ASSOCIATIONS BETWEEN MATERNAL PRE-PREGNANCY BODY MASS INDEX AND EXCLUSIVE HUMAN MILK PUMPING IN A MICHIGAN COHORT

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ABSTRACT

Background: Infant feeding recommendations prioritize exclusive human milk (HM) for the first 4-6 mos. Recent US data show 87% of parent/infant dyads initiate HM, however, some exclusively pump instead of feeding at the breast, i.e., exclusive pumpers (EPs). We aimed to describe characteristics of EPs and test associations between maternal pre-pregnancy body mass index (BMI) and exclusive pumping (EP). **Methods:** The Michigan Archive for Research on Child Health (MARCH) is a statewide prospective cohort with prenatal recruitment (n=1,165). Self-reported maternal height and pre-pregnancy weight were obtained early in pregnancy; BMI was calculated. Infant feeding practices were assessed in a 3-month post-partum survey (n=750). The analytic sample included only those who initiated HM (n=651). Feeding groups were defined as exclusive pumpers, breastfeeding only, or mixed feeding - including both pumping and breastfeeding. Multiple logistic regression was used to examine whether pre-pregnancy BMI was associated with EP. **Results:** Of those who initiated HM, 5% were EPs. Maternal characteristics of exclusive pumpers included: 55% White, 58% unmarried, and 77% below bachelor's degree. BMI categories included 32%, 10%, and 52% of participants for normal, overweight, and obese, respectively. Gestational age at delivery ranged from 25-39 wks. The unadjusted model including all BMI categories suggested a weak non-significant association between obesity and a higher chance of EP (OR = 1.8, 95% CI 0.80-4.1) when compared to those using other HM feeding methods. Post hoc subgroup analyses excluding those underweight resulted in significant findings (OR = 3.8, 1.07-13.3). **Conclusions:** Although we did not find a significant association between maternal BMI category overall and EP, odds ratios were strong; understanding characteristics of EPs may contribute insights to healthcare professionals when providing advice to pregnant patients considering alternative feeding methods.

This thesis would not be possible without the families that participated in the Michigan Archive for Research on Child Health (MARCH), as well as the Child Health Advances from Research with Mothers (CHARM) study team, without you and your commitment, this work would not be possible. Thank you.

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LIST OF ABBREVIATIONS

aOR	Adjusted Odds Ratio
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CHARM	Child Health Advances from Research with Mothers
EP	Exclusive Pumping
HM	Human Milk
IFPS II	Infant Feeding Practices Study II
MARCH	Michigan Archive for Research on Child Health
NICU	Neonatal Intensive Care Unit
OR	Odds Ratio
PROBIT	Promotion of Breastfeeding Intervention Trial
US	United States
WIC	Women Infant and Children Supplemental Nutrition Program

CHAPTER 1: INTRODUCTION

1.1 Infant Feeding Recommendations

Human milk (HM) is the recommended food source for infants to consume, as it encompasses the necessary nutrients for an infant's growth and development, while also providing protection from diseases. (1) The World Health Organization recommends that children are fed human milk for the first six months of life. (2) Likewise, the American Academy of Pediatrics recommends to exclusively breastfeed for at least the first six months of the child's life and continue up to two years if able. (26) Recent United States (US) data show that 87% of parent/infant dyads initiate HM feeding, showing an increase in initiation compared to previous years; in 1999-2000 it was 68%. (3) Breastfeeding is a common feeding method, with more than 80% of individuals initiating feeding at the breast. However, this percentage decreases over the span of the infant's life. (4) Some have tried to address this issue, in a randomized clinical trial in Belarus by Kramer et al., it was shown that the implementation of breastfeeding promotion and training courses increased the likelihood of infants breastfeeding and sustaining breastfeeding for longer durations than those who did not get the intervention. (7) This was known as the Promotion of Breastfeeding Intervention Trial (PROBIT), initially completed in 1996-1997, that led to the Baby Friendly Hospital Initiative and underscores the impact that enhancing structural supports at the hospital level, as well as individuals' knowledge of breastfeeding methods can have on their overall breastfeeding outcomes. (7) (51)

Despite the recommendations, breastfeeding promotion, and the breastfeeding initiation rates, few infants get fed for the recommended duration periods. The Centers for Disease Control and Prevention (CDC) presented rates of breastfeeding for infants as time went on, from the National Immunization Survey, and reported that for babies born in 2020 breastfeeding rates

decreased from 83% initiation, to 58% at six months, to 37% at 1 year. For exclusively breastfed, however, the CDC reported even lower rates with 45% through three months, and 25% through six months. (4)

There are also many benefits to continuing breastfeeding, as for those who do breastfeed their baby, it has been shown it can offer benefits for both the feeder and recipient. Beyond providing infants with human milk, breastfeeding is associated with a decreased likelihood of developing numerous illnesses for both infants and their mothers. (5) Moreover, breastfeeding offers a cost-effective solution; families adhering to ideal breastfeeding practices can save $1,200-$1,500 by forgoing formula purchases in the first year of their infant's life. (6)

1.2 Personal and Societal Barriers to Breastfeeding are Pervasive

Socioeconomic factors can have an impact on whether the mother initiates breastfeeding and the duration of feeding at the breast, despite their desire to utilize this method. These barriers encompass many challenges including exhaustion, social media, peer and family perspectives, lack of support, community acceptance, and hospitals lacking in breastfeeding expertise. (8) Addressing these barriers is essential to creating an environment optimal to breastfeeding practices and maternal-infant health outcomes. (8)

Breastfeeding induces other challenges as well; many may feel that they lack experience, leading to self-doubt or reluctance to seek guidance from those with more knowledge or experience. In addition, the absence of accommodations made in the workplace for breastfeeding can leave individuals to navigate work and motherhood without sufficient support. Lack of resources and assistance for breastfeeding practices also poses a problem and can cause frustration for many. (6)

Similarly, some individuals reported that societal expectations and their own beliefs were

among the greatest pressures to breastfeed, this pressure also caused a negative overall breastfeeding experience, which could impact future feeding habits to subsequent children from that individual. (9) Moreover, external pressures women felt impacted their decisions were nurses and female family members, especially mother-in-law's. (9)

On the other hand, arguments have been made that breastfeeding has caused a 'feminist problem' due to its public perception of being sex-specific. This issue emerges due to challenging the feminist principle of gender-neutral childrearing. (10) Some women feel that they are constrained by breastfeeding responsibilities and perceive it as a hindrance. As a result, turning to bottle feeding is freeing for them. (11) There are some households advocating that tasks should be distributed equally amongst the family, meaning the partner, often the father, should also feed the baby. To achieve this distribution of tasks, to alleviate stress and time on the pregnant person, many turn to formula or human milk pumping methods. (11) This shift in thinking reflects an evolving understanding of childcare dynamics and gives way to a more inclusive caregiving practice within families.

Also, medically it may not be wise for individuals with certain health conditions to breastfeed. Psychiatrists may recommend that for those with mental illnesses, breastfeeding may cause more harm than good, especially for the mother, putting them at high-risk for reoccurrences in psychiatric episodes. Breastfeeding often entails mother's waking up often in the night to feed, causing them to become sleep deprived. (31) Sleep deprivation is a risk-factor for mental illness events to occur which could include depression, suicidal thoughts, mania, anxiety, substance abuse, and more. (29) (30)

While many studies report advantages of breastfeeding, it is important to note that most of these investigations rely on observational data, which can introduce biases in the findings. In

the only randomized clinical trial conducted by Kramer et al., the benefits of breastfeeding on some specific infant health outcomes were not substantiated. (7) This underscores the need to consider alternative methods that may offer superior advantages.

1.3 Associations Between Body Mass Index and Breastfeeding Practices

As the rates for adults and children being overweight and obese continue to increase, it is pertinent to examine the correlation between these trends and breastfeeding practices. (12) Increased body mass index (BMI) has been linked to a decrease in breastfeeding initiation and duration among obese mothers compared to those who are not obese. (13) It has been noted that the rates of intention to breastfeed and initiation of breastfeeding were notably lower among those who were underweight (64%) and obese (68%) compared to those who were normal weight (92%) and overweight (80%). (14)

For those who were obese, reasons for cessation of breastfeeding included maternal complications, insufficient milk supply, sucking problems, and work resumption. (14) For obese women, challenges such as poor self-body image and doubting the nutritional adequacy of breast milk may contribute to disparities between their intended and actual breastfeeding durations. Other barriers were that women who were obese reported that they did not have many friends or family members that preferred breastfeeding methods or had performed said methods, resulting in the obese person's choice to not breastfeed or to breastfeed for a shorter duration. (15)

Among ethnic groups, Black women tend to display higher obesity rates (49.6%) alongside the lowest rates of breastfeeding initiation (45.3%) and continued breastfeeding duration to three months (33.7%). Conversely, White and Hispanic women tend to display lower obesity rates and are more likely to continue breastfeeding at 3 months postpartum and beyond. (16) These differences in rates likely reflect variations in cultural and community norms, but

closing these gaps is essential to increase breastfeeding initiation and duration.

1.4 Human Milk Feeding Includes Expressed Milk in a Bottle

Breastfeeding can be broken down into exclusive breastfeeding and any breastfeeding. According to the CDC exclusive breastfeeding can be defined as only feeding breastmilk, and no other method of feeding including solids or liquids of any kind, not even water. On the other hand, the CDC defines any breastfeeding as feeding breastmilk, but also including solids or other liquids, including water. (52)

However, in addition to breastfeeding there are other methods of infant feeding, one of note is the expression of human milk. HM expression (pumping) can be done with various methods, such as by hand, with a manual pump, an electric pump, or a double electric pump. (27) "Expressing milk" is equivalent to "pumping milk", as pumping milk is a branch of expressing milk; "Expressed milk" can be defined as a way of removing milk when your baby is not feeding at the breast. Under this definition, there are two ways to express milk: hand expression and manual or electric machines, otherwise known as a pump. (28) Most mothers choose a pump to remove the milk from their breast over doing it by hand. (28)

HM initiation can take many forms, some parents choose to feed their baby exclusively at the breast *i.e.,* exclusive breastfeeders, or in this study, the breastfeeding only group. Another group of parents are opting to feed their child exclusively pumped milk instead of feeding at the breast *i.e.,* exclusive pumpers. On the other hand, many parents choose to use a combination of feeding methods and feed pumped milk and at the breast. Formula methods are also used, however for this current study, formula use was not evaluated other than the "formula only" group who only fed their child formula and did not initiate any HM.

1.5 Potential Reasons for Exclusive Pumping

Although there is little research on this relatively new phenomenon of exclusive pumping, some research has shown that exclusive pumping, a method of human milk delivery distinct from breastfeeding, is chosen by some individuals for various reasons. Exclusive pumpers may choose this route of HM delivery over breastfeeding due to historical experiences of sexual abuse (17) (18), societal pressures to breastfeed, emotional distress (9), latching issues, or the convenience of another person being able to feed the baby. (19) Furthermore, medical considerations, such as maternal or infant health conditions that prevent effective breastfeeding, like preterm birth, can also influence the decision. Medical professionals, when speaking of parent's options for infant feeding, often do not mention exclusive pumping as an option; many seek guidance from social media platforms instead (20), highlighting a gap in professional discourse and potentially leaving parents underserved in their awareness of infant feeding care possibilities.

Most people remain unaware of the exclusive pumping phenomenon, with 71% reporting they had not heard of the method until after their baby was born. (21) Those who did hear of the feeding method expressed enhanced confidence in exclusive pumping and experienced reduced levels of frustration, insecurity, depression, rejection, guilt, and embarrassment while exclusively pumping. (21) Research indicates that 5-14% of American families that initiated human milk were exclusively pumping within the first six months of their child's life. (20)

In a concept analysis, authors used literature from various databases to describe exclusive pumping practices along with physical and psychological aspects involved. Authors noted parents have expressed feeling heartbroken or having feelings of grief when not being able to breastfeed or not being able to for the duration they intended. They then were adaptive and began

to exclusively pump so that their child could still receive the benefits of HM. (20) Sometimes exclusive pumping methods are proposed for a solution after there are challenging experiences with breastfeeding. In other cases, pumping starts as soon as the baby is born; some of these instances occur when an infant is in the neonatal intensive care unit (NICU), but that parent remains committed to providing human milk to the baby. (20)

Through a series of case-reports among women who were exclusive pumpers, it was commonly noted that sexual abuse is a potential reason for individuals to choose to exclusively pump. (17) (18) About 12-35% of all women encounter various forms of sexual abuse at some point in their life. (22) The traumatic experience of sexual abuse is different for everyone, occurring in childhood, adulthood, and sometimes even during pregnancy. The psychological impact this has on someone can lead them to maladaptive strategies for various aspects of motherhood, including breastfeeding. (23) Understanding the complex interaction between trauma and motherhood is helpful for providing support to individuals enduring these challenges.

The sensual feelings that occur during breastfeeding can pose challenges for sexual abuse survivors regarding breastfeeding or initiation, triggering memories that are linked to the sensation. (24) These memories can also cause the survivor to experience increased psychological distress, depression, post-traumatic stress disorder, and social isolation. (25) When contemplating putting their baby to the breast, survivors have reported a variety of emotions. For some, there is a feeling of disgust that they force their baby to suck on their nipples, others when thinking of the feeling reported that they “Just can’t stand it”. Many survivors consider alternative methods of feeding, such as exclusive pumping, instead of forcing their baby to breastfeed to avoid the discomfort and emotional turmoil associated with breastfeeding. (17)

1.6 Study Aims

The impact of maternal pre-pregnancy BMI categories on exclusive pumping methods constitutes a crucial, yet understudied area in the realm of maternal and infant health. The existing body of research offers limited insight into this potential association. Moreover, there is a scarcity of studies that delve into the characteristics of individuals who opt to use exclusive human milk pumping as their chosen method of infant feeding.

This study aims to fill these gaps by examining two domains: firstly, to elucidate characteristics of individuals who exclusively pump human milk for their infants, shedding light on demographics and socio-economic factors. Secondly, we aim to investigate the relationship between maternal pre-pregnancy BMI categories and exclusive pumping practices. While maternal BMI has been implicated in various aspects of maternal and infant health, its potential influence on exclusive pumping warrants closer examination. Our long-term goal is to contribute meaningful insights to the issues surrounding infant feeding practices and maternal health by bridging the gap between research and practice and empowering healthcare professionals with more knowledge and tools to support a wide range of infant feeding practices.

CHAPTER 2: METHODS

2.1 Data Collection

2.1.1 Study Population and Design

Participants were from a prospective pregnancy cohort, the Michigan Archive for Research on Child Health (MARCH). Pregnant women were enrolled from 23 prenatal clinics associated with 11 hospitals in Michigan's Lower Peninsula. The MARCH cohort serves as a research platform that includes survey data and biospecimens collected during pregnancy and longitudinally collected data on child health outcomes. The purpose of the cohort is to facilitate the discovery of factors that contribute to adverse maternal and child health outcomes. Eligibility criteria for MARCH participation was broad and included participants who were 18 years or older and had the ability to answer survey questions in the English language. Enrollment began in 2016 and ended in 2023.

This analysis used data from participants who completed one survey during pregnancy and one at three months postpartum. Initial analyses included the 750 pregnant participants with complete data at the three-month postpartum survey, but most analyses presented here excluded those who did not initiate human milk feeding (n=99), leaving a final sample size of 651 mother-infant dyads. Approval for this study was obtained from the Institutional Review Board at Michigan State University (STUDY00009534).

2.2 Measures

2.2.1 Prenatal Survey

Women were enrolled at their first prenatal visit, regardless of when the appointment occurred during their pregnancy; participants were not enrolled at any specific gestational age. At this visit, the prenatal survey was completed in which the self-reported mother's race, age, job

status, education level, income, marital status, and smoking habits were all ascertained. For descriptive and analytic purposes mothers were categorized according to the following: mother's race was categorized into "Asian", "American Indian", "Black and African American", "White", and "Unknown/Other". Mother's age was categorized as "18-25" years old, "26-29", "30-36", and "37-52". Mother's job status was categorized as "Full time", "Part time", or "Not working for pay". Mother's education level was categorized as "Below a bachelor's degree" and "Bachelor's degree or Above". Household income was categorized as "Less than $25,000", "$25,000 - $74,999", and "$75,000 +". Mother's marital status was categorized as "Married" or "Unmarried". Mother's smoking habits were categorized as "Smokers" and "Nonsmokers".

2.2.2 Prenatal Survey and/or Birth Certificate

Pre-pregnancy body mass index (BMI) category was determined from the continuous BMI that was calculated from the self-reported pre-pregnancy height and weight, obtained early in pregnancy during the prenatal survey. In cases where height or weight was missing from the prenatal survey, the height or weight was taken from the provided birth certificate. BMI values were then calculated and converted into categorical data. Individuals with a BMI less than 18.5 kg/m^2 were categorized as Underweight; Normal Weight were those within the BMI range of 18.5 - 24.9 kg/m^2; Overweight were those in the BMI range of 25 - 29.9 kg/m^2; and Obese were those with a BMI of 30 kg/m^2 and above. The pre-pregnancy BMI categories and their association with sociodemographic and health-related characteristics are shown in Table 1.

2.2.3 Three-month Postpartum Survey

The three-month survey was not collected at exactly three months of age for the infant, time varied within a "visit window" in which data were collected. The three-month survey for our sample of participants ranged in date of administration from infant age of 83 to 195 days.

This is equivalent to approximately 12 to 27 weeks, or two to six months; however, a majority of the surveys were recorded around the 100-day mark.

Table 2 aids in visualizing the data used for defining each feeding group. Exclusive pumping status was determined using data from the three-month infant survey via telephone; mothers were asked “Did the baby ever have expressed (pumped) milk”, and those who answered “yes” to this question and “no” to all other human milk feeding methods were categorized as exclusive pumpers. Conversely, those who had not ever fed their baby pumped milk or had fed the baby pumped milk but also fed them at the breast were classified as non-exclusive pumpers. This categorical variable streamlined comparisons between the group of interest and the reference group (defined below), facilitating characteristic analyses.

The reference group was made up of those who initiated human milk but were not exclusive pumpers (referred to as non-exclusive pumpers). This group could further be subdivided into the breastfeeding-only group and the Breast ± Pump group. The breastfeeding-only group consisted of individuals exclusively feeding their baby HM at the breast, this was gathered via the question “Was baby ever breastfed directly at breast?”. The Breast ± Pump group were those who fed their baby both breast and pumped human milk. This data was also collected from the three-month infant survey.

Feeding groups did not specifically account for infant formula use, but instead focused on the method for delivery of human milk, either by placing the baby directly at the breast, or feeding the baby expressed human milk, or some combination. Participants who exclusively fed their infant formula without HM initiation (referred to as the formula only group) were excluded from the study, however descriptive statistics were generated.

Supplementary variables were collected at the three-month postpartum survey. Here, the mother was asked if she had endured any health conditions preventing her from feeding the baby in the last two weeks; this self-reported variable was categorized by “Yes” or “No”. The individual’s participation in the Women Infant and Children Supplemental Nutrition Program (WIC) was also assessed and they were asked if they had received a WIC voucher for themselves or the baby in the past month; this self-reported variable was also categorized as “Yes” or “No”. The baby’s gestational age at delivery was also taken which was categorized as “≤ 24” weeks, “25-31”, “32-37” and “38+”.

2.3 Analysis Plan

2.3.1 Software

All statistical analyses were completed using Statistical Analysis System (SAS®) software version 9.4 (SAS Institute, Cary NC). The analytic sample included only those who initiated human milk feeding. The number of missing values for all variables is limited, indicating that efforts were made to prevent attrition and collect data at each planned study visit. For all statistical testing, a two-sided p-value ≤ 0.05 was considered significant.

2.3.2 Chi-Square and Fisher’s Exact tests

Descriptive analyses were conducted based on exclusive pumping status. *P*-values were obtained for covariate by exposure and outcome analyses. Additionally, Chi-square and Fisher’s exact tests were utilized to compare the characteristics between exclusive pumpers and the other feeding groups. Due to small sample sizes among groups, not all analyses could be conducted using Chi-square tests, so Fisher’s exact test was utilized in this instance. This approach provided an understanding of the dynamics surrounding exclusive pumping practices and associated maternal characteristics, contributing to a deeper interpretation of the study findings.

2.3.3 Survival Analysis

A comprehensive survival analysis, using Kaplan-Meier curves with 95% confidence intervals was conducted to compare the duration of human milk feeding among different groups. Survival analyses serve as a robust method for examining feeding duration, particularly due to the ability to adjust for varying lengths of follow-up; offering a more accurate representation of feeding patterns over time. Covariates were not included in the survival analysis to maintain a clear focus on the primary comparison of feeding durations among groups under investigation. This allowed for a more straightforward interpretation of the results, highlighting key differences in HM feeding durations.

Table 3 depicts the questions used for the duration of feeding along with the medians for each feeding group. Durations of feeding were calculated into days for both months and weeks and were added together with the already calculated days to get the total duration for each particular feeding method. Breast ± Pump durations were considered complete when both methods of feeding were stopped. If mothers were still feeding human milk at three-months postpartum via any method, they were asked the following set of questions, “Did (baby) completely stop feeding at the breast?” and “Did (baby) completely stop drinking expressed breast milk?”. Answers for both questions included “Yes” or “No”. If the participant answered “No” then they were labeled as still feeding via that respective human milk feeding method.

2.3.4 Multiple Logistic Regression

Multiple logistic regression was employed to examine whether obesity was associated with exclusive pumping in unadjusted and adjusted models incorporating various covariates. The probability of exclusive pumping was modeled with a logistic regression, with several predictors, including obesity. We adjusted a series of nested models to sequentially evaluate the effect of

several covariates. The model building strategy of including covariates was based on the associations between both the exposure and the outcome, along with previous literature, and knowledge of biological factors, which resulted in including maternal race, mother's education level, household income, mother's marital status, receiving WIC in the last month, gestational age category at delivery, mother's smoking status, mother's marital status, mother's job status, and mother's age. We report the odds for a mother to adopt an exclusively pumping method (EP) only as opposed to breastfeeding/mixed feeding (BFMF), *i.e.*, $P(Feeding = EP)/P(Feeding = BFMF)$ P(Feeding=EP)/P(Feeding=BFMF), and for each covariate considered in the model, we report the odds ratio of the different exposures or covariates. For example, for the groups of obese and non-obese mothers, the odds ratio will be:

$$OR_{Ob} = \frac{P(Feeding = EP|Ob)/P(Feeding = BFMF|Ob)}{P(Feeding = EP|not\ Ob)/P(Feeding = BFMF|not\ Ob)}$$

The breakdown of the models is as follows: Model 1 was unadjusted ((logit(p) =$\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$); β_0 corresponds to a common intercept, $\beta_1 X_1$, $\beta_2 X_2$, and $\beta_3 X_3$ are coefficient and predictor for underweight, overweight, and obese, respectively). Model 2 incorporates adjusting for gestational age at delivery, acknowledging that mothers with preterm babies have been more likely to pump, due to preterm infants having lower success rates for breastfeeding compared to full-term babies. (33) (41) Model 3 adjusts for mother's marital status, reflecting findings that those unmarried are less likely to initiate human milk feeding, than those who are married. (42) (43) Model 4 accounts for household income, recognizing that mothers who initiate human milk are more likely to have a higher household income, however studies have shown that exclusive pumpers are more likely to be those with an annual income less than $35,000. (36) (33) Model 5 adjusted for mother's education level, reflecting the association between higher education and increased likelihood of initiating human milk feeding than those

with less education. (42) Model 6 considers mother's cigarette smoking status, as those who smoke have shown lower durations in lactation and feeding; which could be partly to the perceptions of the harmful effects to the milk through the mother's eyes, or even the lower production of volume of human milk compared to those who do not smoke. (44) (45) (46) Model 7 adjusts for maternal race, because it has been noted in previous literature that those who pump for longer durations tend to be White. (47) Model 8 incorporates mother's WIC status in the last month, given its association with shorter duration of human milk feeding and higher likelihood of exclusive pumping. (48) (33) Model 9 adjusted for mother's job status, since feeding status can be impacted by the mothers continuing work, as this can impact feeding schedules and/or pumping schedules. (19) Additionally, those who are employed are more likely to initiate human milk compared to those who are not. (36) Model 10 adjusted for mother's age, considering those who are older tend to be more experienced at providing human milk, meaning they may have had an elder child. Those who are older tend to feed human milk for a longer duration than those who are younger. (49) Also, mothers who are 25 years or younger have been found to have more problems regarding breast pump usage, than those who are older, which could impact initiation and duration. (50) Model 11 added all the above variables for a comprehensive analysis.

Covariates listed above were selected based on existing literature, aiming to mitigate potential confounding effects and facilitate a deeper understanding of the relationships being investigated. We sought to provide a comprehensive analysis that accounts for factors influencing the associations between exclusive pumping and obesity.

A post hoc analysis was conducted excluding those who were in the underweight category to see the effects of excluding this small group, in addition to this exclusion the reference group was made up of those who were considered normal weight and overweight.

CHAPTER 3: RESULTS

3.1 Study Participants

As of November 2023, n=1,382 individuals had consented to participate in MARCH. Of these participants, n=1,165 completed the first prenatal survey, constituting the initial data collection phase; n=217 are not included in the MARCH cohort study because they withdrew, miscarried, or delivered outside of the state of Michigan. Following the application of exclusion criteria (participants without 3-month postpartum survey data, participants who did not initiate human milk and those who did not respond to the breastfeeding and pumping questions), n=750 completed the 3-month postpartum survey (n=415 did not), and n=651 participants initiated HM feeding (n=99 did not), forming the final analytic sample. Taking the 3-month postpartum survey was determined by the participant answering the question "Have you EVER initiated human milk to your baby", those who answered "yes" or "no" were determined to have completed the survey. The analytic sample comprises those that initiated HM, (n=651) and can further be categorized into exclusive pumpers (pump only group) (n=31), the Breast ± Pump group (n=545), and the breastfeeding only group (n=75), as illustrated in Figure 1.

The sociodemographic and health-related characteristics of mothers who completed the 3-month survey are included in Table 4. Among those who initiated human milk, about 5% were identified as exclusive pumpers. Characteristics of exclusive pumpers included (in comparison to the Breast ± Pump group): 55% White (vs. 78%; p= 0.02), 77% with education below a bachelor's degree (vs. 48%; p= 0.003), 48% with household income below $25,000 (vs. 20%; p= 0.001), 58% unmarried (vs. 35%; p= 0.01), 53% received WIC (vs. 32%; p= 0.03), and regarding BMI categories, 52% were obese, 32% were normal weight, 10% overweight, and 6% underweight (vs. 35%, 39%, 23%, and 3%, respectively; p= 0.05).

3.2 Survival Analysis: Feeding Durations

To visually interpret feeding durations across the subdivided groups, a survival analysis was conducted using a Kaplan-Meier curve with 95% confidence intervals (Figure 2). Feeding durations, represented in days, depict the 'survival probability' as participants stopped feeding their baby via the corresponding methods. The blue line represents the exclusive pumping group, the red line represents the breastfeeding only group, and green line represents the Breast ± Pump group. The Breast ± Pump group had the longest duration of feeding for that method. In terms of the median number of days, 50% of mothers in the breastfeeding only group stopped feeding human milk to their baby by day 13 (standard error = 4.9), the exclusive pumping group by day 29 (standard error 5.3), and the Breast ± Pump group by day 30 (standard error = 2.2). Initially, more people in the pump only group sustained feeding for a longer duration compared to the breastfeeding only group, and both of these groups had a minimal number of people still feeding for these respective methods at the 90-day mark. Whereas the Breast ± Pump group had more people sustaining longer durations, with about 40% of people still feeding at the 90-day mark, showing more people in the sample opting for using a combination of methods for feeding and for a longer duration.

3.3 Defining Covariates

In Table 1, there were statistically significant associations between pre-pregnancy BMI category and maternal race (p= <.0001), mother's age (p= <.0001), mother's education level (p= <.0001), mother's job status (p= 0.03), household income (p= <.0001), mother's marital status (p= <.0001), mother's smoking habits (p= 0.01), receiving WIC in the last month (p= <.0001), and gestational age category (p= <.0001) are presented in Table 4. Table 1 shows statistically significant results between pre-pregnancy BMI category and maternal race (p= 0.002), mother's

education level (p= <.0001), household income (p= <.0001), mother's marital status (p= 0.0004), mother's smoking habits (p= <.0001), receiving WIC in the last month (p= <.0001), and gestational age category (p= <.0001).

As shown in Table 4, there were some differences between the exclusive pumpers and the referent group. Among those who initiated human milk: 74% were White, 36% aged 30-36 years, 53% with education below a bachelor's degree, 59% employed full-time, 44% with household income of $75,000 or above, 62% married, 91% nonsmokers, 63% not receiving WIC, 68% with full-term babies, and regarding BMI categories, 35% were obese, 38% normal weight, and 24% overweight.

Statistically significant associations were found between feeding method status and maternal race (p= <.0001), mother's age (p= 0.04), mother's education level (p= <.0001), mother's job status (p= <.0001), household income (p= <.0001), mother's marital status (p= 0.02), mother's smoking habits (p= 0.05), receiving WIC in the last month (p= 0.05), and gestational age category (p= <.0001) are presented in Table 4. Due to statistical significance in both the exposure and outcome, along with previous literature, the following covariates were included in the adjusted model (Table 5): gestational age at delivery, mother's marital status, annual household income, mother's education, mother's smoking status, mother's race, WIC status in the past month, mother's job status, and mother's age.

3.4 Multiple Logistic Regression: Exclusive Pumping Status at 3-months Postpartum and Pre-Pregnancy BMI Category

In the unadjusted model presented in Table 5, there was a weak, non-significant association between obesity and higher odds of exclusive pumping (OR = 1.8, 95% Confidence Interval 0.80-4.1) compared to those using other HM feeding methods. Even though the

unadjusted model was nonsignificant, odds ratios were quite large. Non-significance could be due to sample sizes, so despite nonsignificance, covariates were still added. The association remained nonsignificant for all covariates added to each model: gestational age OR (95% Confidence Interval) 1.8, (0.80-4.1) indicating that odds of adopting the exclusive pumping method as opposed to breastfeeding or mixed feeding was 1.8 higher for mothers with gestational age one week later. Mother's marital status indicates that married mothers have an odds ratio of 1.5 (0.65-3.4) relative to unmarried mothers. When annual household income was added to the model, those with a higher income category had an odds ratio of 1.4 (0.63-3.3) relative to those with lower incomes. Similarly, the odds of using exclusive pumping to feed over other HM feeding methods was 1.4 (0.61-3.2) times higher for mothers with a higher education level compared to those with less education. The odds ratio of 1.6 (0.71-3.8) suggests that mothers who smoke have 1.6 times higher odds of choosing exclusive pumping over breastfeeding or mixed feeding compared to non-smoking mothers. An odds ratio of 1.5 (0.62-3.6) implies that mothers who are White are 1.5 times more likely to adopt exclusive pumping compared to other races. Those who received WIC in the last month were 1.8 (0.75-4.2) times more likely to exclusively pump than those who did not. In terms of mother's job status those who were employed full-time were 1.7 (0.77-3.9) times more likely to be an exclusive pumper than those who are not. For mother's age an odds ratio of 1.8 (0.80-4.1) implies that for each year increase in maternal age, the odds of adopting exclusive pumping increased by 1.8 times. When all the above covariates were added together in a model there was an odds ratio of 1.4 (0.55-3.7).

Table 5 also addresses those who are overweight; in the unadjusted model, there was a nonsignificant, lower likelihood of being an exclusive pumper in the obese group than those who

were in the normal weight group (OR = 0.48, 95% Confidence Interval 0.13-1.8). The association remained nonsignificant for all covariates added to each model: gestational age (0.48, 0.13-1.8), mother's marital status (0.42, 0.11-1.6), household income (0.44, 0.12-1.7), education level (0.41, 0.11-1.5), mother's smoking status (0.46, 0.12-1.7), maternal race (0.42, 0.11-1.6), WIC in the last month (0.49, 0.13-1.8), mother's job status (0.47, 0.13-1.7), mother's age (0.48, 0.13-1.8), and when all the above covariates were added together in a model (0.20, 0.04-1.1).

Those who were underweight were also examined in Table 5, and even though the potential for those who are considered underweight to be closely aligned with those who are obese in terms of infant feeding practices, there is a very low sample size in the underweight group and is difficult to draw conclusions. Nevertheless, the odds ratios were examined. In the unadjusted model, there was a non-significant association between being underweight and exclusive pumping (OR = 3.0, 95% CI 0.60-14.9) compared to those using other HM feeding methods. This odds ratio indicates a large effect but was nonsignificant, potentially due to a small sample size. The association remained nonsignificant for all covariates added to each model: OR (95% Confidence Interval) 3.0 (0.60-14.9) indicating that odds of adopting the exclusive pumping method as opposed to breastfeeding or mixed feeding was 3.0 higher for mothers with gestational age one week later. Mother's marital status indicates that married mothers have an odds ratio of 2.1 (0.41-10.5) relative to unmarried mothers. When annual household income was added to the model, those with a higher income category had an odds ratio of 1.8 (0.36-8.9) relative to those with lower incomes. Similarly, the odds of using exclusive pumping to feed over other HM feeding methods was 2.0 (0.40-10.2) times higher for mothers with a higher education level compared to those with less education. The odds ratio of 2.7 (0.55-13.1) suggests that mothers who smoke have 2.7 times higher odds of choosing exclusive

pumping over breastfeeding or mixed feeding compared to non-smoking mothers. An odds ratio of 2.3 (0.49-11.2) implies that mothers who are White are 2.3 times more likely to adopt exclusive pumping compared to other races. Those who received WIC in the last month were 2.7 (0.49-14.5) times more likely to exclusively pump than those who did not. In terms of mother's job status those who were employed full-time were 2.9 (0.51-16.0) times more likely to be an exclusive pumper than those who are not. For mother's age an odds ratio of 3.1 (0.57-16.6) implies that for each year increase in maternal age, the odds of adopting exclusive pumping increased by 3.1 times. When all the above covariates were added together in a model there was an odds ratio of 1.5 (0.21-10.3).

We also conducted other analyses; In a post hoc subgroup analysis with the reference group consisting of those who were normal weight and overweight, while also excluding those considered underweight, the test resulted in significant findings with a large odds ratio (OR = 3.8, 95% Confidence Interval 1.07-13.3). Another analysis that was done can be found in Appendix Table 6, as it examines exclusive pumping status and its association with sociodemographic and health-related characteristics. Additionally, we used other reference groups for the outcome, including the Breast ± Pump and the Breastfeeding only groups, these – Table 7 and Table 8, can be found in the Appendix. Due to non-significance and small sample sizes, we added covariates individually to see their effects in Table 5, however we did conduct a multiple logistic regression where covariates were added together across models, this can also be found in the Appendix in Table 9. We also looked at the distribution for each variable within each group, to examine differences within the groups individually; these results can be found in Appendix Table 10. Furthermore, Table 11 discusses the questions asked regarding human milk

feeding, in the order in which they were asked, to provide a better understanding of how feeding groups were formed, along with frequencies, and was used as a quality check of the data.

CHAPTER 4: DISCUSSION

4.1 Exclusive Pumper Characteristics

Of those who participated in this study, 4.7% identified as exclusive pumpers. This mirrors findings in the Infant Feeding Practices Study II (IFPS II) where proportions were 5.6%, (32) and also aligns closely with observations of Keim et al. who reported 6.9% were exclusive pumpers within their sample. (33) Keim's research in a prospective pregnancy cohort in an urban area of Ohio, delved into feeding duration among exclusive pumpers, and found that exclusive pumpers in their sample tended to feed for a shorter duration compared to other feeding methods. (33) Their study found that most exclusive pumpers pumped for less than six months. (33) This finding was echoed in our study, as evidenced by the decline in pumping duration over time. By day 91 of our study, 84% of exclusive pumpers ceased providing pumped milk to their child, leaving only 16% continuing to provide pumped milk at the three-month mark.

In our exclusive pumping group, 77% of mothers had an education level below a bachelor's degree. This finding is similar to Keim et al., who found that, for their exclusive pumping group, 67% had completed some college or less (33). In contrast, another US cohort study noted that among those who pumped and fed their babies human milk in months 1.5 to 4.5 postpartum, a higher educational attainment was evident, with 52% holding a bachelor's degree or higher. (19)

In our exclusive pumping group, 55% identified as White in terms of race. This proportion appears lower compared to findings from other studies, done by Felice and Keim, where a higher percentage of Whites exclusively pumped with 85% and 73% reported, respectively. (19) (33) This discrepancy may suggest that our sample included a more diverse demographic makeup than previous studies.

Exclusive pumpers in our study were notably more inclined to belong to lower socioeconomic strata, with 48% reporting annual household incomes below $25,000. This stands in contrast to prevailing trends observed in other studies, where individuals who express milk tend to be those with a higher income compared to non-exclusive pumpers. (36) (37) Nevertheless, this finding does coincide with Keim et al. who also identified participants with incomes less than $35,000 in their study. (33)

In contrast to prior research findings, our exclusive pumper group exhibited a higher proportion of unmarried individuals, accounting for 58%. This contrasts to studies where the majority of participants in the pump-only groups were married with rates of 85% and 82% reported. (19) (33) This variance might be attributed to the convenience factor, as additional caregivers are able to participate in feeding the baby other than solely the mother, so she can return to work. Additionally, this may be due to the different timeframes, as unmarried rates have increased over time. (53)

In terms of smoking status, 19% of participants in our exclusive pumping group reported smoking during pregnancy, aligning with findings from other studies as smokers were more likely to pump compared to the referent group. (33) Regarding WIC status, 53% of our participants received WIC services, mirroring the results of previous studies such as Keim's, where 48% of participants were enrolled in WIC. (33)

In 2022, the CDC documented a preterm birth rate (babies born less than 37 weeks' gestation) of 10.4% across the US. (34) In Michigan, in 2021, the CDC reported a slightly higher preterm birth rate of 10.6%. (35) Comparatively, Keim's Mom2Mom study found that 33% of their exclusive pumping group had gestational ages less than 32 weeks (33), aligning closely with our study's findings, where 33% of the exclusive pumping group also fell into this category.

4.2 Exclusive Pumping and Body Mass Index

Previous research suggests a correlation between pumping and obesity (38), prompting our investigation into whether exclusive pumpers are also more likely to be obese. Our findings revealed a weak, non-significant association between exclusive pumping and a higher chance of being obese. This association remained non-significant across all models, even with different covariates added. There was a significant association, however, when the reference group was changed to normal and overweight individuals combined, while also excluding those who were considered underweight. One potential explanation is that obese women may opt for exclusive pumping due to a lack of confidence in their body type, which may lead to discomfort with breastfeeding in public. (39) Additionally, the presence of large breasts, which is common among obese women, may pose challenges for infant latching, potentially prompting them to opt for exclusive pumping. (13) Interestingly, overweight women in our study were less likely than obese women to exclusively pump, which could suggest that they may face fewer physical or emotional barriers than obese women. (40)

4.3 Strengths and Limitations

This study presents a combination of both strengths and limitations. Notably, one of its strengths lies in its utilization of a Michigan population-based sample, thereby when sampling weights are added, it will have enhanced generalizability of the findings to the broader population in Michigan. However, the study faces certain limitations. The lack of available sampling weight data to accommodate the complex survey design poses a challenge at this moment in time, although sampling weights will be available soon. Furthermore, the sample size, particularly in the exclusive pumping group (n=31), warrants consideration for replication in larger studies to enhance statistical power and reliability.

Data collection relied on self-reporting for feeding methods, duration, weight, and height, which could lead to some measures being under or overestimated. The study did not account for factors such as neonatal intensive care unit (NICU) stay, food stamp use, parity, mode of delivery, and feeding duration in its analyses, which could have provided valuable insights into the dynamics of exclusive pumping. Additionally, the study did not address formula feeding due to constraints related to sample size, although it is likely many participants across all feeding groups utilized formula feeding.

Moreover, the study did not delve into the underlying reasons behind why mothers chose to exclusively pump, such as previous negative breastfeeding experiences or their feeding intentions prior to initiating pumping. Addressing these aspects could have provided a more comprehensive understanding of the factors influencing exclusive pumping behaviors among mothers.

4.4 Future Research

Future research endeavors should prioritize the replication of this study using a larger sample size, particularly aiming to include a more substantial representation of exclusive pumpers. Expanding the sample size would increase statistical power, enabling more robust analyses and yielding more reliable findings. Furthermore, future studies should examine covariates highlighted in the limitations section, such as NICU stay, feeding intentions, feeding durations, mode of delivery, parity, and food stamp use. Exploring these factors could shed light on their potential influence on exclusive pumping behavior and outcomes.

In addition, future studies should consider the inclusion of formula feeding data across all groups to comprehensively examine its impact on feeding practices and outcomes. By incorporating these data into the analyses, researchers can gain insights into any differences or

associations among feeding methods. This approach will contribute to a more nuanced understanding of infant feeding practices and their implications for maternal and child health.

4.5 Funding

We acknowledge that this secondary data analysis study was conducted without the receipt of any external funding or financial support.

4.6 Conclusions

For individuals lacking confidence, with a history of sexual abuse, or concerns about sleep or their body type impeding breastfeeding, exclusive pumping may emerge as a viable option. Despite potential limitations in duration, exclusive pumping could serve as an initial approach for providing human milk to their baby, with the possibility of transitioning to alternative feeding methods later on. While our study did not reveal a significant association between maternal BMI category and exclusive HM pumping, understanding characteristics of exclusive pumpers may contribute valuable insights.

Understanding the unique traits of exclusive pumpers can empower healthcare professionals with valuable knowledge when advising pregnant patients exploring alternative feeding methods. By recognizing the diverse needs and considerations of individuals contemplating exclusive pumping, healthcare providers can offer tailored guidance and support, facilitating informed decision-making and optimal infant care.

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APPENDIX A: TABLES

Table 1. Pre-pregnancy body mass index categories and their association with sociodemographic and health-related characteristics.

	Pre-pregnancy Body Mass Index (BMI) Category (kg/m^2) Max N = 651								
	Underweight BMI = <18.5 N = 18		Normal BMI = 18.5 – 24.9 N = 250		Overweight BMI = 25 -29.9 N = 154		Obese BMI = 30+ N = 229		Fishers Exact *p*
	N	(%)	N	(%)	N	(%)	N	(%)	
Maternal Race									
American Indian	0	(0)	6	(2)	2	(1)	3	(1)	**<.0001**
Asian	0	(0)	9	(4)	1	(1)	2	(1)	
Black and African American	7	(39)	31	(12)	32	(21)	68	(30)	
Other/Unknown	1	(6)	1	(1)	2	(1)	3	(1)	
White	10	(55)	199	(81)	117	(76)	148	(66)	
Mother Age at Enrollment (years)									
18 - 25	5	(28)	73	(30)	53	(34)	58	(25)	**<.0001**
26 - 29	7	(39)	56	(22)	36	(24)	62	(27)	
30 - 36	6	(33)	90	(36)	51	(33)	85	(38)	
37 – 52	0	(0)	29	(12)	14	(9)	23	(10)	
Mother's Education Level									
Below a Bachelor's degree	3	(17)	150	(60)	83	(54)	149	(65)	**<.0001**
Bachelor's degree and above	15	(83)	99	(40)	70	(46)	80	(35)	
Mother's Job Status									
Full time	6	(33)	135	(54)	102	(66)	140	(61)	**0.03**
Part time	4	(23)	57	(23)	26	(17)	40	(18)	
Not working for pay	8	(44)	57	(23)	25	(17)	49	(21)	
Household Income									
Less than $25,000	10	(56)	48	(19)	34	(22)	69	(30)	**<.0001**
$25,000-$74,999	4	(22)	49	(20)	48	(31)	77	(33)	
$75,000 and Above	2	(11)	144	(58)	71	(46)	70	(31)	
Don't Know/Refuse	2	(11)	7	(3)	1	(1)	13	(6)	
Mother's Marital Status									
Married	4	(22)	186	(75)	94	(61)	116	(51)	**<.0001**
Unmarried	14	(78)	63	(25)	60	(39)	113	(49)	
Mother's Smoking (Cigarettes)									
Smoker	3	(17)	13	(5)	14	(9)	30	(13)	**0.01**
Nonsmoker	15	(83)	237	(95)	140	(91)	199	(87)	

Table 1 (cont'd)

Health Conditions in Last 2 Weeks Preventing from Feeding									
Yes	1	(6)	19	(8)	11	(7)	14	(6)	0.94
No	17	(94)	225	(92)	142	(93)	210	(94)	
Received WIC in Last Month									
Yes	11	(61)	64	(26)	55	(36)	104	(46)	**<.0001**
No	7	(39)	180	(74)	98	(64)	120	(54)	
Gestational Age Category									
24 Weeks or Less	1	(6)	25	(10)	17	(11)	35	(15)	**<.0001**
25 – 31 Weeks	1	(6)	3	(1)	4	(3)	4	(2)	
32 – 37 Weeks	6	(32)	30	(12)	29	(18)	52	(23)	
Full 38+ Weeks	10	(56)	192	(77)	104	(68)	138	(60)	

Missing Data:
Underweight: None

Normal: Maternal Race (N=4), Mother's Age Enrollment (N=2), Mother's Education (N=1), Mother's Job Status (N=1), Household Income (N=2), Marital Status (N=1), Health Last 2 Weeks (N=6), WIC Last Month (N=6)

Overweight: Mother's Age Enrollment (N=1), Mother's Education (N=1), Job Status (N=1), Health Last 2 Weeks (N=1), WIC Last Month (N=1)

Obese: Maternal Race (N=5), Health Last 2 Weeks (N=5), WIC Last Month (N=5)

Variable Notes:
Maternal Race:
American Indian (= Asian Indian, Black and American Indian or Alaska Native, White and American Indian or Alaska Native, and American Indian or Alaska Native)
Asian: (= Asian, Chinese, Korean, White and Korean)
Black and African American: (= Black and African American, White and Black and African American)
Other/Unknown: (= Don't Know, Other, Unknown)

Mother's Education:
Below a Bachelor's degree: (= None, 8th grade or less, Some high school – no degree, High school graduate/diploma/GED, Some college credit – no degree, Trade/Technical/Vocational, Associate degree)
Bachelor's or above: (= Bachelor's degree, Master's degree, Doctorate or professional degree)

Household income:
Less than $25,000: (= Less than $10,000, Less than $25,000, $10,000-$14,999, $15,000-$19,999, $20,000-$24,999)
$25,000-$75,499: (= $25,000-$34,999, $35,000-$49,999, $50,000-$74,999)
$75,000+: (= $75,000-$100,000, Greater than $100,000)

Mother's Marital Status:
Unmarried: (= Living with partner, Divorced, Separated, Widowed, Never married)

Table 2. Defining the different human milk feeding groups with questions from the three-month postpartum survey.

Feeding method	Questions and Answers Used for Defining HM Feeding Groups
Breast ± Pump	Was (baby) ever breastfed directly at the breast? = YES AND Did baby ever drink expressed breast milk? = YES
Breastfeeding Only	Was (baby) ever breastfed directly at the breast? = YES AND Did baby ever drink expressed breast milk? = NO
Exclusive Pumpers	Was (baby) ever breastfed directly at the breast? = NO AND Did baby ever drink expressed breast milk? = YES

Table 3. Questions and terms used to define durations along with duration medians for that respective feeding method.

Feeding method	Duration Questions Used	Median Duration (Days)
Breast ± Pump	How old was (baby) when [she/he] started feeding at the breast? How old was (baby) when [she/he] completely stopped feeding at the breast? Did (baby) completely stop feeding at the breast? How old was (baby) when [she/he] started drinking expressed breastmilk? How old was (baby) when [she/he] completely stopped drinking expressed breast milk? Did (baby) completely stop drinking expressed breast milk?	30.0
Exclusive Breastfeeding	How old was (baby) when [she/he] started feeding at the breast? How old was (baby) when [she/he] completely stopped feeding at the breast? Did (baby) completely stop feeding at the breast?	13.0
Exclusive Pumping	How old was (baby) when [she/he] started drinking expressed breastmilk? How old was (baby) when [she/he] completely stopped drinking expressed breast milk? Did (baby) completely stop drinking expressed breast milk?	29.0

Table 4. Comparing Sociodemographic and health-related characteristics by human milk feeding method among eligible MARCH cohort participants (n=651).

	Initiated Human Milk Max N = 651 N (%)		Exclusive Pumpers N = 31 N (%)		Breast ± Pump N = 545 N (%)		Breastfeeding Only N = 75 N (%)		Fishers Exact *p*-value
Prenatal Survey									
BMI Category (kg/m^2)									
Underweight	18	(3)	2	(6)	14	(3)	2	(3)	0.19
Normal	250	(38)	10	(32)	213	(39)	27	(36)	
Overweight	154	(24)	3	(10)	130	(23)	21	(28)	
Obese	229	(35)	16	(52)	188	(35)	25	(33)	
Maternal Race									
American Indian	11	(2)	1	(3)	0	(0)	0	(0)	**<.0001**
Asian	12	(2)	0	(0)	20	(4)	2	(3)	
Black and African American	138	(21)	13	(42)	92	(17)	33	(45)	
Other/Unknown	7	(1)	0	(0)	5	(1)	2	(3)	
White	474	(74)	17	(55)	420	(78)	37	(49)	
Mother Age at Enrollment (years)									
18 - 25	189	(29)	8	(26)	160	(29)	21	(29)	**0.04**
26 - 29	161	(25)	10	(32)	127	(24)	24	(33)	
30 - 36	232	(36)	8	(26)	196	(36)	28	(37)	
37 – 52	66	(10)	5	(16)	60	(11)	1	(1)	
Mother's Education Level									
Below a Bachelor's degree	346	(53)	24	(77)	261	(48)	61	(81)	**<.0001**
Bachelor's degree and above	303	(47)	7	(23)	282	(52)	14	(19)	
Mother's Job Status									
Full time	383	(59)	19	(61)	336	(62)	28	(37)	**<.0001**
Part time	127	(20)	3	(10)	111	(20)	13	(18)	
Not working for pay	139	(21)	9	(29)	96	(18)	34	(45)	
Household Income									
Less than $25,000	161	(25)	15	(48)	107	(20)	39	(52)	**<.0001**
$25,000-$74,999	178	(27)	7	(23)	153	(28)	18	(24)	
$75,000 and Above	287	(44)	7	(23)	265	(49)	15	(20)	
Don't Know/Refused	23	(4)	2	(6)	18	(3)	3	(4)	
Mother's Marital Status									
Married	400	(62)	13	(42)	353	(65)	34	(45)	**0.0004**
Unmarried	250	(38)	18	(58)	191	(35)	41	(55)	

Table 4 (cont'd)

Mother's Smoking (Cigarettes)									
Smoker									
Nonsmoker	60	(9)	6	(19)	37	(7)	17	(23)	**<.0001**
	591	(91)	25	(81)	508	(93)	58	(77)	
3 Month Survey									
Health Conditions in Last 2 Weeks Preventing from Feeding									
Yes									
No	45	(7)	4	(13)	35	(7)	6	(8)	0.27
	594	(93)	26	(87)	500	(93)	68	(92)	
Received WIC in Last Month									
Yes	234	(37)	16	(53)	172	(32)	46	(62)	**<.0001**
No	405	(63)	14	(47)	363	(68)	28	(38)	
Birth Certificate									
Gestational Age Category									
24 Weeks or Less	78	(12)	3	(10)	66	(12)	9	(12)	**<.0001**
25 – 31 Weeks	12	(2)	7	(23)	5	(1)	0	(0)	
32 – 37 Weeks	117	(18)	8	(25)	96	(18)	13	(17)	
Full 38+ Weeks	444	(68)	13	(42)	378	(69)	53	(71)	

Note: *p*-values across feeding groups

Missing Data:
Initiated Human Milk: Maternal Race (N=9), Mother's Age Enrollment (N=3), Mother's Education Level (N=2), Mother's Job Status (N=2), Household Income (N=2), Mother's Marital Status (N=1), Health Last 2 Weeks (N=12), WIC Last Month (N=12)

Exclusive Pumpers: Health Last 2 Weeks (N=1), WIC Last Month (N=1)

Breast ± Pump: Maternal Race (N=8), Mother's Age Enrollment (N=2), Mother's Education Level (N=2), Mother's Job Status (N=2), Household Income (N=2), Mother's Marital Status (N=1), Health Last 2 Weeks (N=10), WIC Last Month (N=10)

Breastfeeding Only: Maternal Race (N=1), Mother's Age Enrollment (N=1), Health Last 2 Weeks (N=1), WIC Last Month (N=1)

Variable Notes:
Maternal Race:
American Indian (= Asian Indian, Black and American Indian or Alaska Native, White and American Indian or Alaska Native, and American Indian or Alaska Native)
Asian: (= Asian, Chinese, Korean, White and Korean)
Black and African American: (= Black and African American, White and Black and African American)
Other/Unknown: (= Don't Know, Other, Unknown)

Mother's Education:
Below a Bachelor's degree: (= None, 8th grade or less, Some high school – no degree, High school graduate/diploma/GED, Some college credit – no degree, Trade/Technical/Vocational, Associate degree)

Table 4 (cont'd)

Bachelor's or above: (= Bachelor's degree, Master's degree, Doctorate or professional degree)

Household income:
Less than $25,000: (= Less than $10,000, Less than $25,000, $10,000-$14,999, $15,000-$19,999, $20,000-$24,999)
$25,000-$75,499: (= $25,000-$34,999, $35,000-$49,999, $50,000-$74,999)
$75,000+: (= $75,000-$100,000, Greater than $100,000)

Mother's Marital Status:
Unmarried: (= Living with partner, Divorced, Separated, Widowed, Never married)

Table 5. Pre-pregnancy body mass index (kg/m^2) among mothers in eligible MARCH cohort participants in associate with feeding practices.

	Pre-pregnancy Body Mass Index (BMI) (kg/m^2) N = 651														
	Under-weight BMI = <18.5 N = 18 N (%)	Normal (ref) BMI = 18.5-24.9 N = 250 N (%)	Over-weight BMI = 25–29.9 N = 154 N (%)	Obese BMI = 30+ N = 229 N (%)	Model 1 OR (95% CI)	Model 2 aOR (95% CI)	Model 3 aOR (95% CI)	Model 4 aOR (95% CI)	Model 5 aOR (95% CI)	Model 6 aOR (95% CI)	Model 7 aOR (95% CI)	Model 8 aOR (95% CI)	Model 9 aOR (95% CI)	Model 10 aOR (95% CI)	Model 11 aOR (95% CI)
Exclusive Pumping Status															
No (ref) N = 620	16 (89)	240 (96)	151 (98)	213 (93)	--	--	--	--	--	--	--	--	--	--	--
Yes N = 31	2 (11)	10 (4)	3 (2)	16 (7)	Un: 3.00 (0.60, 14.9)	Un: 3.00 (0.60, 14.9)	Un: 2.08 (0.41, 10.5)	Un: 1.78 (0.36, 8.93)	Un: 2.03 (0.40, 10.2)	Un: 2.68 (0.55, 13.1)	Un: 2.35 (0.49, 11.2)	Un: 2.67 (0.49, 14.5)	Un: 2.86 (0.51, 16.0)	Un: 3.08 (0.57, 16.6)	Un: 1.47 (0.21, 10.3)
					Ov: 0.48 (0.13, 1.77)	Ov: 0.48 (0.13, 1.77)	Ov: 0.42 (0.11, 1.62)	Ov: 0.44 (0.12, 1.68)	Ov: 0.41 (0.11, 1.50)	Ov: 0.46 (0.12, 1.73)	Ov: 0.42 (0.11, 1.56)	Ov: 0.49 (0.13, 1.88)	Ov: 0.47 (0.13, 1.72)	Ov: 0.48 (0.13, 1.79)	Ov: 0.20 (0.04, 1.07)
					Ob: 1.80 (0.80, 4.07)	Ob: 1.80 (0.80, 4.07)	Ob: 1.50 (0.65, 3.45)	Ob: 1.44 (0.63, 3.29)	Ob: 1.41 (0.61, 3.25)	Ob: 1.66 (0.71, 3.86)	Ob: 1.50 (0.62, 3.61)	Ob: 1.78 (0.75, 4.21)	Ob: 1.75 (0.77, 3.99)	Ob: 1.80 (0.78, 4.13)	Ob: 1.44 (0.55, 3.74)

Table 5 (cont'd)

Missing Data: None

Un = Underweight
Ov = Overweight
Ob = Obese

Model 1: unadjusted model
Model 2: adjusted for gestational age at delivery
Model 3: adjusted for marital status
Model 4: adjusted for household income
Model 5: adjusted for mother's education
Model 6: adjusted for mother's smoking status
Model 7: adjusted for mother's race
Model 8: adjusted for WIC status
Model 9: adjusted for mother's job status
Model 10: adjusted for mother's age
Model 11: adjusted for gestational age at delivery, marital status, household income, mother's education, mother's smoking status, mother's race, WIC status, mother's job status, and mother's age

Table 6. Exclusive pumping status and its association with sociodemographic and health-related characteristics.

	Exclusive Pumping Status				
			Max N = 651		
	Yes		No		Fishers Exact
	N = 31		N = 620		*p*
	N	(%)	N	(%)	
Pre-pregnancy Body Mass Index Category (kg/m^2)					
Underweight	2	(6)	16	(3)	**0.05**
Normal	10	(32)	240	(39)	
Overweight	3	(10)	151	(24)	
Obese	16	(52)	213	(34)	
Maternal Race					
American Indian	1	(3)	10	(2)	0.06
Asian	0	(0)	12	(2)	
Black and African American	13	(42)	125	(20)	
Other/Unknown	0	(0)	7	(1)	
White	17	(55)	457	(75)	
Mother Age at Enrollment (years)					
18 - 25	8	(26)	181	(29)	0.45
26 - 29	10	(32)	151	(25)	
30 - 36	8	(26)	224	(36)	
37 – 52	5	(16)	61	(10)	
Mother's Education Level					
Below a Bachelor's degree	24	(77)	322	(52)	**0.01**
Bachelor's degree and above	7	(23)	296	(48)	
Mother's Job Status					
Full time	19	(61)	364	(59)	0.31
Part time	3	(10)	124	(20)	
Not working for pay	9	(29)	130	(21)	
Household Income					
Less than $25,000	15	(48)	146	(24)	**0.007**
$25,000-$74,999	7	(23)	171	(28)	
$75,000 and Above	7	(23)	280	(45)	
Don't Know/Refuse	2	(6)	21	(3)	
Mother's Marital Status					
Married	13	(42)	387	(63)	**0.02**
Unmarried	18	(58)	232	(37)	
Mother's Smoking (Cigarettes)					
Smoker	6	(19)	54	(9)	**0.05**
Nonsmoker	25	(81)	566	(91)	
Health Conditions in Last 2 Weeks Preventing from Feeding					
Yes	4	(13)	41	(7)	0.15
No	26	(87)	568	(93)	
Received WIC in Last Month					
Yes	16	(53)	218	(36)	0.08
No	14	(47)	391	(64)	
Gestational Age Category					
24 Weeks or Less	3	(10)	75	(12)	**<.0001**
25 – 31 Weeks	7	(23)	5	(1)	
32 – 37 Weeks	8	(26)	109	(18)	
Full 38+ Weeks	13	(41)	431	(69)	

Table 6 (cont'd)

Missing Data:
Non-exclusive pumpers: Maternal Race (N=9), Mother age enrollment (N=3), Mother's Education (N=2), Mother's Job Status (N=2), Household Income (N= 2), Mother's Marital Status (N=1), Heath Last 2 Weeks (N=11), WIC Last Month (N= 11)

Exclusive Pumpers: Heath Last 2 Weeks (N=1), WIC Last Month (N= 1)

Variable Notes:
Maternal Race:
American Indian (= Asian Indian, Black and American Indian or Alaska Native, White and American Indian or Alaska Native, and American Indian or Alaska Native)
Asian: (= Asian, Chinese, Korean, White and Korean)
Black and African American: (= Black and African American, White and Black and African American)
Other/Unknown: (= Don't Know, Other, Unknown)

Mother's Education:
Below a Bachelor's degree: (= None, 8th grade or less, Some high school – no degree, High school graduate/diploma/GED, Some college credit – no degree, Trade/Technical/Vocational, Associate degree)
Bachelor's or above: (= Bachelor's degree, Master's degree, Doctorate or professional degree)

Household income:
Less than $25,000: (= Less than $10,000, Less than $25,000, $10,000-$14,999, $15,000-$19,999, $20,000-$24,999)
$25,000-$75,499: (= $25,000-$34,999, $35,000-$49,999, $50,000-$74,999)
$75,000+: (= $75,000-$100,000, Greater than $100,000)

Mother's Marital Status:
Unmarried: (= Living with partner, Divorced, Separated, Widowed, Never married)

Table 7. Exclusive pumping status and its association with pre-pregnancy body mass index (kg/m^2) among eligible MARCH cohort participants with the reference group being the Breast ± Pump group.

	Pre-pregnancy Body Mass Index (BMI) (kg/m^2) N = 576														
	Under-weight BMI = <18.5	Normal (ref) BMI = 18.5-24.9	Over-weight BMI = 25–29.9	Obese BMI = 30+	Model 1 OR (95% CI)	Model 2 aOR (95% CI)	Model 3 aOR (95% CI)	Model 4 aOR (95% CI)	Model 5 aOR (95% CI)	Model 6 aOR (95% CI)	Model 7 aOR (95% CI)	Model 8 aOR (95% CI)	Model 9 aOR (95% CI)	Model 10 aOR (95% CI)	Model 11 aOR (95% CI)
	N = 16 N (%)	N = 223 N (%)	N = 133 N (%)	N = 204 N (%)											
Human Milk Feeding Status															
Breast ± Pump (ref) N = 545	14 (87)	213 (95)	130 (98)	188 (92)	--	--	--	--	--	--	--	--	--	--	--
Exclusive Pumpers N = 31	2 (13)	10 (5)	3 (2)	16 (8)	Un: 3.04 (0.60, 15.4)	Un: 1.92 (0.34, 10.6)	Un: 1.90 (0.36, 9.39)	Un: 1.49 (0.28, 7.74)	Un: 1.86 (0.36, 9.52)	Un: 2.71 (0.56, 13.1)	Un: 1.89 (0.38, 9.3)	Un: 2.44 (0.42, 14.0)	Un: 2.84 (0.49, 16.3)	Un: 3.05 (0.59, 16.7)	Un: 1.19 (0.17, 8.51)
					Ov: 0.49 (0.13, 1.83)	Ov: 0.30 (0.07, 1.37)	Ov: 0.42 (0.11, 1.64)	Ov: 0.43 (0.11, 1.66)	Ov: 0.40 (0.11, 1.47)	Ov: 0.46 (0.12, 1.77)	Ov: 0.40 (0.11, 1.50)	Ov: 0.49 (0.13, 1.90)	Ov: 0.49 (0.13, 1.83)	Ov: 0.49 (0.13, 1.86)	Ov: 0.21 (0.04, 1.12)
					Ob: 1.81 (0.80, 4.11)	Ob: 1.59 (0.66, 3.81)	Ob: 1.44 (0.62, 3.36)	Ob: 1.32 (0.57, 3.07)	Ob: 1.32 (0.57, 3.09)	Ob: 1.63 (0.70, 3.81)	Ob: 1.43 (0.58, 3.53)	Ob: 1.70 (0.71, 4.10)	Ob: 1.76 (0.77, 4.02)	Ob: 1.80 (0.78, 4.15)	Ob: 1.30 (0.48, 3.49)

Table 7 (cont'd)

Missing Data: None

Un = Underweight
Ov = Overweight
Ob = Obese

Model 1: unadjusted model
Model 2: adjusted for gestational age at delivery
Model 3: adjusted for marital status
Model 4: adjusted for household income
Model 5: adjusted for mother's education
Model 6: adjusted for mother's smoking status
Model 7: adjusted for mother's race
Model 8: adjusted for WIC status
Model 9: adjusted for mother's job status
Model 10: adjusted for mother's age
Model 11: adjusted for gestational age at delivery, marital status, household income, mother's education, mother's smoking status, mother's race, WIC status, mother's job status, and mother's age

Table 8. Exclusive pumping status and its association with pre-pregnancy body mass index (kg/m^2) among mothers in the MARCH study who completed the three-month postpartum survey with the reference group being the breastfeeding only group.

	Pre-pregnancy Body Mass Index (BMI) (kg/m^2) N = 106														
	Underweight BMI = <18.5 N = 4 N (%)	Normal (ref) BMI = 18.5 - 24.9 N = 37 N (%)	Overweight BMI = 25 – 29.9 N = 24 N (%)	Obese BMI = 30+ N = 41 N (%)	Model 1 OR (95% CI)	Model 2 aOR (95% CI)	Model 3 aOR (95% CI)	Model 4 aOR (95% CI)	Model 5 aOR (95% CI)	Model 6 aOR (95% CI)	Model 7 aOR (95% CI)	Model 8 aOR (95% CI)	Model 9 aOR (95% CI)	Model 10 aOR (95% CI)	Model 11 aOR (95% CI)
Human Milk Feeding Status															
Breastfeeding Only (ref) N = 75	2 (50)	27 (73)	21 (87)	25 (61)	--	--	--	--	--	--	--	--	--	--	--
Exclusive Pumpers N = 31	2 (50)	10 (27)	3 (13)	16 (39)	Un: 2.70 (0.31, 23.3)	Un: 1.68 (0.09, 30.1)	Un: 2.70 (0.31, 23.8)	Un: 2.89 (0.33, 25.2)	Un: 3.05 (0.34, 26.9)	Un: 3.13 (0.33, 29.7)	Un: 5.86 (0.31, 109.3)	Un: 2.79 (0.30, 25.8)	Un: 3.31 (0.40, 27.4)	Un: 2.61 (0.29, 23.6)	Un: 6.45 (0.17, 240.4)
					Ov: 0.39 (0.09, 1.65)	Ov: 0.37 (0.07, 2.17)	Ov: 0.39 (0.09, 1.66)	Ov: 0.39 (0.09, 1.67)	Ov: 0.38 (0.09, 1.70)	Ov: 0.38 (0.09, 1.58)	Ov: 0.38 (0.08, 1.75)	Ov: 0.39 (0.09, 1.71)	Ov: 0.29 (0.07, 1.25)	Ov: 0.29 (0.06, 1.48)	Ov: 0.09 (0.004, 2.34)
					Ob: 1.73 (0.64, 4.65)	Ob: 2.15 (0.69, 6.73)	Ob: 1.73 (0.64, 4.67)	Ob: 1.90 (0.66, 5.52)	Ob: 1.82 (0.67, 4.91)	Ob: 1.81 (0.65, 5.01)	Ob: 1.79 (0.64, 4.94)	Ob: 1.92 (0.69, 5.36)	Ob: 1.53 (0.54, 4.35)	Ob: 1.30 (0.44, 3.86)	Ob: 1.77 (0.35, 8.98)

Table 8 (cont'd)

Missing Data: None

Un = Underweight
Ov = Overweight
Ob = Obese

Model 1: unadjusted model
Model 2: adjusted for gestational age at delivery
Model 3: adjusted for marital status
Model 4: adjusted for household income
Model 5: adjusted for mother's education
Model 6: adjusted for mother's smoking status
Model 7: adjusted for mother's race
Model 8: adjusted for WIC status
Model 9: adjusted for mother's job status
Model 10: adjusted for mother's age
Model 11: adjusted for gestational age at delivery, marital status, household income, mother's education, mother's smoking status, mother's race, WIC status, mother's job status, and mother's age

Table 9. Exclusive pumping status and its association with pre-pregnancy body mass index (kg/m^2) among eligible MARCH cohort participants with exclusive pumping status as the reference group, with covariates added across models.

	Pre-pregnancy Body Mass Index (BMI) (kg/m^2) N = 651													
	Underweight BMI = <18.5 N = 18 N (%)	Normal (ref) BMI = 18.5 - 24.9 N = 250 N (%)	Overweight BMI = 25 – 29.9 N = 154 N (%)	Obese BMI = 30+ N = 229 N (%)	Model 1 OR (95% CI)	Model 2 aOR (95% CI)	Model 3 aOR (95% CI)	Model 4 aOR (95% CI)	Model 5 aOR (95% CI)	Model 6 aOR (95% CI)	Model 7 aOR (95% CI)	Model 8 aOR (95% CI)	Model 9 aOR (95% CI)	Model 10 aOR (95% CI)
Exclusive Pumping Status														
No (ref) N = 620	16 (89)	240 (96)	151 (98)	213 (93)	--	--	--	--	--	--	--	--	--	--
Yes N = 31	2 (11)	10 (4)	3 (2)	16 (7)										
					Un: 3.00 (0.61, 14.9)	Un: 1.88 (0.29, 12.0)	Un: 1.39 (0.21, 9.34)	Un: 1.34 (0.19, 9.64)	Un: 1.31 (0.18, 9.40)	Un: 1.36 (0.19, 9.64)	Un: 1.41 (0.19, 10.3)	Un: 1.26 (0.17, 9.19)	Un: 1.37 (0.20, 9.28)	Un: 1.47 (0.21, 10.3)
					Ov: 0.48 (0.13, 1.76)	Ov: 0.30 (0.07, 1.29)	Ov: 0.26 (0.06, 1.17)	Ov: 0.25 (0.05, 1.19)	Ov: 0.25 (0.05, 1.18)	Ov: 0.23 (0.05, 1.13)	Ov: 0.22 (0.05, 1.09)	Ov: 0.22 (0.04, 1.14)	Ov: 0.21 (0.04, 1.08)	Ov: 0.20 (0.04, 1.07)
					Ob: 1.80 (0.80, 4.06)	Ob: 1.62 (0.67, 3.90)	Ob: 1.40 (0.57, 3.45)	Ob: 1.49 (0.60, 3.73)	Ob: 1.48 (0.59, 3.70)	Ob: 1.44 (0.56, 3.59)	Ob: 1.42 (0.56, 3.58)	Ob: 1.48 (0.58, 3.79)	Ob: 1.41 (0.55, 3.64)	Ob: 1.44 (0.55, 3.74)

Table 9 (cont'd)

Missing Data: None

Un = Underweight
Ov = Overweight
Ob = Obese

Model 1: unadjusted model
Model 2: Model 1 + gestational age category
Model 3: Model 2 + marital status
Model 4: Model 3 + household income
Model 5: Model 4 + mother's education
Model 6: Model 5 + mother's smoking status
Model 7: Model 6 + mother's race
Model 8: Model 7 + WIC status
Model 9: Model 8 + mother's job status
Model 10: Model 9 + mother's age

Table 10. Sociodemographic and health-related characteristics among mothers in MARCH from those who completed the three-month postpartum survey by human milk feeding method.

	Initiated Human Milk		Exclusive Pumpers			Breast ± Pump			Breastfeeding Only		
	Max N = 651		N = 31			N = 545			N = 75		
	N	(%) *p*	N	(%)	*p*	N	(%)	*p*	N	(%)	*p*
Prenatal Survey											
BMI Category (kg/m^2)											
Underweight	18	(3)	2	(6)	**<.0001**	14	(3)	**<.0001**	2	(3)	**<.0001**
Normal	250	(38)	10	(32)		213	(39)		27	(36)	
Overweight	154	(24)	3	(10)		130	(23)		21	(28)	
Obese	229	(35)	16	(52)		188	(35)		25	(33)	
Maternal Race											
American Indian	11	(2)	1	(3)	0.99	0	(0)	0.99	0	(0)	0.99
Asian	12	(2)	0	(0)		20	(4)		2	(3)	
Black and African American	138	(21)	13	(42)		92	(17)		33	(45)	
Other/Unknown	7	(1)	0	(0)		5	(1)		2	(3)	
White	474	(74)	17	(55)		420	(78)		37	(49)	
Mother Age at Enrollment (years)											
18 - 25	189	(29)	8	(26)	1.00	160	(29)	0.69	21	(29)	0.99
26 - 29	161	(25)	10	(32)		127	(24)		24	(33)	
30 - 36	232	(36)	8	(26)		196	(36)		28	(37)	
37 – 52	66	(10)	5	(16)		60	(11)		1	(1)	
Mother's Education Level											
Below a Bachelor's degree	346	(53)	24	(77)	**<.0001**	261	(48)	0.04	61	(81)	**<.0001**
Bachelor's degree and above	303	(47)	7	(23)		282	(52)		14	(19)	
Mother's Job Status											
Full time	383	(59)	19	(61)	0.99	336	(62)	0.28	28	(37)	0.99
Part time	127	(20)	3	(10)		111	(20)		13	(18)	
Not working for pay	139	(21)	9	(29)		96	(18)		34	(45)	
Household Income											
Less than $25,000	161	(25)	15	(48)	0.99	107	(20)	0.98	39	(52)	1.00
$25,000-$74,999	178	(27)	7	(23)		153	(28)		18	(24)	
$75,000 and Above	287	(44)	7	(23)		265	(49)		15	(20)	
Don't Know/Refuse	23	(4)	2	(6)		18	(3)		3	(4)	
Mother's Marital Status											
Married	400	(62)	13	(42)	0.99	353	(65)	0.96	34	(45)	0.95
Unmarried	250	(38)	18	(58)		191	(35)		41	(55)	
Mother's Smoking (Cigarettes)											
Smoker	60	(9)	6	(19)	**<.0001**	37	(7)	**<.0001**	17	(23)	**<.0001**
Nonsmoker	591	(91)	25	(81)		508	(93)		58	(77)	

Table 10 (cont'd)

3 Month Survey											
Health Conditions in Last 2 Weeks Preventing from Feeding											
Yes	45	(7)	4	(13)	0.96	35	(7)	0.68	6	(8)	0.97
No	594	(93)	26	(87)		500	(93)		68	(92)	
Received WIC in Last Month											
Yes	234	(37)	16	(53)	0.97	172	(32)	0.94	46	(62)	0.98
No	405	(63)	14	(47)		363	(68)		28	(38)	
Birth Certificate											
Gestational Age Category											
24 Weeks or Less	78	(12)	3	(10)	0.99	66	(12)	0.99	9	(12)	0.99
25 – 31 Weeks	12	(2)	7	(23)		5	(1)		0	(0)	
32 – 37 Weeks	117	(18)	8	(25)		96	(18)		13	(17)	
Full 38+ Weeks	444	(68)	13	(42)		378	(69)		53	(71)	

Note:
p-values using Chi-Square test
p-values calculated within respective feeding group

Missing Data:
Initiated Human Milk: Maternal Race (N=9), Mother's Age Enrollment (N=3), Mother's Education Level (N=2), Mother's Job Status (N=2), Household Income (N=2), Mother's Marital Status (N=1), Health Last 2 Weeks (N=12), WIC Last Month (N=12)

Exclusive Pumpers: Health Last 2 Weeks (N=1), WIC Last Month (N=1)

Breast ± Pump: Maternal Race (N=8), Mother's Age Enrollment (N=2), Mother's Education Level (N=2), Mother's Job Status (N=2), Household Income (N=2), Mother's Marital Status (N=1), Health Last 2 Weeks (N=10), WIC Last Month (N=10)

Breastfeeding Only: Maternal Race (N=1), Mother's Age Enrollment (N=1), Health Last 2 Weeks (N=1), WIC Last Month (N=1)

Variable Notes:
Maternal Race:
American Indian (= Asian Indian, Black and American Indian or Alaska Native, White and American Indian or Alaska Native, and American Indian or Alaska Native)
Asian: (= Asian, Chinese, Korean, White and Korean)
Black and African American: (= Black and African American, White and Black and African American)
Other/Unknown: (= Don't Know, Other, Unknown)

Mother's Education:
Below a Bachelor's degree: (= None, 8th grade or less, Some high school – no degree, High school graduate/diploma/GED, Some college credit – no degree, Trade/Technical/Vocational, Associate degree)
Bachelor's or above: (= Bachelor's degree, Master's degree, Doctorate or professional degree)

Table 10 (cont'd)

Household income:
Less than $25,000: (= Less than $10,000, Less than $25,000, $10,000-$14,999, $15,000-$19,999, $20,000-$24,999)
$25,000-$75,499: (= $25,000-$34,999, $35,000-$49,999, $50,000-$74,999)
$75,000+: (= $75,000-$100,000, Greater than $100,000)

Mother's Marital Status:
Unmarried: (= Living with partner, Divorced, Separated, Widowed, Never married)

Table 11. List of questions both used and not in the order in which they were asked on the three-month postpartum survey; excludes questions not pertaining to human milk feeding and those with more than 60% missing from the human milk initiating group (N=651).

Question	Possible Answers	Frequencies
Did (baby) ever have breast milk, including directly at the breast or from a bottle, or mixed in cereal or other foods?	1. Yes 2. No	651 group: Yes = 651 No = 0 = 651 (M=0) 545 group: Yes = 545 No = 0 = 545 (M=0) 75 group: Yes = 75 No = 0 = 75 (M=0) 31 group: Yes = 31 No = 0 = 31 (M=0)
Was (baby) ever breastfed directly at the breast?	1. Yes 2. No	651 group: Yes = 620 No = 31 = 651 (M=0) 545 group: Yes = 545 No = 0 = 545 (M=0) 75 group: Yes = 75 No = 0 = 75 (M=0) 31 group: Yes = 0 No = 31 = 31 (M=0)
How old was (baby) when [she/he] started feeding at the breast?	_____Days -OR- _____Weeks -OR- _____Month	651 group: Range: 1-5 d/w/m = 393 (M=258) 545 group: Range: 1-5 d/w/m = 329 (M=216) 75 group: Range: 1-5 d/w/m = 64 (M=11) 31 group: Range: 0 (M=31)
Did (baby) completely stop feeding at the breast?	1. Yes 2. No	651 group: Yes = 223 No = 397 = 620 (M=31) 545 group: Yes = 172 No = 373 = 545 (M=0) 75 group: Yes = 51 No = 24 = 75 (M=0) 31 group: 0 (M=31)
How old was (baby) when [she/he] completely stopped feeding at the breast?	_____Days -OR- _____Weeks -OR- _____Month	651 group: Range: 1-12 d/w/m = 222 (M=429) 545 group: Range: 1-12 d/w/m = 171 (M=374 75 group: Range: 1-9 d/w/m = 51 (M=24) 31 group: Range: 0 (M=31)
Did (baby) ever drink expressed breast milk? Include fresh and frozen breast milk and breast milk mixed in cereal.	1. Yes 2. No	651 group: Yes = 576 No = 75 = 651 (M=0) 545 group: Yes = 545 No = 0 = 545 (M=0) 75 group: Yes = 0 No = 75 = 75 (M=0) 31 group: Yes = 31 No = 0 = 31 (M=0)
How old was (baby) when [she/he] started drinking expressed breastmilk?	_____Days -OR- _____Weeks -OR- _____Month	651 group: Range: 1-15 d/w/m = 576 (M=75) 545 group: Range: 1-15 d/w/m =545 (M=0) 75 group: Range: 0 (M=75) 31 group: Range: 1-6 d/w/m = 31 (M=0)

Table 11 (cont'd)

Did (baby) completely stop drinking expressed breast milk?	1. Yes 2. No	651 group: Yes = 195 No = 381 = 576 (M=75) 545 group: Yes = 170 No = 375 = 545 (M=0) 75 group: Range: 0 (M=75) 31 group: Yes = 25 No = 6 = 31 (M=0)
How old was (baby) when [she/he] completely stopped drinking expressed breast milk?	_____Days - OR- _____Weeks - OR- _____Month	651 group: Range: 1-13 d/w/m = 194 (M=457) 545 group: Range: 1-12 d/w/m = 170 (M=375) 75 group: Range: 0 (M=75) 31 group: Range: 1-13 d/w/m = 24 (M=7)
Have you expressed milk since (baby) was born?	1. Yes 2. No	651 group: Yes = 24 No = 87 (M=540) 545 group: Yes = 22 No = 84 (M=439) 75 group: 0 (M=75) 31 group: Yes = 2 No = 3 (M=26)
How old was (baby) when you started using a breast pump or your hands to express your breast milk?	_____Days - OR- _____Weeks - OR- _____Months	651 group: Range: 1-15 d/w/m = 573 (M=78) 545 group: Range: 1-15 d/w/m = 542 (M=3) 75 group: Range: 0 (M=75) 31 group: Range: 1-3 d/w/m = 31 (M=0)
Have you stopped using a breast pump or your hands to express your breastmilk?	1. Yes 2. No	651 group: Yes = 195 No = 379 = 574 (M=77) 545 group: Yes = 169 No = 374 = 543 (M=2) 75 group: Range: 0 (M=75) 31 group: Yes = 26 No = 5 = 31 (M=0)

Table 11 (cont'd)

How old was (baby) when you stopped using a breast pump or your hands to express your breast milk?	_____Days -OR- _____Weeks -OR- _____Months	651 group: Range: 1-15 d/w/m = 244 (M=457) 545 group: Range: 1-15 d/w/m = 168 (M=377) 75 group: Range: 0 (M=75) 31 group: Range: 1-11 d/w/m. = 26 (M=5)
Was (baby) fed formula in the past 7 days?	1. Yes 2. No	651 group: Yes = 348 No = 236 = 584 (M=67) 545 group: Yes = 265 No = 216 = 481 (M=64) 75 group: Yes = 56 No = 17 = 73 (M=2) 31 group: Yes = 27 No = 3 = 30 (M=1)
In the past 7 days, how often was (baby) fed formula?	___ feedings per day OR ___ feedings per week	651 group: Range: 1-100 d/w/m = 342 (M=309) 545 group: Range: 1-100 d/w/m = 261 (M=284) 75 group: Range: 2-32 d/w/m = 56 (M=19) 31 group: Range: 1-14 d/w/m = 25 (M=6)
In the past 7 days, about how many ounces of formula did (baby) drink at each feeding?	1. 1 to 2 2. 3 to 4 3. 5 to 6 4. 7 to 8 5. More than 8	651 group: 1 = 17 2 = 89 3 = 124 4 = 37 5 = 3 (M=381) 545 group: 1 = 15 2 = 70 3 = 102 4 = 34 5 = 2 (M=322) 75 group: 1 = 1 2 = 13 3 = 20 4 = 2 5 = 1 (M=38) 31 group: 1 = 1 2 = 6 3 = 2 4 = 1 5 = 0 (M=21)
How often is (baby) encouraged to finish a bottle if [she/he] stops drinking before the formula is all gone? Would you say never, rarely, sometimes, most of the time, or always?	1. Never 2. Rarely 3. Sometimes 4. Most of the time 5. Always	651 group: 1 = 43 2 = 39 3 = 78 4 = 63 5 = 48 (M=380) 545 group: 1 = 32 2 = 33 3 = 67 4 = 51 5 = 41 (M=321) 75 group: 1 = 8 2 = 4 3 = 10 4 = 10 5 = 5 (M=38) 31 group: 1 = 3 2 = 2 3 = 1 4 = 2 5 = 2 (M=21)

Table 11 (cont'd)

Now I'm going to ask a few more questions about the type of formula. Which type of formula was fed to (baby) in the past 7 days?	1. Ready-to-feed 2. Powder from a can that makes more than one bottle 3. Powder from single serve packs 4. Liquid concentrate	651 group: 1 = Yes: 30 No: 396 2 = Yes: 256 No:170 3 = Yes: 3 No: 423 4 = Yes: 6 No: 420 (M=225) 545 group: 1 = Yes: 22 No: 328 2 = Yes: 213 No: 137 3 = Yes: 2 No: 348 4 = Yes: 3 No: 347 (M=195) 75 group: 1 = Yes: 5 No: 52 2 = Yes: 35 No: 22 3 = Yes: 1 No: 56 4 = Yes: 3 No: 54 (M=18) 31 group: 1 = Yes: 3 No: 16 2 = Yes: 8 No: 11 3 = Yes: 0 No: 19 4 = Yes: 0 No: 19 (M=12)
Was (baby) breastfed in the past 7 days?	1. Yes 2. No	651 group: Yes = 188 No = 6 (M=457) 545 group: Yes = 161 No = 4 (M=380) 75 group: Yes = 27 No = 2 (M=46) 31 group: Yes = 0 No = 0 (M=31)
Does (baby) usually feed from both breasts at each feeding?	1. Yes 2. No	651 group: Yes = 112 No = 76 (M=463) 545 group: Yes = 92 No = 69 (M=384) 75 group: Yes = 20 No = 7 (M=48) 31 group: Yes = 0 No = 0 (M=31)
Was (baby) fed expressed breastmilk in the past 7 days?	1. Yes 2. No	651 group: Yes = 145 No = 27 (M=479) 545 group: Yes = 138 No = 20 (M=387) 75 group: Yes = 0 No = 6 (M=69) 31 group: Yes = 7 No = 1 (M=23)

Table 11 (cont'd)

How many times in the past 7 days was (baby) fed pumped breast milk to drink?	___ feedings per day OR ___ feeding per week (Range 0-100)	651 group: Range: 0-78 (d/w) = 141 (M=510) 545 group: Range: 0-78 (d/w) = 134 (M=411) 75 group: Range: 0 (d/w) = 0 (M=75) 31 group: Range: 3-42 (d/w) = 7 (M=24)
How often is (baby) encouraged to finish a bottle if [she/he] stops drinking before the pumped breast milk is all gone? Would you say never, rarely, sometimes, most of the time, or always?	1. Never 2. Rarely 3. Sometimes 4. Most of the time 5. Always	651 group: 1= 22 2 = 27 3 = 44 4 = 39 5 = 27 (M=492) 545 group: 1= 21 2 = 24 3 = 44 4 = 38 5 = 24 (M=394) 75 group: 1= 0 2 = 0 3 = 0 4 = 0 5 = 0 (M=75) 31 group: 1= 1 2 = 3 3 = 0 4 = 1 5 = 3 (M=23)
Did you breastfeed as long as you wanted to?	1. Yes 2. No	651 group: Yes = 43 No = 81 (M=527) 545 group: Yes = 38 No = 71 (M=436) 75 group: Yes = 5 No = 10 (M=60) 31 group: 0 (M=31)
Using 1 to mean "very unfavorable" and 5 to mean "very favorable," what number represents the way you feel about the experience of having breastfed your baby?	1 (very unfavorable) 2 3 4 5 (very favorable)	651 group: 1 = 10 2 = 14 3 = 55 4 = 57 5 = 200 (M=315) 545 group: 1 = 8 2 = 12 3 = 44 4 = 53 5 = 171 (M=257) 75 group: 1 = 2 2 = 2 3 = 11 4 = 4 5 = 29 (M=27) 31 group: 0 (M=31)
Using 1 to mean "not at all likely" and 5 to mean "very likely," how likely is it that you would breastfeed again if you had another child?	1 (not at all likely) 2 3 4 5 (very likely)	651 group: 1 = 15 2 = 4 3 = 11 4 = 27 5 = 280 (M=318) 545 group: 1 = 11 2 = 3 3 = 11 4 = 23 5 = 241 (M=256) 75 group: 1 = 4 2 = 1 3 = 0 4 = 4 5 = 39 (M=27) 31 group: 0 (M=31)

M= Missing data
d = Days

Table 11 (cont'd)

w = Weeks
m = Months

651 group = All those who initiated human milk
545 group = Breast ± Pump
75 group = breastfeeding only
31 group = exclusive pumpers

APPENDIX B: FIGURES

Figure 1. Participant flow chart deriving the different infant feeding groups from those initiating human milk feeding.

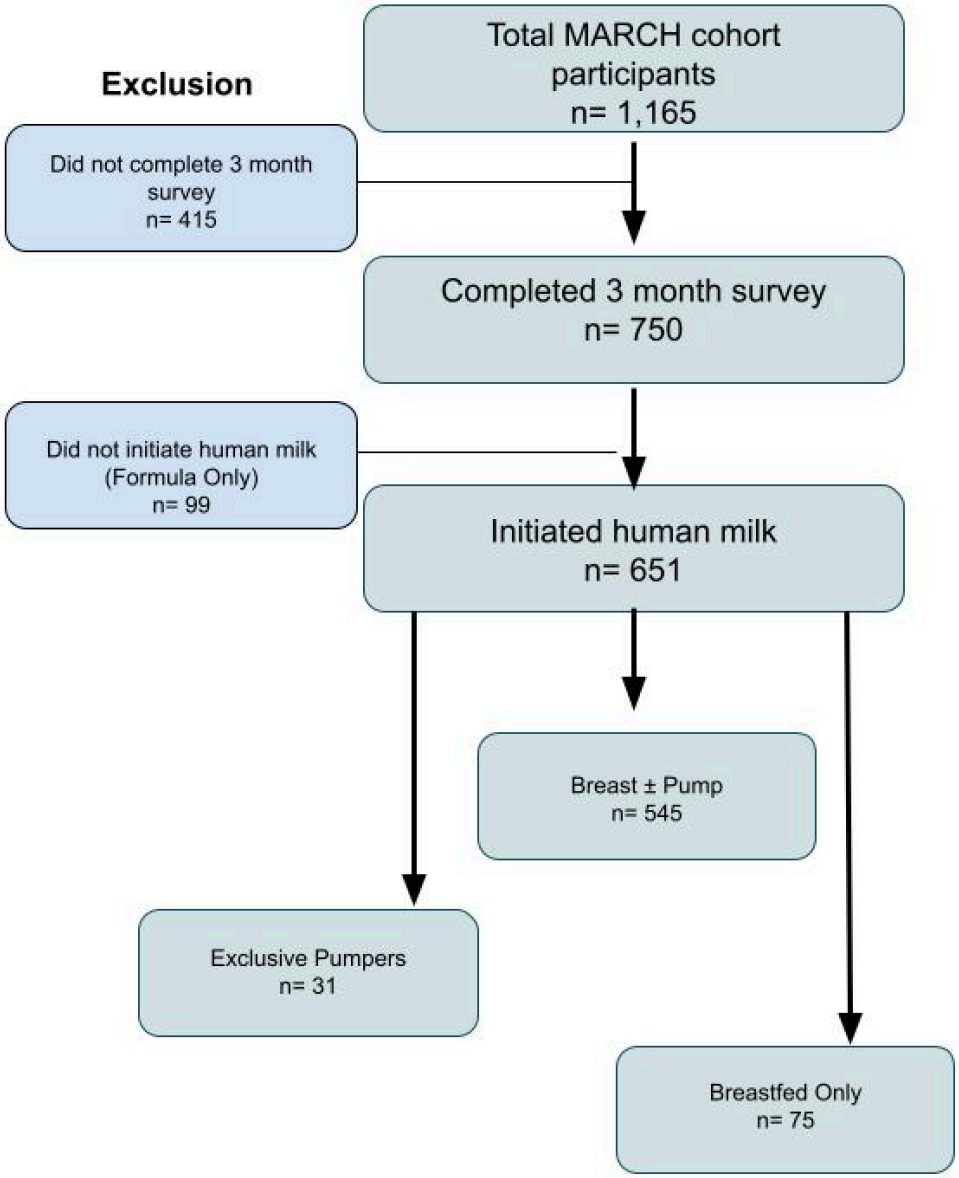

Figure 2. Survival analysis, using an unadjusted Kaplan-Meier curve, showing feeding duration for the three subgroups of those who initiated human milk: exclusive pumping group (n=31), breastfeeding only group (n=75), and the Breast ± Pump group (n=575). Feeding duration is censored for those still feeding via that respective method at the time in which the survey was taken.