for infant feeding are different according to maternal BMI status, and investigate the extent to which these contribute to early infant feeding practices.

Aims and Objectives

This study aimed to identify 1) whether antenatal attitudes or intentions for infant feeding differ according to maternal BMI status; 2) explore the extent to which maternal BMI independently predicts both attitudes and intentions for infant feeding; and 3) identify to what

extent maternal BMI, and antenatal attitudes and intentions for infant feeding predict early infant feeding practices.

Methodology

Design

An online questionnaire study recruiting women at least 34^{+0} weeks pregnant with a follow-up questionnaire within the first month postpartum.

Participants

Women were eligible for the antenatal questionnaire if they reported they were 18 years or older, at least 34^{+0} weeks pregnant, expecting a healthy singleton baby and currently living in the UK. Women were recruited into the study online between 21-December-2017 and 31-March-2018 on a voluntary opportunity basis. To be eligible to complete the follow-up questionnaire, women had to have delivered a healthy full term ($\geq 37^{+0}$ weeks) baby who was well and at home, and not admitted to a neonatal care unit.

Procedure

Online advertisements for the study were displayed on social media and internal institutional research pages, and paper advertisements were displayed in local public notice boards. JISC Online Surveys was used a platform for online data collection. Women were recruited into the study by clicking or accessing the study link advertised. A study information page and consent form were displayed at the beginning of the questionnaires, ensuring women read and fully consented before choosing to continue to complete the questionnaires. Eligibility was then assessed via self-report. Women who did not meet eligibility criteria were screened out prior to questionnaire completion. The antenatal questionnaire contained three sections capturing women's sociodemographic information ('About you'), information about their pregnancy and health ('About your pregnancy'), and 'About Infant Feeding' practices and previous experience(s), including attitudes and

intentions for feeding their newborn. At the end of the questionnaire women selected whether to take part in the follow-up questionnaire, which was sent to them via email in the first month postpartum based on their estimated due date.

The follow-up questionnaire was designed to collect information about women's 'Baby and Birth' and their 'Feeding Practices': initial infant feeding (first 48 hours), and current feeding (last 48 hours). As a token of appreciation for participating, women were offered the opportunity to enter a prize draw at the end of each questionnaire to win a shopping voucher for a popular mother and infant department store. Ethical approval was awarded by institutional level Research Ethics Committee (LRS-17/18-5158).

Measures and Materials

Antenatal Questionnaire.

The antenatal questionnaire collected data on women's age, ethnicity, marital status, education, socioeconomic status (UK Index of Multiple Deprivation [IMD]) (ONS, 2015), BMI (kg/m^2) (from self-reported pre-pregnancy height and weight), parity, diabetic status and estimated due date. Previous infant feeding experience was assessed on an 11 point scale of proportionate infant feeding. The scale invites women to rate what proportion (%) of their older children's feeds in the first six months of life were breastmilk and/or formula milks, ranging from 100% formula-fed to 100% breastfed (which includes feeding baby expressed breastmilk) in 10% increments.

The Iowa Infant Feeding Attitude Scale (IIFAS) (Mora, Russell, Dungy, Losch & Dusieker, 1999) is a self-report, validated questionnaire used to assess attitudes and perceptions of infant feeding. The scale includes 17 statements about feeding practices rated on a five point likert scale of agreement (Strongly Disagree to Strongly Agree). Items are summed to create a total score between 17 (more positive attitude to formula feeding) to 85 (more positive attitude towards breastfeeding). Items on the scale include, for example,

"Breastfeeding increases mother-infant bonding", "Formula milk is as healthy for an infant as breastmilk" and "Fathers feel left out if a mother breastfeeds".

Intentions for infant feeding were investigated using the Infant Feeding Intentions Scale (IFIS) developed by Nommsen-Rivers and Dewey (2009); a validated scale. The IFIS includes five statements about the intended duration and exclusivity of breastfeeding such as "When my baby is 1 month old, I will be breastfeeding without using any formula or other milk", which are rated on a five point likert scale of agreement (Strongly Agree to Strongly Disagree). Item scores are summed to provide a total score between 0 (intention to not breastfeed at all) to 16 (strong intention to exclusively breastfeed to six months postpartum).

Postnatal Questionnaire

The postnatal follow-up questionnaire collected data on infant's date of birth, sex, birthweight and delivery. Initial and current infant feeding was assessed using the proportionate scale of infant feeding by asking women how their new baby was fed in the first 48 hours of birth, and last 48 hours respectively.

Statistical Analysis

Descriptive and appropriate inferential statistics were used to explore sample characteristics, including missing data analysis of study completers. One-way analyses of variance were used to investigate whether attitudes and intentions for infant feeding differed according to maternal BMI status. A small proportion of women included in the sample (n = 3) reported a BMI <18.5 kg/m^2, indicating they were 'underweight', and were collapsed into the healthy weight BMI group. Sensitivity analysis revealed this had no significant impact on the direction or magnitude of overall results observed. Multivariate regression analyses were used to assess the relative influence of maternal BMI status on attitudes and intentions, and the extent to which maternal BMI, attitudes and intentions were associated with early postnatal feeding practices. Multivariate regression models were adjusted for potential

confounding correlates of the outcome. All analyses were performed using Stata (Version 15.0).

A power analysis indicated at least $n = 119$ women are needed to detect a medium effect of the influence of maternal intentions for infant feeding on early postnatal feeding practices, assuming $\alpha = .05$ level of significance, controlling for up to seven sociodemographic and clinical factors

Results

Sample Characteristics

In total, 168 women accessed the online survey, of which 29 were ineligible and screened out prior to questionnaire completion. A total of 139 women completed the antenatal questionnaire but 11 responses were excluded from analysis: eight women were less than 34^{+0} weeks pregnant at time of questionnaire completion and three responses were deemed unreliable. A total of $N = 128$ responses were included in analyses.

Table 1 provides a summary of demographic and clinical characteristics for women included in the sample. The average age of women in the sample was 31.10 years ($SD = 4.82$). The majority of women were white (93.0%), born in the UK (87.5%), married or cohabiting with a long-term partner (93.7%), and educated to degree level (64.0%). There was variation in relative deprivation amongst the sample, although women tended to reside among less deprived areas of the UK. Over half of women had a healthy BMI, while 25.8% were classified with an overweight and 22.7% with an obese BMI. There were no statistically significant associations between sociodemographic characteristics and maternal BMI (see Table 1). Most women were multiparous: 50% ($n = 64$) were having their second baby, 10.9% ($n = 14$) were having their third baby, and two women (1.6%) were having their fourth and fifth baby respectively. On average, women were 36.92 weeks ($SD = 2.04$) pregnant

when they completed the antenatal questionnaire.

The majority of multiparous women had previous experience breastfeeding their infants in the first six months, with 34.4% reporting exclusive breastfeeding and 10.9% exclusively formula feeding for six months with their eldest child. Among women with two or more children, most exclusively breastfed their second eldest to six months (n = 10; 7.8%) or breastfed at least 70% of the time (n = 3; 2.4%), while some exclusively formula fed (n = 4; 3.1%).

Attitudes According to Maternal BMI

Women's attitudes to feeding practices were relatively breastfeeding-positive (M = 66.81, SD = 10.47). A full summary of responses is available in Online Supplement 1 (see Table S1). A one-way analysis of variance observed attitudes to infant feeding did not differ significantly according to maternal BMI status (F (2, 125) = 1.129, p =.327). Post-hoc comparisons using Tukey HSD test confirmed the observed main effect (see Table 2).

Intentions According to Maternal BMI

Women had strong intentions to breastfeed exclusively throughout the postpartum period (M = 12.54, SD = 3.85), although the intensity of intentions decreased over time: 51.6% of women strongly intended to exclusively breastfeed to one month, 49.2% to three months, and 42.2% to six months (see Online Supplement 1 Table S2 for full descriptives). Although women in the healthy BMI category had the strongest intentions to exclusive breastfeed to six months (see Table 2), there were no significant differences in intentions for breastfeeding depending on women's BMI status (F (2, 125) = 1.385, p =.254). The main effect observed was confirmed with post-hoc analysis.

Predicting Attitudes

Maternal BMI status (healthy weight vs. overweight vs. obese) was not significantly associated with attitudes to infant feeding in adjusted regression model (F (16, 64) = 4.25, p <.001; AR^2 = .393). Women's previous experience with breastfeeding was the only significant predictor of attitudes to infant feeding (see Table 3). Women with more previous experience of breastfeeding had significantly more breastfeeding-positive attitudes to infant feeding (p = .003). However, having more previous formula feeding experience was not associated with more formula feeding-positive attitudes (p = .791).

Predicting Intentions

In the adjusted regression model (F (13, 67) = 14.74, p <.001; AR^2 = .691), maternal BMI status was not significantly associated with women's intentions for infant feeding (p = .801) (see Table 4). Women with more previous experience with breastfeeding (β = .019, p = .010), less previous experience with formula feeding (β = -.023, p = .005) and more breastfeeding-positive attitudes (β =.145, p <.001) had significantly higher intentions to exclusively breastfeed throughout the postpartum period.

Missing Data Analysis

A total of n = 113 (88.3%) women agreed to be followed-up postnatally, but only n = 48 (42.48%) completed the follow-up postnatal questionnaire. Comparative analyses revealed women who did not agree to follow-up were significantly younger (Mean Difference [MD] = -2.76, Standard Error Difference [SED] = 1.31, p = .037), had less positive attitudes to breastfeeding (MD = -11.57, SED = 2.69, p <.001), and weaker intentions for prolonged exclusive breastfeeding (MD = -3.14, SED = 1.03, p = .003) than women who agreed to follow-up. However, comparative analysis among women who responded to the postnatal

invitation (n = 48) and women who did not respond (n = 65) revealed no significant demographic, attitudinal or intentional differences. Specifically, maternal BMI was not significantly associated with whether women responded to the follow-up questionnaire (χ^2 = 2.47, p = .291). Drop-out rates were high across all BMI groups: 56.1%, 72.3% and 65.5% among healthy, overweight and obese women respectively. There was no significant difference in the average BMI between women who did (M = 25.85, SD = 5.19) and did not respond (M = 26.89, SD = 5.88, p = .334)

Predicting Infant Feeding Practices

Women who completed the postnatal questionnaire (n = 48) delivered healthy full-term infants (M = 40.42 weeks, SD = 1.23) between 28 January and 11 May 2018. Most women delivered girls (n = 26), with infants weighing an average of M = 3.65kgs (SD = 0.49). In the first 48 hours after birth women reported that, on average, their infants received almost 90% breastmilk (see Table 2).

At follow-up, infants were M = 14.73 days old (SD = 8.47) and reportedly received breastmilk for 85.21% of their feeds (SD = 28.95) in the last two days (see Online Supplement 1 Figure S1and S2 for full infant feeding practices).

Adjusted multivariate regression analysis of all women completing follow-up (n = 48) revealed only intentions for infant feeding was a significant predictor of current infant feeding practices (F (8, 22) = 2.61, p = .036; AR^2 = .301) (see Table 5). Women with greater intentions for exclusive and prolonged breastfeeding were significantly more likely to breastfeed with greater exclusivity in the first month postpartum (p = .038). Maternal BMI did not predict early feeding practices, and a one-way analysis of variance (F (2, 45) = .08, p = .927) confirmed no significant differences in early breastfeeding practices among healthy weight women (M = 86.21% breastfed), overweight women (M = 85.56% breastfed) or obese

299 women (M = 82.0% breastfed) (see Table 2). Similarly, attitudes for infant feeding did not
300 significantly predict early infant feeding practices (p = .158).
301
302 **Discussion**
303 Maternal antenatal attitudes and intentions for infant feeding did not differ
304 significantly among women with a healthy, overweight or obese BMI. Women with stronger
305 intentions for breastfeeding were significantly more likely to breastfeed with greater
306 exclusivity, but there were no significant differences in breastfeeding practices in the first
307 month postpartum between healthy weight, overweight or obese women.
308 Although TPB (Azjen, 1991; 2002) is frequently used to identify psychosocial
309 associations of breastfeeding behaviour, the predictive utility of the model is low. The
310 variance in breastfeeding practices explained by constructs in the model (attitudes, subjective
311 norm, perceived behavioural control and intentions) ranges from 10% (Ismail et al., 2016) to
312 4% (Wambach, 1997), and is less accurate at predicting breastfeeding behaviour over the
313 postpartum period (McMillan et al., 2008). Intentions for infant feeding in this cohort are
314 consistently measured using dichotomous and categorical scales (Hauff et al., 2014; Jarlenski
315 et al., 2014; Newby & Davies, 2016; Visram et al., 2013; Lyons et al., 2018) which dilutes
316 the wide variability in intentions for infant feeding and subsequently overinflates the
317 magnitude of differences observed. Using the Infant Feeding Intentions Scale (IFIS)
318 (Nommsen-Rivers & Dewey, 2009), which is both theoretically informed and
319 psychometrically validated, observed differences in the strength of intentions to breastfeed
320 among healthy weight, overweight and obese women are negligible.
321 Attitudes towards infant feeding were breastfeeding-positive across women in this
322 study. No differences in beliefs about breastfeeding have been observed in the wider
323 literature with regards to maternal BMI (Lyons et al., 2018), and little evidence is available to

explain why differences in beliefs or attitudes would be dependent on maternal BMI alone. Knowledge and beliefs about breastfeeding vary as a function of access to education and socioeconomic environment (Johnson et al., 2018; McAndrew et al., 2012). Considered together with the recognised inverse association between maternal BMI and socioeconomic status (Poston et al., 2016), attitudes to breastfeeding observed here are likely to be uniformly positive across BMI categories because women in this cohort lived in less deprived areas of the UK with high educational-attainment backgrounds. Findings of this study are supported by previous observations that intentions to breastfeed are also uniformly high among healthy weight, overweight and obese women (Cordero, Oza-Frank, Landon & Nankervis, 2015; Guelinckx, Devlieger, Bogaerts, Pauwels & Vansant, 2011; Newby & Davies, 2016) as well as the UK population (McAndrew et al., 2012).

When antenatal intentions were comparable between obese and non-obese women, rates of breastfeeding initiation and duration were previously observed to be significantly lower among women with a pre-pregnancy BMI ≥30kg/m^2 (Babendure et al., 2015; Lyons et al., 2018; Marshall, Lau, Purnell & Thornburg, 2018). In this study, no differences in feeding practices were recorded in the early postnatal period, suggesting variation in practices may only emerge over time. When women completed follow-up questionnaires, they were still under the care of health professionals who would have supported women through any breastfeeding challenges and encouraged them to continue breastfeeding. As healthcare availability and support diminish over the postnatal period, breastfeeding rates decline (McAndrew et al., 2012) and BMI group-differences may emerge. Followed longer term across the postnatal period, women with a BMI ≥30kg/m^2 were found to have increased risk of early breastfeeding cessation over time (Flores et al., 2018; Wojcicki, 2011). During the early postnatal period, women may also have felt pressured to conform to healthcare professional or societal expectations to breastfeed, which may in part explain the high

exclusivity of breastfeeding practices reported across BMI groups. Average proportions of breastmilk feeds was higher than 80%, which suggests women who were formula-feeding their babies may not have responded.

In the UK, white women have the lowest incidence of breastfeeding (McAndrew et al., 2012) but are more likely to live in the less deprived areas with higher socioeconomic and educational attainment backgrounds, each of which independently increase the likelihood of breastfeeding (McAndrew et al., 2012; Oakley et al., 2014). Women in this sample were predominantly white, but also degree-educated and lived in less socioeconomically deprived areas of the UK, suggesting positive sociodemographic predictors of breastfeeding may have overshadowed any independent effect of maternal BMI on breastfeeding practices. A high proportion of multiparous women with previous breastfeeding experience is likely to have further contributed to the null findings observed. Given the relatively strong sociodemographic predictors of breastfeeding, alternative observations and conclusions from samples with greater ethnic and socioeconomic diversity are likely.

Understanding practices in the well-defined sample observed here is helpful for further scoping the content and necessity of targeted support. Efforts should be made to consider the influence of sociodemographic factors when developing support strategies, as breastfeeding interventions that are socially and culturally tailored have been effective (Dyson et al., 2005; Fairbank et al., 2000). The wider evidence available has identified reduced uptake and duration of breastfeeding across women with overweight and obese BMIs during pregnancy (Amir & Donath, 2007; Mäkelä et al., 2014; Turcksin et al., 2012; Wojcicki, 2011), however the extent to which maternal BMI independently predicts lower rates of breastfeeding initiation and duration may still differ among different sociodemographic and clinical sub-groups of women.

374 **Limitations**

375 The current study did not consider the construct of breastfeeding self-efficacy
376 (comparable to perceived behavioural control) in the associations explored. Self-efficacy is a
377 recognised predictor of breastfeeding initiation and duration across cohorts (DeJagger,
378 Skouteris, Broadbent, Amir, & Mellor, 2013; Lawton et al., 2012; Martinez-Brockman et al.,
379 2017) with evidence to date indicating women with higher BMIs (≥25kg/m^2) may have lower
380 confidence in their ability to breastfeed, both antenatally and postnatally (Babendure et al.,
381 2015; Lyons et al., 2018). Some intervention studies targeting breastfeeding self-efficacy
382 have been successful at increasing rates of exclusive breastfeeding (Noel-Weiss, Rupp,
383 Cragg, Bassett & Woodend, 2006; Wu, Hu, McCoy & Efird, 2014), although this was not
384 observed among cohorts of women with overweight or obese BMIs (Chapman et al., 2013).
385 Self-efficacy may be a key mechanism responsible for observed associations between
386 maternal BMI and reduced uptake and duration of breastfeeding, and should continue to be
387 explored and targeted in intervention.

388 Although sufficiently powered to detect differences in associations between antenatal
389 social-cognitions and maternal BMI, the study is limited by a small sample size (N = 128),
390 particularly in the proportion of women who responded to the postnatal questionnaire (n =
391 48). Despite comparable average proportions of breastmilk feeds across the BMI groups, it is
392 important to note the study was underpowered to detect significant differences in
393 breastfeeding practices between BMI categories. The drop-out rate to respond to the postnatal
394 questionnaire was high (62.5%), most likely due to the timing of questionnaire delivery.
395 Follow-up questionnaires were sent to women between one and 28 days postpartum; a time
396 when motherhood duties and postnatal recovery are priority. As such, drop-out rates across
397 each BMI group were comparatively high and did not differ significantly.

398 Despite this, missing data analysis revealed no significant differences in the

sociodemographic profile of completing versus non-completing women. Observations from this study reinforce the need for future studies to sample purposively on a range of sociodemographic factors including socioeconomic status and ethnicity. Given the online nature of this study, purposive sampling was not undertaken which is a limitation. The sample was recruited opportunistically and was highly homogenous (majority white, low socioeconomic deprivation, highly educated), reflecting a self-selecting bias of women likely to breastfeed, interested in perceptions and practices of infant feeding, and receptive to taking part in research. This limits the generalisability of associations observed outside this well-defined cohort.

Future Research

Plausible mechanisms for differences in antenatal social-cognitions for breastfeeding between obese and non-obese women are yet to be identified, and the extent to which psychosocial factors contribute to reduced rates of breastfeeding uptake and duration previously observed in this cohort remains unclear (Babendure et al., 2015; Lyons et al., 2018). Additionally, intervention studies attempting to improve breastfeeding rates have been limited in effectiveness (Chapman et al., 2012; Rasmussen, Dietterich, Zelek, Altabet & Kjolhede, 2011). One intervention among women with a BMI ≥30kg/m^2 significantly improved rates of exclusive and any breastfeeding across the postpartum period (Carlsen et al., 2013), however underlying mechanisms of action were not identified as psychosocial factors were unaccounted for throughout. A proposed Cochrane review evaluating evidence available for breastfeeding support and interventions in this cohort likewise ignores the role of social-cognitive and psychological associations (Soltani & Fair, 2016). As such, the evidence to date provides little meaningful targets for future intervention.

As intentions for breastfeeding among women who are overweight or obese during

pregnancy remain comparable to women with a healthy BMI (Cordero et al., 2015; Guelinckx et al., 2011; Newby & Davies, 2016) and there were no observed differences in antenatal social-cognitions for infant feeding practices, postnatal factors are likely to be key in supporting prolonged breastfeeding among women with overweight or obese BMIs. The extent to which maternal BMI independently impacts breastfeeding uptake and duration should be examined across sociodemographic and clinical sub-groups to ensure support strategies and necessary and acceptable to women. Longitudinal investigations of associations of infant feeding among cohorts of women who are overweight or obese during pregnancy are needed to identify plausible and modifiable social-cognitive mechanisms of action for use as priority targets in future intervention studies.

Key Messages

- Evidence to date suggests women with a pre-pregnancy BMI in the overweight (25-29.9kg/m^2) or obese (≥30kg/m^2) range are less likely to initiate and continue breastfeeding than healthy weight women
- In a sample of women in the UK, early breastfeeding practices were comparable and did not differ significantly between healthy weight, overweight and obese women
- Validated questionnaire measures found maternal antenatal attitudes were breastfeeding-positive and intentions for exclusive breastfeeding were high, which but did not differ significantly according to maternal BMI
- Given strong antenatal intentions for breastfeeding and comparable initiation rates, postnatal factors are likely to contribute significantly to lower rates of breastfeeding practices in this cohort
- Longitudinal investigations of infant feeding among cohorts of women who are overweight or obese are needed to identify priority targets for intervention strategies

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Table 1
Demographic and Clinical Characteristics of Women and Infants Included in the Sample

Women	**Total*** *n* (%)	**BMI** ≤ 24.9kg/m² (*n* = 66)	**BMI** ≥ 25.0 - ≤ 29.9 kg/m² (*n* = 33)	**BMI** ≥ 30.0 kg/m² (*n* = 29)	***p* value**
Age (*n* = 128) *M (SD)*	31.10 (4.82)	31.62 (5.21)	30.97 (3.93)	30.07 (4.80)	.349
Age Range	19 - 43	19 - 42	23 – 40	22 - 43	
Born in UK (*n* = 128)	112 (87.5)	58 (87.9)	28 (84.8)	26 (89.7)	.842
Ethnicity[1] (*n* = 128)					.774
Asian	5 (3.9)	3 (4.5)	1 (3.0)	1 (3.45)	
White	119 (93.0)	60 (90.9)	32 (97.0)	27 (93.1)	
BME background	4 (3.1)	3 (4.5)	0	1 (3.45)	
Marital / Co-habiting status (*n* = 128)					.144[a]
Single	5 (3.9)	1 (1.51)	0 (0)	4 (13.8)	
Married / Civil Partnership	84 (65.6)	46 (69.7)	22 (66.7)	16 (55.2)	
Cohabiting with partner	36 (28.1)	18 (27.3)	10 (30.0)	8 (27.6)	
Partnered; not cohabiting	3 (2.3)	1 (1.51)	1 (3.0)	1 (3.5)	
Education Level (*n* = 128)					.255[a]
Secondary school	6 (4.7)	2 (3.03)	1 (3.0)	3 (10.3)	
College	40 (31.3)	18 (27.3)	12 (36.4)	10 (34.5)	
University (UG)	41 (32.0)	19 (28.8)	11 (33.3)	11 (37.9)	
University (PG)	41 (32.0)	27 (40.9)	9 (27.3)	5 (17.2)	
IMD-10[2] (*n* = 128) *M (SD)*	6.16 (2.81)	6.59 (2.64)	6.09 (2.94)	5.24 (2.91)	.096
Parity (*n* = 128)					.812
Primiparous	46 (35.9)	22 (33.3)	13 (39.4)	11 (37.9)	
Multiparous	82 (64.06)	44 (66.6)	20 (60.6)	18 (62.1)	
Diabetic Status (*n* = 127)					
No Diabetes	121 (94.5)	65 (100)	31 (93.9)	25 (86.2)	.006[a]*
GDM[3]	6 (4.7)	0	2 (6.06)	4 (13.8)	
BMI (kg/m²) ***M (SD)***	26.49 (5.59)	22.28 (1.84)	27.58 (1.45)	34.83 (4.01)	<.001*
Previous infant feeding					
Previous Breastfeeding[4] (*n* = 82)	83.78 (52.51)	90.68 (53.37)	78.50 (49.34)	72.78 (54.10)	.421
Previous Formula Feeding[5] (*n* = 82)	38.29 (51.49)	30.0 (45.44)	36.50 (56.59)	60.56 (55.89)	.103

*Figures shown for categories are proportions unless otherwise noted as Mean (Standard Deviation). [1]Only one participant reported to be 'Black', 'Hispanic / Latino', 'Mixed' and 'Other', respectively; collapsed together as Black and/or Minority Ethnic (BME). [2]IMD-10= Index of Multiple Deprivation measures relative deprivation across each *output area* in England, Scotland, Wales, Northern Ireland. Most populated deciles were 10 (least deprived) (*n* =19), 4 (*n* =18), 8 (*n* =16), 9 (*n* =15), and 6 (*n* =14). [3]GDM= Gestational diabetes mellitus. [4]Average % of breastfeeding (vs. formula feeding) in the first 6-months postpartum with previous children. [5]Average % of formula feeding in the first 6-months postpartum with previous children. [a]Fisher's exact test was used due to low cell frequencies.

Table 2
Attitudes, Intentions and Infant Feeding Practices According to Maternal BMI Status

	Total *M* (*SD*)	BMI ≤24.9kg/m²	BMI ≥25.0-≤29.9 kg/m²	BMI ≥30.0kg/m²	*p* value
		(*n* = 66)	(*n* = 33)	(*n* = 29)	
Attitudes (IIFAS score) (*n* = 128)	66.81 (10.47)	67.85 (9.49)	64.52 (12.23)	67.07 (10.41)	.327
Score range	36 - 85	46 - 85	36 - 83	48 - 84	
Intentions (IFIS score) (*n* = 128)	12.54 (3.85)	12.93 (3.83)	11.59 (4.31)	12.72 (3.25)	.254
Score range	1 - 16	1 - 16	1 - 16	4 - 16	
Infant feeding practices (*n* = 48)	48	29	9	10	
Initial Infant Feeding[1] (*n* = 48)	89.79 (25.05)	91.38 (23.41)	80.00 (35.0)	94.0 (18.97)	.421
Current Infant Feeding[2] (*n* = 48)	85.21 (28.95)	86.21 (29.57)	85.56 (22.42)	82.00 (34.58)	.927

M= Mean; *SD*= Standard Deviation; Tukey HSD post-hoc analysis revealed no significant differences in mean attitude (A) or intention (I) scores between healthy weight vs. overweight women (Mean Difference [MD] (A) = 3.33, *p* =.297; (I) MD = 1.34, *p* =.234); healthy weight vs. obese women ((A) MD = .780, *p* =.940; (I) MD = .208, *p* =.968); or overweight vs. obese women ((A) MD =-2.55, *p* =.604; (I) MD =-1.13, *p* =.480); Attitude scores (Levene's = (2, 125), 1.202, *p* =.304); (MD =-1.13, *p* =.480) and Intention scores (Levene's = (2, 125), .872, *p* =.420) were homogenous; [1]Average % of breastfeeding (vs. formula feeding) in the first 48 hours following birth; [2]Average % of breastfeeding (vs. formula feeding) in the last 48 hours (two days)

Table 3
Associations of Maternal Antenatal Attitudes (IIFAS) to Infant Feeding

	β coefficient	***SE***	***p***	**95% CI**
Constant	65.76[1]	12.78	<.001	40.23, 91.30
Maternal BMI[2]				
Overweight	-3.59	2.53	.162	-8.65, 1.48
Obese	-1.48	2.89	.610	-7.25, 4.29
Ethnicity[3]				
Asian	-11.28	6.61	.093	-24.48, 1.93
BME	10.62	5.62	.063	-.608, 21.86
Born outside UK[4]	-.4.61	3.78	.227	-12.15, 2.94
Marital status[5]				
Married	7.35	7.31	.319	-7.25, 21.95
Cohabiting with partner	5.40	7.72	.487	-10.02, 20.82
Partnered; not cohabiting	5.44	11.71	.644	-17.95, 28.83
Education[6]				
College	-9.88	6.11	.111	-22.08, 2.32
University (UG)	-8.62	5.97	.153	-20.54, 3.30
University (PG)	-10.49	5.86	.078	-22.20, 1.22
Maternal age	.070	.272	.795	-.473, .615
IMD-10	-.343	.417	.413	-1.18, .490
Parity	-3.90	2.75	.160	-9.40, 1.59
Previous breastfeeding	.127	.041	.003*	.045, .209
Previous formula feeding	-.012	.044	.791	-.099, .076

Regression model was adjusted for confounds listed; β coefficient= Standardized beta coefficient; *SE*= Standard Error; 95% CI= 95% Confidence Interval; *significant at α=.05 level. Underlying statistical assumptions of homoscedasticity and multicollinearity were met. [1]Unstandardized beta coefficient; [2]Healthy BMI as reference category; [3]White as reference category; [4]Born in the UK as reference category; [5]Single as reference category; [6]Secondary education as reference category

Table 4
Associations of Maternal Antenatal Intentions (IFIS) for Infant Feeding

	β coefficient	***SE***	***p***	**95% CI**
Constant	4.46	3.85	.252	-3.23, 12.15
Maternal BMI[1]				
Overweight	-.164	.646	.801	-1.45, 1.13
Obese	.101	.741	.892	-1.38, 1.58
Education[2]				
College	-2.51	1.59	.119	-5.68, .663
University (UG)	-.684	1.51	.653	-3.70, 2.34
University (PG)	-.332	1.51	.827	-3.35, 2.69
Marital status[3]				
Married	3.58	1.85	.057	-.115, 7.27
Cohabiting with partner	3.03	1.98	.131	-.920, 6.97
Partnered; not cohabiting	2.24	2.99	.456	-3.72, 8.20
Maternal age	-.094	.068	.174	-.230, .042
IMD-10	-.211	.107	.053	-.426, .003
Previous Breastfeeding	.019	.007	.010*	.005, .033
Previous Formula Feeding	-.023	.008	.005*	-.039, -.007
Attitudes (IIFAS)	.145	.030	<.001*	.084, .205

Regression model was adjusted for confounds correlating with IFIS scores: maternal age; marital status; IMD-10; education; previous breastfeeding experience; previous formula feeding experience.[1]Healthy weight as reference category; [2]Secondary education as reference category; [3]Single as reference category; *β* coefficient= Unstandardized beta coefficient; *SE*= Standard Error; 95% CI= 95% Confidence Interval; *significant at α=.05 level.

Table 5
Associations of Early Infant Feeding Practices (Breastfeeding in the Last 48 hours)

	β coefficient	***SE***	***p***	**95% CI**
Constant	58.66	38.72	.144	-21.64, 138.97
Marital status[1]				
Cohabiting with partner	-7.74	8.93	.395	-26.27, 10.78
Previous Experience Breastfeeding	.017	.094	.857	-.178, .212
Previous Experience Formula Feeding	-.080	.092	.395	-.272, .111
Baby birthweight	7.88	6.48	.237	-5.55, 21.31
Maternal BMI				
Overweight	8.55	8.28	.313	-8.63, 25.72
Obese	.195	7.99	.981	-16.37, 16.76
Attitudes (IIFAS)	-.755	.517	.158	-1.83, .317
Intentions (IFIS)	4.18	1.89	.038*	.264, 8.09

Regression model was adjusted for confounds correlating with infant feeding practices in the most recent 48 hours: Marital status, previous experience with breastfeeding, previous experience with formula feeding and baby birthweight. [1]Married as reference category; β coefficient= Unstandardized beta coefficient; *SE*= Standard Error; 95% CI= 95% Confidence Interval; *significant at α=.05 level.

ONLINE SUPPLEMENTARY MATERIAL 1: MATERNAL BMI: BREASTFEEDING ATTITUDES & INTENTIONS

Table S1
Responses to the Iowa Infant Feeding Attitudes Scale (IIFAS) (Mora et al., 1999)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The nutritional benefits of breastmilk […]	57 (44.5)	45 (35.2)	14 (10.9)	9 (7.0)	3 (2.3)
2. Formula feeding is […]	44 (34.3)	50 (39.1)	13 (10.2)	18 (14.1)	3 (2.3)
3. […] mother-infant bonding	3 (2.3)	9 (7.0)	7 (5.5)	39 (30.5)	70 (54.7)
4. […] lacking in iron	35 (27.3)	57 (44.5)	32 (25.0)	4 (3.1)	0
5. […] be overfed […]	5 (3.9)	20 (15.6)	31 (24.2)	50 (39.1)	22 (17.2)
6. […] work outside the house	33 (25.8)	39 (30.5)	32 (25.0)	17 (13.3)	7 (5.5)
7. […] joys of motherhood	20 (15.6)	25 (19.5)	40 (31.3)	28 (21.9)	15 (11.7)
8. […] breastfeed in public places […]	114 (89.1)	7 (5.5)	5 (3.9)	0	2 (1.6)
9. […] are healthier […]	11 (8.6)	19 (14.8)	28 (21.9)	37 28.9)	33 (25.8)
10. Breastfed babies are […]	65 (50.8)	43 (33.6)	14 (10.9)	3 (2.3)	3 (2.3)
11. Fathers feel […]	31 (24.2)	36 (28.1)	29 (22.7)	29 (22.7)	3 (2.3)
12. […] ideal food […]	5 (3.9)	0	19 (14.8)	28 (21.9)	76 (59.4)
13. […] digested […]	5 (3.9)	3 (2.3)	18 (14.1)	36 (28.1)	66 (51.6)
14. […] healthy for an infant […]	25 (19.5)	39 (30.5)	35 (27.3)	22 (17.2)	7 (5.5)
15. […] convenient […]	6 (4.7)	13 (10.2)	20 (15.6)	42 (32.8)	47 (36.7)
16. […] expensive […]	5 (3.9)	1 0.8)	1 (0.8)	20 (15.6)	101 (78.9)
17. […] drinks alcohol [...]	53 (41.4)	39 (30.5)	22 (17.2)	11 (8.6)	3 (2.3)

Note. Numbers displayed a n (%) responses to the items. NB: The IIFAS (Mora et al., 1999) is a copyrighted instrument.

ONLINE SUPPLEMENTARY MATERIAL 1: MATERNAL BMI: BREASTFEEDING ATTITUDES & INTENTIONS

Table S2
Responses to the Infant Feeding Intention Scale (IFIS) (Nommsen-Rivers & Dewey, 2009)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I am planning to only formula feed my baby (I will not breastfeed at all)	101 (78.9)	17 (13.3)	3 (2.3)	3 (2.3)	4 (3.1)
2. I am planning to at least give breastfeeding a try	5 (2.9)	2 (2.3)	3 (2.3)	15 (11.7)	102 (79.7)
3. When my baby is 1-month old, I will be breastfeeding without using any formula or other milk	7 (5.5)	5 (3.9)	25 (19.5)	25 (19.5)	66 (51.6)
4. When my baby is 3-months old, I will be breastfeeding without using any formula or other milk	5 (3.9)	8 (6.3)	25 (19.5)	27 (21.1)	63 (49.2)
5. When my baby is 6-months old, I will be breastfeeding without using any formula or other milk.	9 (7.0)	9 (7.0)	38 (29.7)	18 (14.1)	54 (42.2)

Note. Numbers displayed a n (%) responses to the items. Total score is calculated using the following formula: ((item 1 + item 2 / 2) + (item 3 + item 4 + item 5)). Total scores range from 0 – 16.

ONLINE SUPPLEMENTARY MATERIAL 1: MATERNAL BMI: BREASTFEEDING ATTITUDES & INTENTIONS

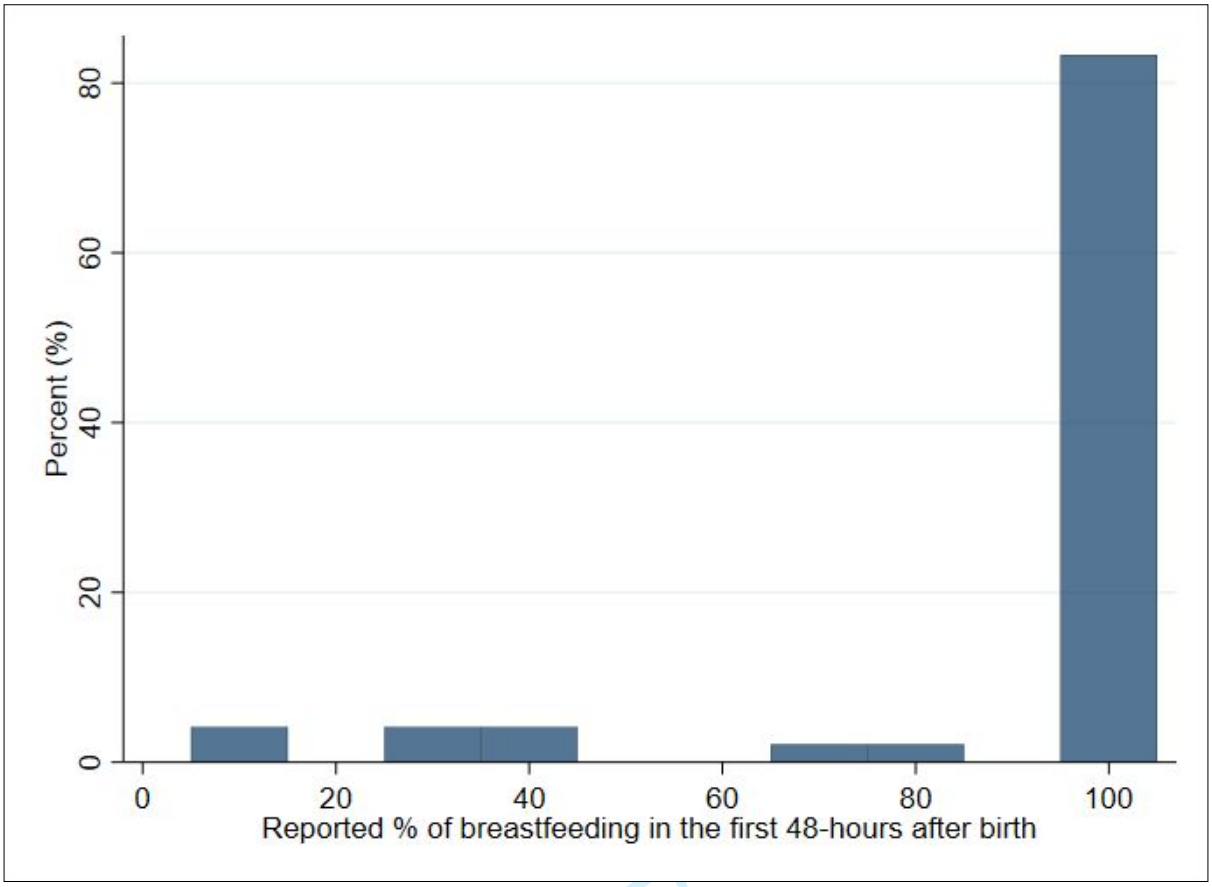

Figure S1. Initial feeding practices in the first 48 hours of infants' life (*n = 48)*. On average, 89.79% of infants' feeds were breastmilk (SD = 25.05) in comparison to formula milk. *n* = 40 women reported exclusively breastfeeding their infants.

ONLINE SUPPLEMENTARY MATERIAL 1: MATERNAL BMI: BREASTFEEDING ATTITUDES & INTENTIONS

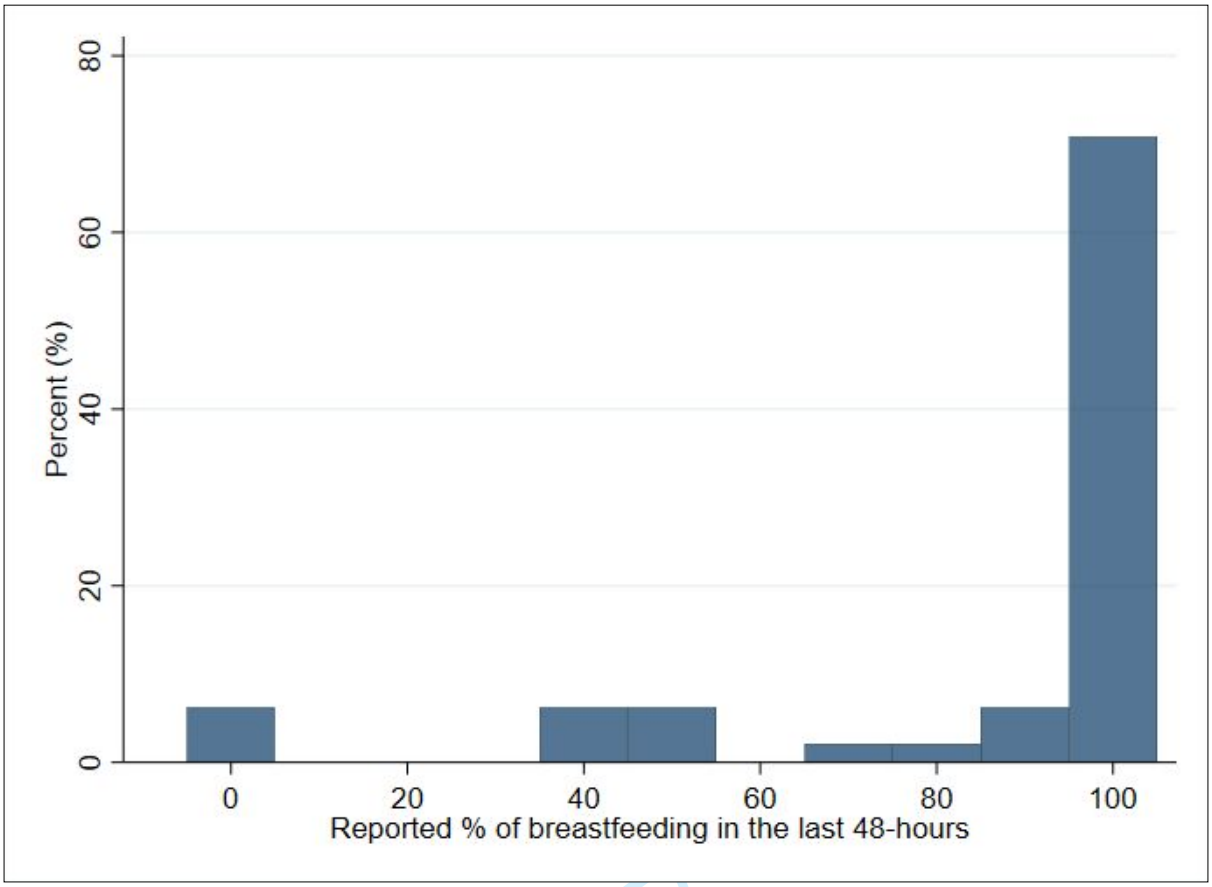

Figure S2. Current feeding practices (previous 48 hours) among $n = 48$ women at an average of (M) 14.73 days ($SD = 8.47$) postpartum. On average, 85.21% of infants' feeds were breastmilk ($SD = 28.95$) in comparison to formula milk. $n = 34$ women reported exclusively breastfeeding their infants.