

Exploring breastfeeding intentions and behaviors from a socio-ecological perspective

by

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B.Sc., University of Ghana, 2003
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AN ABSTRACT OF A DISSERTATION

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Abstract

The health benefits of breastfeeding for infants, including cognitive development, health, and child survival, are well-documented globally. Key organizations like the World Health Organization (WHO), the American Academy of Pediatrics, and the U.S. Surgeon General recommend breastfeeding for the first six months of life due to the significant health advantages for both the infant and the mother. Despite these recommendations, breastfeeding rates remain suboptimal in the U.S.

This research aims to explore three key areas related to breastfeeding. First, an ecological study analyzed the relationship between statewide breastfeeding rates and statewide breastfeeding support indicators using data from the CDC's 2019 Breastfeeding Report Card (Chapter 2). The study found that early introduction of formula before 2 days was negatively associated with all breastfeeding durations at 12 months ($\beta = -.59, p < .12$), exclusively breastfeeding at 3 ($\beta = -.106, p < .001$) and exclusively breastfeeding at 6 months ($\beta = -.59, p < .001$) respectively, while state-level breastfeeding support, measured by the Hospital Maternity Practices in Infant Nutrition and Care (mPINC) indicator, was positively correlated with longer breastfeeding durations at 6 months ($\beta = .71, p < .01$), at 12 months ($\beta = .61, p < .01$), exclusively breastfeeding at 3 ($\beta = .52, p < .01$), and exclusively breastfeeding at 6 months ($\beta = .37, p < .01$).

Secondly, individual demographic and infant feeding data from the CDC's 2019 National Immunization Survey (n = 29,217) were analyzed to explore the relationship between early formula introduction and early cessation of breastfeeding (Chapter 3). Results showed that 72.7% of breastfed infants were still breastfeeding at 6 months. Early formula introduction, either before 2 days or before 30 days, significantly reduced the likelihood of breastfeeding

continuation. Key predictors for early formula introduction included maternal age ≥ 29 years and first-born status of the infant.

Lastly, a cross-sectional web-based survey of expectant mothers ($n = 222$) across the U.S. was conducted to assess their breastfeeding attitudes and intentions. The survey aimed to understand if exposure to information about the infant formula shortage affected their breastfeeding attitudes (Chapter 4). The study used validated instruments, including the Iowa Infant Feeding Attitude Scale (IIFAS) and the Infant Feeding Intention (IFI) scale, as well as a novel self-developed tool measuring the frequency of exposure to information about formula shortage (i.e., the Formula Shortage Exposure Scale). The mean score on the Infant Feeding Attitude scale was $M = 54.89$, $SD = 7.99$, with scores ranging from 34 to 75. The mean score on the Infant Feeding Intentions scale was $M = 11.90$, $SD = 3.93$, with a range of 0 to 16. The mean Formula Shortage Exposure Scale score was $M = 28.73$, $SD = 7.77$, with scores ranging from 11 to 44. Infant feeding attitude scores were positively associated with feeding intention scores ($B = 1.37$, $p < .001$). However, formula shortage exposure scores were not significantly associated with either feeding intention ($B = -0.09$, $p = 0.820$) or feeding attitudes ($B = -0.15$, $p = .129$). Significant differences in formula shortage exposure scores were found based on age, $F(1, 219) = 15.43$, $p < .001$; education level, $F(2, 218) = 6.65$, $p < .001$; WIC participation, $F(1, 220) = 16.87$, $p < .001$; and monthly income, $F(2, 216) = 11.82$, $p < .001$. These demographic factors, however, were not significantly associated with Infant Feeding Intentions scores.

In summary, these combined studies highlight the multifactorial determinants of breastfeeding, emphasizing the complex interplay of physiological, behavioral, and socioeconomic factors that influence breastfeeding outcomes. In particular, this research highlights the critical role of breastfeeding support in prolonging breastfeeding duration and the

negative impact of early formula introduction. The findings regarding early introduction of formula are particularly noteworthy given that the proportion of breastfed infants supplemented with formula before 2 days of age rose from 15.5% in 2014 to 20.5% in 2021. Future research is needed to assess the impact of specific interventions intended to increase breastfeeding initiation and duration.

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Lastly, a cross-sectional web-based survey of expectant mothers ($n = 222$) across the U.S. was conducted to assess their breastfeeding attitudes and intentions. The survey aimed to understand if exposure to information about the infant formula shortage affected their breastfeeding attitudes (Chapter 4). The study used validated instruments, including the Iowa Infant Feeding Attitude Scale (IIFAS) and the Infant Feeding Intention (IFI) scale, as well as a novel self-developed tool measuring the frequency of exposure to information about formula shortage (i.e., the Formula Shortage Exposure Scale). The mean score on the Infant Feeding Attitude scale was $M = 54.89$, $SD = 7.99$, with scores ranging from 34 to 75. The mean score on the Infant Feeding Intentions scale was $M = 11.90$, $SD = 3.93$, with a range of 0 to 16. The mean Formula Shortage Exposure Scale score was $M = 28.73$, $SD = 7.77$, with scores ranging from 11 to 44. Infant feeding attitude scores were positively associated with feeding intention scores ($B = 1.37$, $p < .001$). However, formula shortage exposure scores were not significantly associated with either feeding intention ($B = -0.09$, $p = 0.820$) or feeding attitudes ($B = -0.15$, $p = .129$). Significant differences in formula shortage exposure scores were found based on age, $F(1, 219) = 15.43$, $p < .001$; education level, $F(2, 218) = 6.65$, $p < .001$; WIC participation, $F(1, 220) = 16.87$, $p < .001$; and monthly income, $F(2, 216) = 11.82$, $p < .001$. These demographic factors, however, were not significantly associated with Infant Feeding Intentions scores.

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Dedication

This work is dedicated to my family, whose unwavering love and encouragement have been my greatest source of strength. Their constant support and understanding have guided me through every challenge and inspired me to pursue my goals with determination.

To my family—thank you for your patience, sacrifices, and endless faith in my journey. This achievement is as much yours as it is mine.

Preface

This project represents the culmination of my research on “Exploring Breastfeeding Intentions and Behaviors from a Socio-Ecological Perspective” undertaken as part of my academic program in Public Health Nutrition in the School of Health Sciences. It reflects my effort to contribute to a deeper understanding of the critical role of breastfeeding support in prolonging breastfeeding duration, the negative impact of early formula introduction, and the potential influence of information about formula shortages on expectant mothers’ breastfeeding intentions.

I am sincerely grateful to my supervisor, committee members, professors, and family for their continuous guidance, encouragement, and support, which have been invaluable throughout this journey.

Chapter 1 - Introduction

Breastfeeding is widely recognized as the optimal source of nutrition for infants up to six months of age, offering significant benefits for both survival and development (Eidelman, 2012; Meek & Noble, 2022). Human breast milk contains essential antibodies and enzymes that protect infants from a range of infectious diseases, including respiratory and gastrointestinal infections, otitis media, and urinary tract infections (Hanson, 2004; Heinig, 2001; Heinig & Dewey, 1996; Meek & Noble, 2022; Oddy, 2020; Section on Breastfeeding, 2005; Weiss, 2013). These protective effects stem from breast milk's immunological and antibacterial properties, which help eliminate pathogens and reduce the risk of illness (Heinig, 2001; Oddy, 2020). In addition to preventing infections, breastfeeding reduces the risk of sudden infant death syndrome (SIDS) (Hauck et al., 2011; McVea et al., 2000; Vennemann et al., 2009) and promotes cognitive development and intelligence, independent of maternal IQ (Angelsen et al., 2001; Fergusson et al., 1982; Jain et al., 2002; Kramer et al., 2008; Meek & Noble, 2022; Oddy et al., 2003; Quigley et al., 2012; Rao et al., 2002). It also lowers the likelihood of developing asthma, allergies, and atopic diseases, even in high-risk children (Friedman & Zeiger, 2005; Harvey et al., 2021; Huo et al., 2018; Lodge et al., 2015; Oddy, 2017; Sears et al., 2002).

Breastfeeding is a means to improve a child's health trajectory, in that breastfeeding allows the child to self-regulate food intake which indirectly helps reduce the risk of childhood obesity (Arenz et al., 2004; Dewey, 2003; Fisher et al., 2000; Owen et al., 2005; Plagemann & Harder, 2005). Breastfeeding is thought to facilitate feeding self-control and allow the child to moderate their food intake in response to internal hunger and satiety cues (Lauzon-Guillain et al., 2012; Pang et al., 2020) by exposure to the appetite-regulating hormones of leptin, adiponectin and ghrelin that are found in human breast milk (Casabiell et al., 1997). Continuous and

prolonged consumption of human breast milk exposes the child to abundant appetite-regulating hormones and the child learns the appropriate internal signaling cues to satiety (Casabiell et al., 1997) which is absent when the child is fed with infant formula. Among formula-fed infants, parental influences such as encouragement to empty a bottle, contribute to the child's overconsumption and poor self-regulation of energy intake (Fisher et al., 2000; Savage et al., 2007; Wright et al., 1980).

Neurodevelopmental and Mortality Benefits of Breastfeeding

Exclusive breastfeeding is associated with a reduced risk of neurodevelopmental disorders, including ADHD, autism, cerebral palsy, cognitive delays, epilepsy, and mood disorders (Belfort et al., 2022; Elgersma et al., 2024; Soled et al., 2021; Zheng et al., 2024). It also plays a critical role in reducing the infant mortality rates, particularly in low- and middle-income countries (Victora et al., 2016). In the U.S., where the infant mortality rate is the highest among high-income nations, promoting breastfeeding could significantly lower mortality rates, especially among low-socioeconomic and minority populations (Bartick et al., 2022; Chen & Rogan, 2004; Eidelman, 2023; Li et al., 2022a; Ware et al., 2023a). A large-scale cohort study of nearly 10 million U.S. infants born between 2016 and 2018 found that breastfeeding initiation was associated with a 33% reduction in post-perinatal mortality during the first year of life (Ware et al., 2023a). This underscores the importance of breastfeeding support and promotion to reduce infant mortality, particularly among Black Americans, who experience disproportionately high rates.

Maternal Health Benefits

Breastfeeding also offers significant health benefits for mothers. It reduces the risk of premenopausal breast cancer, ovarian cancer, type 2 diabetes, myocardial infarction, and metabolic syndrome (Adetola Louis-Jacques & Alison Stuebe, 2018; Chowdhury et al., 2015; Schwarz & Nothnagle, 2015; Stuebe, 2009a). Additionally, breastfeeding aids in uterine involution following delivery, acts as a natural contraceptive, and lowers the risk of postpartum depression (Adetola Louis-Jacques & Alison Stuebe, 2018; Stuebe, 2009a). Long-term benefits include a reduced risk of rheumatoid arthritis and osteoporosis (Ince-Askan et al., 2019; Stuebe, 2009a).

Economic Benefits of Breastfeeding

Breastfeeding provides substantial economic benefits by reducing healthcare costs associated with infectious diseases in infants (Brahm & Valdés, 2017). Research has shown that the U.S. economy could save \$3.7 billion in direct and indirect pediatric health costs, with \$10.1 billion in premature death from pediatric diseases alone, if 90% of mothers followed current medical recommendations around breastfeeding (Bartick, 2011). Furthermore, \$3.9 billion less money would be spent on infant formula (Bartick, 2011), and individual families would save over \$1,700 annually on formula costs (Oliveira et al., 2019). Breastfed infants require fewer medical visits, hospitalizations, and prescriptions, leading to lower insurance and healthcare costs (Lechosa-Muñiz, Paz-Zulueta, Sáez de Adana Herrero, et al., 2020; Taylor et al., 2020). The United States Department of Agriculture (USDA) estimates that increasing breastfeeding rates among Supplemental Nutrition Program for Women, Infants, and Children (WIC) participants could lead to significant cost savings, reducing federal Medicaid expenditure

by \$111.6 million and saving WIC households over \$9.0 billion annually (Oliveira et al., 2019). Additionally, families that choose formula feeding over breastfeeding spend an average of 6.1% of their household income on economy-brand formula during the first two years of an infant's life (Walters et al., 2019a).

Challenges with Infant Formula

Infant formula lacks the bioactive components found in breast milk, which are crucial for immune system development (Carr et al., 2021a; Lokossou et al., 2022a; Szyller et al., 2024). Formula often contains added sugars, emulsifiers, and high fructose corn syrup, which are linked to accelerated growth, obesity, and metabolic syndrome in children (Anderson et al., 2022a, 2022b; Azevedo-Martins et al., 2024; Brand-Miller, 2022). Early introduction to formula also exposes infants to harmful compounds like dietary advanced glycated end products, which are associated with metabolic and allergic diseases (Pischetsrieder & Henle, 2012; Snelson & Coughlan, 2019; Wei et al., 2024). Other significant challenges associated with the use of infant formula include the heightened risk of contamination with toxic, life-threatening pathogens or harmful chemicals (Mielech et al., 2021). Such contaminants can lead to severe allergic reactions, intolerances, or even infant mortality. These risks were notably highlighted during recent incidents of formula shortages, which exacerbated concerns regarding the safety and reliability of infant formula as alternative feeding options for infants.

Barriers to Breastfeeding in the U.S.

Despite recommendations from the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), and American Academy of Pediatrics (AAP), breastfeeding rates in the U.S. remain suboptimal. Only 24.9% of infants are exclusively breastfed, and only 35.9% continue breastfeeding through one year (*Breastfeeding Report Card United States, 2022*, n.d.-a; Ware et al., 2023a). Factors previously linked to low breastfeeding rates include in-hospital formula supplementation, lack of support for breastfeeding mothers, and hospital policies that interfere with breastfeeding initiation and duration (Beggs et al., 2021a; Chantry et al., 2014a; Nommsen-Rivers et al., 2010a; Rollins et al., 2023a). Healthcare professionals play a critical role in influencing breastfeeding decisions. Mothers who perceive hospital staff as unsupportive are more likely to discontinue breastfeeding (Radzysinski & Callister, 2016a).

It is interesting to note that the WIC budget is dependent on formula company rebates which is approximately \$2 billion (Bartick, 2011), creating a conflict of interest in the fight against the early introduction of formula to breastfed infants especially low-income families.

Addressing these barriers through tailored interventions and policy changes is essential to improving breastfeeding rates and achieving the Healthy People 2030 target of 42.4% exclusive breastfeeding at six months (Raju, 2023).

Conclusion

Breastfeeding offers unparalleled health, developmental, and economic benefits for both infants and mothers. Despite its proven advantages, breastfeeding rates in the U.S. remain low, particularly among minority populations. Addressing barriers to breastfeeding through education, policy changes, and healthcare support is crucial to improving infant and maternal health outcomes and reducing healthcare costs. Effective breastfeeding promotion efforts can significantly reduce infant mortality, chronic disease rates, and economic burdens, ensuring a healthier future for generations to come.

This research explored three key socio-ecological themes related to breastfeeding: a) the relationship between statewide breastfeeding rates and statewide breastfeeding support (Chapter 2), b) the relationship between early formula introduction and early cessation of breastfeeding (Chapter 3), and c) expectant mothers' breastfeeding knowledge, attitudes, and intentions as well as exposure to information about the infant formula shortage (Chapter 4). In summary, the research highlights the critical role of breastfeeding support in prolonging breastfeeding duration, the negative impact of early formula introduction, and the potential influence of information about formula shortages on expectant mothers' breastfeeding intentions.

Chapter 2 - Breastfeeding Rates and Breastfeeding

Support: An Ecological Study

Abstract

Introduction: The majority of women who breastfed stop sooner than they desire due to barriers associated with their efforts and ability to breastfeed. Though the stay for infants is short, active support for breastfeeding can be initiated at the maternity center and supported after discharge through public health policy. However, the practices that transpire shortly after birth are not necessarily those that best support breastfeeding. Most notably, many breastfed infants receive infant formula before day 2 of age. This early use of infant formula is a significant concern, potentially interfering with the establishment of lactogenesis and breastfeeding success.

Objective: The aim of this study was to determine the association between statewide rates of breastfeeding and three statewide breastfeeding support indicators including (a) introduction of formula to breastfed infants before 2 days of age, (b) hospital maternity practices in infant nutrition and care (mPINC) scores, and (c) Baby-Friendly facility birth rates.

Methods: Using an ecological design, state-level data on breastfeeding outcomes were obtained from the CDC's Breastfeeding Report Card for infants born in 2019. Breastfeeding outcomes included statewide rates (%) of mothers who reported breastfeeding at (a) 6 months and (b) 12 months, as well as exclusive breastfeeding at (c) 3 months and (d) 6 months. Multiple regression analyses were conducted to control for the role of geographic region in assessing breastfeeding support indicators' ability to predict breastfeeding outcomes.

Results: Statewide rates of providing infant formula to breastfed infants before 2 days of age were negative association with statewide rates of exclusive breastfeeding at 3 months ($\beta = -$

.1.06, $p < .001$) and exclusive breastfeeding at 6 months ($\beta = -.59$, $p < .001$). Statewide mPINC scores were positively associated with statewide breastfeeding rates at 6 months ($\beta = .71$, $p < .01$), at 12 months ($\beta = .61$, $p < .01$), exclusively breastfeeding at 3 ($\beta = .52$, $p < .01$), and exclusively breastfeeding at 6 months ($\beta = .37$, $p < .01$). Statewide Baby-Friendly facility birth rates were not significantly associated with statewide breastfeeding rates.

Conclusion: These findings suggest that introduction of infant formula before 2 days of age may increase the risk of early discontinuation of breastfeeding while hospital maternity practices may decrease the risk of early breastfeeding discontinuation.

Keywords: Breastfeeding, child nutrition, infant formula, hospital maternity practices in infant nutrition and care

Introduction

Numerous studies report increasing evidence of an association between breastfeeding and long-term protection against chronic disease for both the infant and mother (Dieterich et al., 2013; Jackson et al., n.d.; Wang et al., 2022). Infant care practices, especially breastfeeding, can have a lasting impact on health (Bartick et al., 2017) and may protect against the risk of excessive protein and energy intake, thereby reducing the risk of childhood overweight and obesity (F. Liu et al., 2022; Y. H. Liu & Stein, n.d.; Picó et al., 2021; Ruchat et al., 2014).

Overall, the benefits of breastfeeding can be categorized into three general domains, each supported by extensive empirical evidence. The domains encompass breastfeeding benefits include (a) as a child survival intervention in reducing perinatal infant mortality and hospital readmissions as a result of gastrointestinal and respiratory illnesses and allergic reactions (Escobar et al., 2005; Li et al., 2022b; Wilde, 2021a; Young et al., 2013a); (b) as a means to improve a child's health trajectory (Fisher et al., 2000; Y. H. Liu & Stein, n.d.; Picó et al., 2021; Ruchat et al., 2014); and (c) as a factor associated with favorable maternal health outcomes (Chowdhury et al., 2015).

Given the well-established benefits of breastfeeding, the World Health Organization, the United Nations Children's Fund, the Center for Disease Control and Prevention, and the American Academy of Pediatrics recommend human breast milk as the preferred form of nutrition given to newborns upon delivery and also recommend exclusive breastfeeding for the first six months as well as after the introduction of complementary foods (Eidelman, 2012; Meek & Noble, 2022). Despite these recommendations, breastfeeding rates within the United States are less than ideal with only about a quarter (25.4%) of infants exclusively breastfed for 6 months and only 37.6% breastfed through 1 year. These rates are well below the Healthy People

2030 targets of 42.4% for exclusive breastfeeding at 6 months and 54.1% for any extent of breastfeeding at 1 year (Meek & Noble, 2022). The issue of not breastfeeding an infant exclusively for 6 months is not just a personal health matter, but a public health concern which negatively impacts the health and development of the child (Jackson et al., n.d.; Meek & Noble, 2022; Yelverton et al., 2021) and contributes to the socioeconomic burden on the health care system (Oliveira et al., 2019; Walters et al., 2019b).

Although 84.1% of U.S. infants born in 2021 were breastfed (i.e., breastfed for any extent) the rate of exclusive breastfeeding is notably lower as 1 in 6 infants are fed with formula within the first 2 days of life (Harris & Pomeranz, 2020) with over 65% of U.S. infants relying on infant formula as a major source of nutrition starting at birth (Bailey et al., 2018; Harris & Pomeranz, 2020). Early introduction of infant formula to breastfed infants replaces human breast milk, and among women planning to breastfeed, in-hospital use of formula was shown to be associated with an almost 3-fold risk of breastfeeding cessation by day 60 (Chantry et al., 2014b). What is more, the proportion of breastfed infants supplemented with infant formula before day 2 increased from 15.5 % in 2014 to 20.5 % in 2021 (CDC, 2024). Early introduction of infant formula is a significant concern for both the health of the infant and mother (Jackson et al., n.d.; Wang et al., 2022; Wilde, 2021a) and the potential consequences can be viewed as a broader societal problem (Snyder et al., 2021).

According to the Centers for Disease Control and Prevention (CDC), 60% of women in the U.S. stopped breastfeeding sooner than they desired to due to barriers associated with their efforts and ability to breastfeed (Odom et al., 2013a). A randomized controlled trial of mothers identified several factors associated with breastfeeding cessation, including perceived insufficient milk supply, regular use of breast pump, increased time spent breastfeeding infant (>

30 minutes), infant latching problems, use of formula within 7 days or more, cracked nipples, no breastfeeding experiences, return to work, and early introduction of solids (Bond et al., 2021). These findings highlight the multifactorial determinants of breastfeeding discontinuation, emphasizing the complex interplay of physiological, behavioral and socioeconomic factors that influence breastfeeding outcomes. Addressing these barriers through targeted interventions is essential to support sustained breastfeeding practices. Findings from a population-based longitudinal study of mothers revealed that parity, maternal emotional distress during pregnancy, and cesarean delivery were significant factors associated with exclusive breastfeeding duration of less than two months postpartum (Cato et al., 2017). These findings highlight the interplay of physiological, psychological, and delivery-related factors that contribute to shortened breastfeeding duration.

Other factors contributing to the early introduction of infant formula include in-hospital supplementation with formula, insufficient support from birth facilities to address breastfeeding challenges, and hospital practices and policies that disrupt breastfeeding intensity, exclusivity and duration” (CDC, 2024; Chantry et al., 2014b; Snyder et al., 2021). These systematic barriers reveal the critical role of healthcare environments and institutional practices in shaping early infant feeding behaviors. Addressing these factors through evidence-based policies and enhanced support systems is essential to promote optimal breastfeeding practices and improve maternal and infant health outcomes.

Mother’s perception of hospital staff’s attitude and support is a significant predictor breastfeeding intention. Mothers who perceived hospital staff as neutral toward their decision to breastfeed were more likely to wean their babies off breast milk and transition to formula feeding (Radzynski & Callister, 2016b). This is attributed to mothers expectation that hospital staff

including obstetricians and pediatricians would provide the necessary skills and knowledge to assist them to address breastfeeding challenges (Radzyminski & Callister, 2016b). Healthcare professionals play a critical role in influencing breastfeeding and infant feeding practices (Beggs et al., 2021b) due to their health-related expertise, knowledge, and public's trust in their ethical and professional responsibilities (Rollins et al., 2023b).

Additionally, delayed onset of lactogenesis, particularly among primiparous mothers, is a risk factor contributing to the early introduction of formula, which can result in shortened breastfeeding duration and reduced breastfeeding effectiveness (Nommsen-Rivers et al., 2010b).

Early introduction of formula is problematic and concerning because, it displaces breastfeeding and is associated with insufficient breast milk intake, shortened breastfeeding duration, and early cessation of breastfeeding (Chantry et al., 2014b; Holmes et al., 2011; Parry et al., 2013a; Stern et al., 2023). Furthermore, it deprives both the infant and the mother from the optimal health benefits associated with breastfeeding, which serves as a critical modifiable risk factor for reducing the incidence of infectious diseases (Cacho & Lawrence, 2017; Carr et al., 2021b; Lokossou et al., 2022b; Stuebe, 2009b; Stuebe et al., 2009; Stuebe & Rich-Edwards, 2008).

Given the multi-level nature of the issues, the socio-ecological model is a useful framework for understanding and addressing breastfeeding barriers and behaviors (Snyder et al., 2021; Tomori, 2022; Tomori et al., 2022). At the individual level, maternal health and nutritional status, self-efficacy, breastfeeding knowledge, attitudes, beliefs, benefits, challenges, and barriers can influence breastfeeding decisions. Support from immediate social networks be it family (Abbass-Dick et al., 2019), friends, peers, and support from health care providers especially at the delivery facility can also influence breastfeeding outcomes at the interpersonal

level (Sayres & Visentin, 2018). At the community and societal levels, the media, cultural attitudes, social norms governing breastfeeding, and access to breastfeeding support services influence breastfeeding norms, acceptability and practice. In addition, workplace policies, government policies and legislation governing maternal and child health can also shape breastfeeding behaviors.

Using a qualitative design, Snyder et al. (2021) explored supports and barriers to breastfeeding across environmental systems. Addressing the environmental aspect of the socio-ecological model may help alleviate barriers associated with breastfeeding at the individual, interpersonal, socio-cultural and community level. As described by Snyder et al. (2021), optimal breastfeeding outcomes cannot be achieved through individual or small-group interventions alone, but instead require a wider environmental and policy-level approach (Snyder et al., 2021).

The interplay between the delivery facility and the policies in place within the context of that environment significantly impacts breastfeeding exclusivity and continuity (Pérez-Escamilla et al., 2016; Snyder et al., 2021). For example, supportive delivery facilities coupled with effective breastfeeding policies increases exclusive breastfeeding rates in the early days of birth and later at home after hospital discharge (Pérez-Escamilla et al., 2016; Rollins et al., 2016; Snyder et al., 2021). In addition, providing ongoing breastfeeding support services upon hospital discharge improves breastfeeding duration (Pérez-Escamilla et al., 2016; Snyder et al., 2021). To achieve a broader impact on breastfeeding outcomes, delivery and birth facilities need effective policies and practices that promote and support breastfeeding (Pérez-Escamilla et al., 2016; Snyder et al., 2021). This can be achieved through deliberate implementation, ongoing monitoring and evaluation of breastfeeding support practices such as the Baby-Friendly Hospital Initiative (BFHI) and Hospital Maternity Practices in Infant Nutrition and Care (mPINC).

The Baby-Friendly Hospital Initiative (BFHI) is a global strategy launched by the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) for Infant and Young Child Feeding (Pérez-Escamilla et al., 2016). In the United States, the Centers for Disease Control and Prevention (CDC) encourage and recognize hospitals and birth centers to offer an optimal level of care for lactation based on WHO/UNICEF's Ten Steps to Successful Breastfeeding and the International Code of Marketing of Breast-milk Substitutes. Births at facilities with the BFHI designation include, rooming-in, feeding practices, feeding education and support, discharge support, and institutional management (CDC, 2024; Feldman-Winter et al., 2016; Hernández-Aguilar et al., 2018; Pérez-Escamilla et al., 2016). Research has established that a dose-response relationship between the number of BFHI Ten Steps for Successful Breastfeeding practices a mother is exposed to and improved breastfeeding outcomes for her infant (Pérez-Escamilla et al., 2016). Increased exposure to these practices is associated with a 22% higher rate of exclusive breastfeeding, independent of demographic factors (Patterson et al., 2018). In addition to BFHI, the national survey of Maternity Practices in Infant Nutrition and Care (mPINC) initiative also supports optimal breastfeeding. The mPINC survey is conducted by the CDC every 2 years to measure maternity care practices in hospitals and birthing centers particularly in regard to breastfeeding support (Grummer-Strawn et al., 2013).

Breastfeeding is complex and is influenced by an array of factors not limited to the individual (mother and infant attributes and relationship), but by the settings (health system and services, family/community and workplace environment) and components of the enabling environment (Rollins et al., 2016) within the settings designed to support and facilitate breastfeeding. State-level policies and practices also known as breastfeeding indicators within the healthcare system such as maternity practices in infant nutrition and care (mPINC) and

percent of live births at a Baby-Friendly facility not fully implemented, monitored and evaluated threaten breastfeeding exclusivity and duration and results in the early introduction of infant formula to breastfed infants. In addition, the early introduction of infant formula to breastfed infants may displace breastfeeding and reduce infant breastfeeding rates. The aim of this study was to determine the association between statewide rates of breastfeeding and three statewide breastfeeding support indicators (a) introduction of formula to breastfed infants before 2 days of age, (b) hospital maternity practices in infant nutrition and care (mPINC) scores, and (c) Baby-Friendly facility birth rates.

Methods

Using an ecological design, state level data was analyzed to determine the association between breastfeeding outcomes and breastfeeding support indicators.

Breastfeeding Outcomes

Data on breastfeeding outcomes were obtained from the CDC's breastfeeding Report Card of infants born in 2019. Breastfeeding outcomes included statewide rates (%) of breastfeeding mothers who indicated they were breastfeeding at (a) 6 months and (b) 12 months and statewide rates (%) of breastfeeding mothers who indicated they were exclusively breastfeeding at (c) 3 months and (d) 6 months.

Early Introduction to Formula

Statewide rate (%) of breastfed infants who were introduced to infant formula before 2 days of age were obtained from the CDC's breastfeeding Report Card of infants born in 2019.

Breastfeeding Support Indicators

Statewide breastfeeding support indicators obtained from the CDC's 2018 Breastfeeding Report Card were (a) statewide percent of live births occurring at Baby-Friendly Facilities, 2018 (BFFB 2018) and (b) statewide average hospital Maternity Practices in Infant Nutrition and Care scores 2018 (mPINC 2018).

The mPINC score ranges from 0 to 100 and is based on individual hospital reports of sub-scores of categorized maternity care practices subdomains which assess: 1) immediate postpartum care; 2) rooming-in feeding practices; 3) feeding education and support; 4) discharge support; and 5) institutional management. The responses for each score are based on

an “algorithm that denotes the evidence and best practices that promote optimal infant feeding within the maternity care setting” (Nelson et al., 2021). Higher scores indicate better maternity care practices and policies (Nelson et al., 2021; Barrera et al., 2019; Peterson et al., 2019; Boundy et al., 2018; Nelson et al., 2018; Edwards et al., 2010).

U.S. Geographic Regions

Geographic location was categorized into four groups according to U.S. Census regions (1 = Northeast, 2 = Midwest, 3 = South, and 4 = West). A one-way analysis of variance was conducted to examine differences in statewide breastfeeding rates across the four U.S. geographic regions.

Analyses

Data were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics, including means and standard deviations, were calculated to summarize statewide breastfeeding outcomes, the statewide rate (%) of breastfed infants who were introduced to infant formula before two days of age, and statewide breastfeeding support indicators. These statistics provided an overview of the distribution and variability of the study variables. To examine whether statistically significant differences existed among statewide breastfeeding outcomes, early provision of infant formula, and breastfeeding support indicators, a one-way analysis of variance (ANOVA) was conducted. Prior to conducting the analysis, the assumptions of normality and homogeneity of variances were assessed. Normality was evaluated through inspection of the distribution of scores, and homogeneity of variances was assessed using Levene’s test. When statistically significant differences were identified, post hoc comparisons were conducted to determine which groups differed significantly from one another. In addition, Pearson correlation analysis was conducted to examine the relationships among the key variables included in the study. The magnitude of correlations was interpreted according to conventional guidelines for small, moderate, and large effect sizes. Finally, multiple regression analysis was performed to

examine the extent to which breastfeeding support indicators predicted statewide breastfeeding outcomes and the early introduction of infant formula.

All statistical analyses and tests were done using IBM Statistical Package for the Social Sciences (SPSS) Version 28.0 (IBM SPSS) software, with a significance level set at $p < .05$.

Analysis of Variance (ANOVA)

Analysis of variance (ANOVA) was used to compare the differences in U.S. geographic regions and average statewide breastfeeding outcomes at (a) 6 months and (b) 12 months and statewide exclusively breastfeeding at (c) 3 months and (d) 6 months, and (e) statewide rate of breastfed infants who were introduced to infant formula before 2 days of age. In addition, analysis of variance was used to compare the differences in U.S. geographic regions and breastfeeding support indicators. The geographic region was treated as the independent variable to evaluate its association with both statewide breastfeeding outcomes and breastfeeding support indicators. Each breastfeeding outcome and support indicator was tested separately in the ANOVA.

Post-Hoc Analysis

When omnibus tests of the One-way ANOVA revealed significant differences in means of breastfeeding outcomes and support indicators across all the four U.S. geographic location, Tukey's honestly significant difference (HSD) post hoc analyses were performed to determine which specific regions differed significantly from one another.

Pearson Correlation

Pearson correlation analysis was used to assess the relationship between the statewide rate of breastfed infants who were introduced to infant formula before 2 days of age and average

statewide breastfeeding outcomes at (a) 6 months and (b) 12 months, and statewide exclusively breastfeeding at (c) 3 months and (d) 6 months.

Multiple Regressions

Multiple regression analyses were conducted to assess the role of geographic region and breastfeeding support indicators in predicting breastfeeding outcomes. The goal was to examine which breastfeeding support indicator(s) contributes to a higher rate of breastfeeding outcomes at (a) 6 months and (b) 12 months and exclusively breastfeeding at (c) 3 months and (d) 6 months.

Results

Table 2.1 presents the results of the analysis of variance (ANOVA) to look for differences in statewide breastfeeding outcomes and support indicators by geographic region. The ANOVA results indicate statistically significant differences in statewide breastfeeding rates by region. Significant differences by region were found for statewide breastfeeding rates at 6 months $F(3,47) = 10.09, p < .001, \eta^2 = .39$; 12 months $F(3,47) = 10.47, p < .001, \eta^2 = .40$; exclusive breastfeeding at 3 months $F(3,47) = 10.53, p < .001, \eta^2 = .40$ and exclusive breastfeeding at 6 months $F(3,47) = 8.19, p < .001, \eta^2 = .34$ (see Table 2.1).

Table 2.1. Means, Standard Deviation, and One-Way Analysis of Variance by Geographic Region for Statewide Breastfeeding Outcomes and Breastfeeding Support Indicators

Dependent variables	<i>M (%)</i>	<i>SD (±)</i>	<i>F (3, 47)</i>	η^2
Statewide rate of breastfeeding at 6 months	57.01	8.88	10.09***	.39
Statewide rate of breastfeeding at 12 months	36.75	7.70	10.47***	.40
Statewide rate of exclusive breastfeeding at 3 months	47.16	7.69	10.53***	.40
Statewide rate of exclusive breastfeeding at 6 months	26.25	4.90	8.19***	.34
Statewide rate of breastfed infants receiving formula before 2 days of age	17.79	4.28	2.09	.12
Statewide rate of live births occurring at Baby-Friendly Facilities, 2018 (BFFB 2018)	25.51	18.66	0.97	.06
Statewide rate of Hospital Maternity Practices in Infant Nutrition and Care score 2018 (mPINC 2018)	78.55	5.69	7.94**	.34

Table 2.2 represents Pearson correlation coefficients examining the relationships between statewide breastfeeding outcomes and statewide breastfeeding support indicators. The rate of breastfeeding at 6 months was significantly correlated with breastfeeding at 12 months ($r = .93, p < .001$), exclusive breastfeed at 3 months ($r = .84, p < .001$), and exclusive breastfeed at 6 months ($r = .83, p < .001$). These strong positive correlations suggest that early breastfeeding success is closely linked to longer breastfeeding outcomes. Statewide exclusive breastfeeding rates at 3 months were strongly correlated with exclusive breastfeeding rates at 6 months ($r = .88, p < .001$).

The provision of infant formula to breastfed infants before 2 days of age months was negatively correlated with statewide breastfeeding rates at 6 months ($r = -.34, p < .05$), breastfeeding at 12 months ($r = -.39, p < .001$), exclusive breastfeed at 3 months ($r = -.61, p < .001$), and exclusive breastfeed at 6 months ($r = -.51, p < .001$). The mPINC score was positively correlated with exclusive breastfeeding at 3 months ($r = .32, p < 0.05$) and exclusive breastfeeding at 6 months ($r = .32, p < 0.05$). However, the percentage of live births occurring at Baby-Friendly Facilities (BFFB 2018) was not significantly correlated with any breastfeeding outcomes.

Table 2.2 Pearson Correlation of Statewide Breastfeeding Outcomes and Statewide Breastfeeding Support Indicators

Variables	n	M	SD	1	2	3	4	5	6	7	8
1. U.S. Geographic Region	51	2.67	1.05	—							
2. Breastfeeding at 6 months	52	57.01	8.97	.39	—						
3. Breastfeeding at 12 months	52	36.75	7.78	.08	.93**	—					
4. Exclusive BF at 3 months	52	47.16	7.76	.09	.84**	.81**	—				
5. Exclusive BF at 6 months	52	26.25	4.95	-.01	.83**	.79**	.88**	—			
6. Formula before 2 days	52	17.79	4.32	-.15	-.34*	-.39**	-.61**	-.51**	—		
7. BFFB 2018	52	25.51	18.84	-.08	.03	-.07	.72	.01	.09	—	
8. mPINC 2018	51	78.55	5.74	-.24	.33	.27	.32*	.32*	-.05	.56**	—

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Note: BF -Breastfeeding, Breastfed infants receiving formula before 2 days of age - Formula before 2 days, BFFB – Baby Friendly Facility Births, mPINC – hospital maternity practices in infant nutrition and care score

Table 2.3 Multiple Linear Regression of Breastfeeding Through 6 Months and State Level Breastfeeding Support Indicators

Variable	<i>B</i>	<i>SE</i>	<i>95% CI</i>	β	<i>p</i>
Constant	13.68	21.07	[-28.76, 56.11]	-	.52
U.S. Geographic Region	.59	1.14	[-1.71, 2.89]	.07	.61
Formula before 2 days	-.64	.27	[-1.18, -.09]	-.31	.02**
BFFB 2018	-.11	.08	[-.26, .05]	-.22	.16
mPINC 2018	.71	.25	[.20, 1.21]	.45	.01**

Note. $R^2 = .26$, $F(4, 45) = 3.94$, $p = .008$ ** significant at $p < 0.05$

R^2 – indicates variance for the entire equation, B – unstandardized beta, β – standardized beta, SE – standard error, CI – confidence interval, p is significant at the 0.05 level,

BF - Breastfeeding, Breastfed infants receiving formula before 2 days of age - Formula before 2 days, BFFB - Baby Friendly Facility Births, mPINC - hospital maternity practices in infant nutrition and care score

As presented in Table 2.3, the regression model predicted 26% ($R^2 = .26$) of the variance in statewide breastfeeding rates through 6 months. Provision of infant formula to breastfed infants before 2 days of age was significantly negatively associated with breastfeeding at 6 months ($\beta = -.64$, $p < .02$). Specifically, for every increase in the percentage of infants receiving infant formula before 2 days of age, breastfeeding duration at 6 months decreases as well. Additionally, mPINC 2018 demonstrated a statistically significant positive association with breastfeeding at 6 months ($\beta = .71$, $p < .01$), whereas BFFB 2018 showed a small negative association with breastfeeding at 6 months ($\beta = -.11$, $p < .16$).

Table 2.4 Multiple Linear Regression of Exclusive Breastfeeding Through 3 Months and State Level Breastfeeding Support Indicators

Variable	<i>B</i>	<i>SE</i>	<i>95% CI</i>	β	<i>p</i>
Constant	24.25	15.19	[-6.36, 54.85]	-	.12
U.S. Geographic Region	.56	.82	[-1.09, 2.22]	.07	.49
Formula before 2 days	-1.06	.19	[-1.46, -.67]	-.59	.001**
BFFB 2018	-.04	.05	[-.15, .07]	-.08	.52
mPINC 2018	.52	.18	[.16, .89]	.39	.006**

Note. $R^2 = .49$, $F(4, 45) = 11.10$, ** significant at $p < 0.05$

R^2 – indicates variance for the entire equation, *B* – unstandardized beta, β – standardized beta, *SE*- standard error, *CI* – confidence interval, *p* is significant at the 0.05 level,

BF -Breastfeeding, Breastfed infants receiving formula before 2 days of age - Formula before 2 days, BFFB – Baby Friendly Facility Births, mPINC – hospital maternity practices in infant nutrition and care score

Table 2.5 Multiple Linear Regression of Exclusive Breastfeeding Through 6 Months and State Level Breastfeeding Support Indicators

Variable	<i>B</i>	<i>SE</i>	<i>95% CI</i>	β	<i>p</i>
Constant	8.42	9.73	[-11.17, 28.03]	-	.39
U.S. Geographic Region	-0.05	.53	[-1.12, 1.01]	-.01	.92
Formula before 2 days	-.59	.13	[-.84, -.34]	-.53	<.001**
BFFB 2018	-.04	.04	[-.11, .03]	-.15	.28
mPINC 2018	.37	.12	[.14, .60]	.44	.003**

Note. $R^2 = .46$, $F(4, 45) = 9.44$, ** significant at $p < 0.05$

R^2 – indicates variance for the entire equation, *B* – unstandardized beta, β – standardized beta, *SE*- standard error, *CI* – confidence interval, *p* is significant at the 0.05 level,

BF -Breastfeeding, Breastfed infants receiving formula before 2 days of age - Formula before 2 days, BFFB – Baby Friendly Facility Births, mPINC – hospital maternity practices in infant nutrition and care score

Table 2.6 Multiple Linear Regression of Breastfeeding Through 12 Months and State Level Breastfeeding Support Indicators

Variable	<i>B</i>	<i>SE</i>	<i>95% CI</i>	β	<i>p</i>
Constant	.55	18.31	[-36.33, 37.43]	-	.98
U.S. Geographic Region	.79	.99	[-1.21, 2.78]	.11	.43
Formula before 2 days	-.59	.24	[-1.07, -.12]	-.33	.12
BFFB 2018	-.12	.07	[-.25, .01]	-.28	.08
mPINC 2018	.61	.22	[.17, 1.05]	.44	.01**

Note. $R^2 = .28$, $F(4, 45) = 4.32$, ** significant at $p < 0.05$

R^2 – indicates variance for the entire equation, *B* – unstandardized beta, β – standardized beta, *SE*- standard error, *CI* – confidence interval, *p* is significant at the 0.05 level,

BF -Breastfeeding, Breastfed infants receiving formula before 2 days of age - Formula before 2 days, BFFB – Baby Friendly Facility Births, mPINC – hospital maternity practices in infant nutrition and care score

Multiple linear regression analysis revealed that the provision of infant formula to breastfed infants before 2 days of age was significantly associated with exclusive breastfeeding at 3 months ($\beta = -.1.06$, $p < .001$) and exclusive breastfeeding at 6 months ($\beta = -.59$, $p < .001$) as shown in Tables 4, and 5 respectively. However, provision of infant formula to breastfed infants before 2 days of age was not significantly associated with breastfeeding at 12 months ($\beta = -.59$, $p < .12$), see Table 2.6.

A multiple linear regression analysis on mPINC 2018 revealed a statistically significant positive association with all breastfeeding durations, at 6 months ($\beta = .71$, $p < .01$), at 12 months ($\beta = .61$, $p < .01$), exclusively breastfeeding at 3 ($\beta = .52$, $p < .01$), and exclusively breastfeeding at 6 months ($\beta = .37$, $p < .01$).

Post-Hoc Analysis

Post-hoc analyses using Tukey's HSD test revealed regional differences in breastfeeding outcomes and hospital practices by U.S. geographic region (see Tables 2.7 to 2.13).

For breastfeeding at 6 and 12 months, the South had significantly lower rates compared with the Northeast, Midwest, and West (6 months: South vs. Northeast, -10.53%, $p = .005$; South vs. Midwest, -8.29%, $p = .020$; South vs. West, -14.01%, $p < .001$; 12 months: South vs. Northeast, -8.85%, $p = .007$; South vs. Midwest, -6.40%, $p = .045$; South vs. West, -12.51%, $p < .001$), while no other regional differences were significant (see Tables 2.7 and 2.8).

For exclusive breastfeeding, the South also had significantly lower rates through 3 and 6 months compared with all other regions (3 months: South vs. Northeast, -7.42%, $p = .029$; South vs. Midwest, -8.44%, $p = .004$; South vs. West, -12.43%, $p < .001$; 6 months: South vs. Northeast, -5.19%, $p = .016$; South vs. Midwest, -5.27%, $p = .006$; South vs. West, -6.73%, $p < .001$) (see tables 2.9 and 2.10).

In contrast, no significant regional differences were observed for the proportion of breastfed infants receiving formula within the first two days of life (see Table 2.11) or for births at Baby-Friendly Facilities (BFHB 2018) scores (see Table 2.12), suggesting that early formula feeding practices were relatively consistent across all geographic regions.

Examination of 2018 mPINC scores indicated that hospitals in the Northeast achieved higher scores compared with hospitals in the Midwest (mean difference = 8.39, $p = .001$) and the South (mean difference = 9.01, $p < .001$) (see Table 2.13), while differences between other regions were not statistically significant.

Table 2.7 Post Hoc Analysis of Breastfeeding at 6 Months by Geographic Region

U.S. Geographic Region	Mean Difference ($M_i - M_j$)	SE	p	95% CI
Northeast vs Midwest	2.24	3.20	.897	[-6.28, 10.77]
Northeast vs South	10.53*	2.99	.005	[2.55, 8.50]
Northeast vs West	-3.47	3.14	.688	[-11.86, 4.90]
Midwest vs South	8.28*	2.73	.020	[.99, 15.58]
Midwest vs West	-5.72	2.90	.215	[-13.46, 2.02]
South vs West	-14.01*	2.67	<.001	[-21.13, -6.88]

Note. Tukey HSD test was used. N = 222. CI = confidence interval. *The mean difference is significant at the 0.05 level

Table 2.8 Post Hoc Analysis of Breastfeeding at 12 Months by Geographic Region

U.S. Geographic Region	Mean Difference ($M_i - M_j$)	SE	p	95% CI
Northeast vs Midwest	2.45	2.76	.812	[-4.91, 9.81]
Northeast vs South	8.85*	2.58	.007	[1.97, 15.73]
Northeast vs West	-3.65	2.71	.540	[-10.89, 3.58]
Midwest vs South	6.40*	2.36	.045	[.10, 12.69]
Midwest vs West	-6.10	2.51	.085	[-12.79, .58]
South vs West	-12.50*	2.31	<.001	[-18.66, -6.35]

Note. Tukey HSD test was used. N = 222. CI = confidence interval. *The mean difference is significant at the 0.05 level

Table 2.9 Post Hoc Analysis of Exclusive Breastfeeding at 3 Months by Geographic

Region

U.S. Geographic Region	Mean Difference ($M_i - M_j$)	SE	<i>p</i>	95% CI
Northeast vs Midwest	-1.01	2.74	.983	[-8.33, 6.30]
Northeast vs South	7.42*	2.57	.029	[.57, 14.26]
Northeast vs West	-5.00	2.70	.263	[-12.20, 2.19]
Midwest vs South	8.43*	2.35	.004	[2.17, 14.69]
Midwest vs West	-3.98	2.49	.390	[-10.63, 2.65]
South vs West	-12.42*	2.29	<.001	[-18.54, -6.30]

Note. Tukey HSD test was used. N = 222. CI = confidence interval. *The mean difference is significant at the 0.05 level

Table 2.10 Post Hoc Analysis of Exclusive Breastfeeding at 6 Months by Geographic

Region

U.S. Geographic Region	Mean Difference ($M_i - M_j$)	SE	<i>p</i>	95% CI
Northeast vs Midwest	-.075	1.78	1.000	[-4.81, 4.66]
Northeast vs South	5.19*	1.66	.016	[.76, 9.62]
Northeast vs West	-1.53	1.75	.816	[-6.20, 3.12]
Midwest vs South	5.26*	1.52	.006	[1.21, 9.32]
Midwest vs West	-1.46	1.61	.802	[-5.76, 2.84]
South vs West	-6.73*	1.48	<.001	[-10.69, -2.77]

Note. Tukey HSD test was used. N = 222. CI = confidence interval. *The mean difference is significant at the 0.05 level

Table 2.11 Post Hoc Analysis of Breastfed Infants Receiving Formula Before 2 Days of Age by Geographic Region

U.S. Geographic Region	Mean Difference ($M_i - M_j$)	SE	<i>p</i>	95% CI
Northeast vs Midwest	2.43	1.85	.560	[-2.50, 7.38]
Northeast vs South	-.12	1.73	1.000	[-4.75, 4.49]
Northeast vs West	3.17	1.82	.315	[-1.68, 8.04]
Midwest vs South	-2.56	1.58	.380	[-6.79, 1.66]
Midwest vs West	.74	1.68	.971	[-3.74, 5.23]
South vs West	3.30	1.55	.158	[-.82, 7.43]

Note. Tukey HSD test was used. N = 222. CI = confidence interval. *The mean difference is significant at the 0.05 level

Table 2.12 Post Hoc Analysis of Births Occurring at Baby-Friendly Facilities, 2018 (BFFB 2018) by Geographic Region

U.S. Geographic Region	Mean Difference ($M_i - M_j$)	SE	<i>p</i>	95% CI
Northeast vs Midwest	12.72	8.25	.422	[-9.26, 34.72]
Northeast vs South	4.32	7.72	.943	[-16.23, 24.88]
Northeast vs West	9.21	8.12	.670	[-12.41, 30.84]
Midwest vs South	-8.40	7.06	.636	[-27.21, 10.40]
Midwest vs West	-3.51	7.49	.966	[-23.48, 16.45]
South vs West	4.89	6.90	.893	[-13.48, 23.26]

Note. Tukey HSD test was used. N = 222. CI = confidence interval. *The mean difference is significant at the 0.05 level

Table 2.13 Post Hoc Analysis of Hospital Maternity Practices in Infant Nutrition and Care score 2018 (mPINC 2018) by Geographic Region

U.S. Geographic Region	Mean Difference ($M_i - M_j$)	SE	<i>p</i>	95% CI
Northeast vs Midwest	8.38*	2.11	.001	[2.75, 14.02]
Northeast vs South	9.01*	1.99	<.001	[3.69, 14.34]
Northeast vs West	5.04	2.07	.086	[-.50, 10.58]
Midwest vs South	.62	1.83	.986	[-4.26, 5.51]
Midwest vs West	-3.34	1.91	.314	[-8.46, 1.77]
South vs West	-3.97	1.79	.133	[-8.74, .80]

Note. Tukey HSD test was used. N = 222. CI = confidence interval. *The mean difference is significant at the 0.05 level

Discussion

This ecological study was designed to determine the association between statewide rates of breastfeeding and three statewide breastfeeding support indicators. The findings from this study highlight significant regional differences in breastfeeding outcomes and maternity care practices across the United States. The statewide rates of breastfeeding at 6 and 12 months, as well as exclusive breastfeeding at 3 and 6 months, varied significantly across geographic regions, with large effect sizes. These results align with previous research demonstrating that breastfeeding practices are influenced by a combination of individual, cultural, and structural factors, including access to lactation support, maternal education, and workplace policies (Cohen et al., 2018). The observed decline in breastfeeding rates from 6 to 12 months, as well as the drop-in exclusive breastfeeding rates from 3 to 6 months, is consistent with national trends reported by the Centers for Disease Control and Prevention (CDC, 2025), underscoring the challenges mothers face in maintaining breastfeeding as infants age.

The significant regional differences in breastfeeding outcomes may reflect variations in state-level policies, cultural norms, and the availability of breastfeeding support services. For example, states with stronger maternity leave policies and higher densities of International Board-Certified Lactation Consultants (IBCLCs) tend to report higher breastfeeding rates (Hawkins et al., 2014). Additionally, the large effect sizes for breastfeeding outcomes suggest that geographic location plays a critical role in shaping breastfeeding behaviors, which is consistent with findings from studies examining rural-urban disparities in breastfeeding initiation and duration (Sparks, 2010).

The significant regional differences in the Hospital Maternity Practices in Infant Nutrition and Care (mPINC) scores further emphasize the importance of maternity care practices

in supporting breastfeeding. Hospitals with higher mPINC scores are more likely to implement evidence-based practices, such as skin-to-skin contact and rooming-in, which have been shown to improve breastfeeding initiation and duration (Perrine et al., 2015a).

Contrary to other studies on Baby-Friendly facility births, our study did not find a correlation between such births and breastfeeding at 6 and 12 months or exclusive breastfeeding at 3 and 6 months (Pérez-Escamilla et al., 2016). However, the lack of significant regional differences in the percentage of live births occurring at Baby-Friendly Facilities (BFFB 2018) suggests that the Baby-Friendly Hospital Initiative (BFHI) alone may not be sufficient to address regional disparities in breastfeeding outcomes. This finding is consistent with critiques of the BFHI, which highlight the need for complementary strategies, such as community-based support and policy changes, to achieve equitable breastfeeding outcomes (Pérez-Escamilla et al., 2016).

The non-significant differences in the percentage of breastfed infants receiving formula before 2 days of age suggest that early formula supplementation may be influenced by factors other than geographic location, such as hospital practices or maternal preferences. Early formula supplementation has been associated with shorter breastfeeding duration and reduced exclusivity (Chantry et al., 2014b), highlighting the need for targeted interventions to address this practice.

The findings from the study highlight the significant impact of early formula introduction on breastfeeding outcomes. The negative correlations between formula introduction before 2 days of age and breastfeeding rates at 6 and 12 months, as well as exclusive breastfeeding rates at 3 and 6 months, align with previous research demonstrating that early formula supplementation can disrupt breastfeeding initiation and reduce exclusivity (Chantry et al., 2014b). The results underscore the importance of minimizing unnecessary formula supplementation in the early postpartum period to support breastfeeding success. The findings of

a strong positive correlation between statewide breastfeeding rates at 6 months and longer breastfeeding outcomes at 12 months and exclusive breastfeeding at 3 and 6 months suggest that early breastfeeding success, especially within the first few weeks of the postpartum period, is a critical predictor of sustained breastfeeding and is consistent with results from other studies (Rollins et al., 2016). Thus, interventions should be aimed at supporting breastfeeding initiation and addressing common challenges to help improve long-term breastfeeding outcomes.

The positive correlations between mPINC scores and exclusive breastfeeding rates at 3 and 6 months underscore the importance of maternity care practices in supporting breastfeeding. Hospitals with higher mPINC scores are more likely to adopt evidence-based practices, such as skin-to-skin contact and rooming-in, which enhance breastfeeding initiation and exclusivity (Perrine et al., 2015b). In contrast, the lack of significant correlations between Baby-Friendly Facilities (BFFB 2018) Births and breastfeeding outcomes suggests that the Baby-Friendly Hospital Initiative (BFHI) alone may be insufficient to ensure breastfeeding success. This aligns with critiques highlighting the need for additional strategies, such as community support and policy changes, to address broader barriers to breastfeeding (Pérez-Escamilla et al., 2016). In addition, a randomized controlled trial by Wong and Chien (2025) demonstrated that participation in a theory-based educational program significantly increased exclusive breastfeeding rates and improved breastfeeding self-efficacy at 2 months postpartum among primiparous women using the Theory-Based Educational Program, a Real Online Education and Support Program with Telephone Follow-ups (REST). The program provided women with sustained support for breastfeeding outcomes over a 6-month postpartum period and has the potential to enhance breastfeeding outcomes (Wong & Chien, 2025).

Post hoc analyses indicated significant regional differences in breastfeeding outcomes across all the four U.S. geographic regions. Across all the four U.S. geographic regions, mothers in the South exhibited consistently lower breastfeeding rates compared with mothers in the Northeast, Midwest, and West. Specifically, breastfeeding at 6 and 12 months and exclusive breastfeeding at 3 and 6 months were significantly lower in the South relative to the other regions. In contrast, breastfeeding rates among mothers in the Northeast, Midwest, and West were comparable, with no significant differences between. This pattern suggests a persistent regional disparity, with the South, demonstrating systematic disadvantages in breastfeeding outcomes relative to other U.S. geographic regions.

With respect to breastfeeding support indicators, hospitals in the Northeast had significantly higher 2018 Maternity Practices in Infant Nutrition and Care (mPINC) scores compared with those in the Midwest and South, indicating that geographic location accounts for a substantial proportion of variance in key breastfeeding outcomes and support practices. Differences between the Northeast and West were not statistically significant, nor were differences among the Midwest, South, and West.

In contrast, no significant regional differences were observed in the proportion of breastfed infants who received formula within the first two days of life, indicating relative consistency in early formula feeding practices across all states (all four geographic regions of the U.S.).

No significant regional differences were also observed in the percentage of births occurring in Baby-Friendly hospital facilities (2018).

Collectively, these findings indicate that geographic regions are significantly associated with breastfeeding duration and exclusivity, as well as with selected breastfeeding support

indicators. Regions with higher mPINC scores were characterized by stronger breastfeeding support practices and correspondingly higher rates of breastfeeding intensity, exclusivity, and duration.

Limitations and Future Research

This study has several limitations. First, the cross-sectional design limits the ability to establish causal relationships between geographic region and breastfeeding outcomes. Second, the analysis did not account for individual-level factors, such as maternal education or income, which may influence breastfeeding practices. Future research should explore the interplay between individual and structural factors in shaping breastfeeding outcomes, as well as the long-term impact of regional disparities on maternal and child health.

Conclusion

The findings from this study highlight the relationships between statewide breastfeeding outcomes, early introduction of formula before 2 days of age, and statewide mPINC scores across the United States. Substantial regional difference exists in statewide breastfeeding rates at 6 and 12 months, as well as exclusive breastfeeding rates at 3 and 6 months, all with large effect sizes. The differences were not apparent in the multivariate analysis. The results further highlight the influence of geographic location on breastfeeding practices, which can likely be attributed to variation in the various state-level policies, cultural norms, and access to lactation support services (Cohen et al., 2018; Hawkins et al., 2014). In addition, the significant differences in mPINC 2018 scores emphasize the importance of evidence-based maternity care practices in promoting breastfeeding. The positive correlations between mPINC 2018 scores and exclusive breastfeeding rates highlight the role of supportive maternity care practices in fostering breastfeeding success.

The negative impact of early introduction to infant formula on all statewide breastfeeding outcomes, with significant correlations between formula use before 2 days of age and breastfeeding rates at 6 and 12 months and exclusive breastfeeding rates at 3 and 6 months align with previous research demonstrating that, early introduction of infant formula can disrupt breastfeeding initiation and reduce breastfeeding continuity and exclusivity (Chantry et al., 2014b).

The result of the study emphasizes the need for more targeted interventions to address breastfeeding regional disparities and improve maternity care practices to reduce the early introduction of infant formula to breastfed infants.

Chapter 3 - Early Introduction of Infant Formula is Associated with a Shorter Duration of Breastfeeding

Abstract

Introduction: Human milk surpasses its role as mere nutrition, encompassing medicinal qualities crucial for infant health and survival. Human milk is endorsed by the American Academy of Pediatrics as the ideal source of nutrition for infants with unparalleled benefits. Despite these recommendations, early discontinuation of breastfeed is an ongoing public health concern, and the practice of providing breastfed infants formula during the first days of life is potentially disrupting optimal breastfeeding practices

Objectives: To determine the relationship between early introduction of infant formula and early discontinuation of breastfeeding

Methods: Demographic and infant feeding data was obtained from the Centers for Disease Control and Prevention's 2019 National Immunization Survey, a household telephone survey of parents and guardians of children 19-35 months of age. Only infants that were breastfed (i.e., breastfed for any duration) were included in this study ($n = 29,217$). Chi-squared, Pearson's correlation, and linear regression analyses methods were applied to examine the relationship between the duration in days that a child was fed breast milk and the age in days at which the child was first fed formula, with significance set at $p < 0.05$.

Results: Of the 29,217 infants were breastfed for any duration, 72.7% were breastfed at 6 months. Six percent (6.34%) and 13.7% of breastfed infants were fed formula before 2 days and 30 days, respectively. Early formula introduction, whether within 2 days ($X^2 = 572.59$, $p <$

0.001) or 30 days ($X^2 = 1,900$, $p < 0.001$) reduced the likelihood of breastfeeding continuity at 6 months. The age at which child was first fed formula was positively correlated with breastfeeding duration ($r = 0.65$, $p < 0.001$). Significant predictors of early formula introduction were maternal age ≥ 29 years (OR = 1.23, 95% CI [1.10, 1.54], $p = .002$) and first-born status (OR = 1.52, 95% CI [1.33, 1.75], $p < .001$) while WIC program participation (OR = 1.21, 95% CI [0.99, 1.49], $p = .066$) and Northeast region residence (OR = 1.24, 95% CI [0.99, 1.54], $p = 0.059$) neared significance.

Conclusion: These findings suggest that early introduction of formula increases the risk of early discontinuation of breastfeeding. Early introduction of infant formula occurred at a relatively low rate. However, older maternal age and first-born status increased the risk of this practice. These breastfeeding groups may need additional support (e.g., education regarding normal newborn feeding patterns) during the early postpartum period. Future research is needed to better understand the factors predictive of early introduction of formula.

Keywords: breastfeeding, infant formula, human milk, maternity care, public health surveillance

Introduction

Optimal nutrition during infancy sets the foundation for lifelong health, growth, and development, fostering the realization of full human potential. The composition of human breast milk is ideally suited to meet the nutritional and health requirements of infants during the first six months of life (Lessen & Kavanagh, 2015). In addition to its rich nutrient content, human breast milk, contains bioactive components such as growth hormones, cytokines, leukocytes, immunoglobulins, lactoferrin, lysozymes, stem cells, and other immune protective factors. (Cacho & Lawrence, 2017; Carr et al., 2021b; Lokossou et al., 2022b). These elements offer infants critical immunological defense, helping to protect them from infections and diseases. The benefits of human breast milk for infants are unparalleled and cannot be overstated due to its unique composition and the diverse physiological roles each of its components fulfills. For example, a large-scale prospective cohort study analyzing nearly 10 million infants born in the U.S. born between 2016 -2018, followed for one year after birth, found that breastfeeding was associated with a 33% reduction in perinatal infant mortality in the first year of life (Ware et al., 2023b). This research among others provides evidence of breastfeeding as an effective tool in reducing early childhood mortality (Chivers et al., 2010; Labayen et al., 2012; Mantzorou et al., 2022; Roldão et al., 2024; Rzehak et al., 2009; Yan et al., 2014).

The absence of breastfeeding has been associated with more than 80,000 neonatal readmissions annually in the U.S., often resulting from conditions such as jaundice, dehydration, gastrointestinal infections, and hypoglycemia (Li et al., 2022b; Wilde, 2021b; Young et al., 2013b). This leads to higher healthcare costs, including increased hospital visits, treatment expenses, physician fees, and prescription drug costs (Jegier et al., 2024; Walters et al., 2019b). Additionally, it creates added burdens for caregivers, resulting in more time away from work and

other responsibilities. Increased breastfeeding rates, particularly among Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program participants in the U.S., are projected to lower federal Medicaid costs by more than \$100 million and generate \$9 billion in savings to WIC households, as reported by the U.S. Department of Agriculture (M. Bartick, 2011; Oliveira et al., 2019; Walters et al., 2019b).

Shorten breastfeeding duration is associated with the introduction of infants to formula (Chantry et al., 2014b) which constitutes a public health concern and presents a critical challenge to meeting the Health Peoples 2030 target of achieving a 42.45% exclusive breastfeeding rate through six months of age. Additionally, formula introduction has been identified as an indicator of reduced maternal breastfeeding intent (Chantry et al., 2014b), and it complicates infant feeding behaviors and adversely affects maternal lactational capacity from the initial stages of the perinatal period (Academy of Breastfeeding Medicine Protocol Committee, 2009; Chantry et al., 2014b).

Despite the well-documented nutritional advantages of breast milk, over 75% of infants in the United States rely on infant formula as a primary source of nutrition (Cacho & Lawrence, 2017) from birth, and 20.5% of breastfed infants receive formula supplementation within the first 2 days of life (*Breastfeeding Report Card United States, 2022*, n.d.-b). The premature discontinuation of breastfeeding and subsequent transition to formula feeding among mothers is influenced by a variety of factors. The determinants of early formula introduction or breastfeeding cessation are multifaceted and complex. Findings from a population-based longitudinal study of mothers revealed that parity, maternal emotional distress during pregnancy, and cesarean delivery were significant factors associated with exclusive breastfeeding duration of less than two months postpartum (Cato et al., 2017). These findings highlight the interplay of

physiological, psychological, and delivery-related factors that contribute to shortened breastfeeding duration. A randomized controlled trial further identified several factors associated with breastfeeding cessation, including perceived insufficient milk supply, regular use of breast pump, increased time spent breastfeeding infant (> 30 minutes), infant latching problems, use of formula within 7 days or more, cracked nipples, no breastfeeding experiences, return to work, and early introduction of solids (Bond et al., 2021). These findings highlight the multifactorial determinants of breastfeeding discontinuation, emphasizing the complex interplay of physiological, behavioral and socioeconomic factors that influence breastfeeding outcomes. Addressing these barriers through targeted interventions is essential to support sustained breastfeeding practices.

Other factors contributing to the early introduction of infant formula include in-hospital supplementation with formula, insufficient support from birth facilities to address breastfeeding challenges, and hospital practices and policies that disrupt breastfeeding intensity, exclusivity and duration” (CDC, 2024; Chantry et al., 2014b; Snyder et al., 2021). These systematic barriers reveal the critical role of healthcare environments and institutional practices in shaping early infant feeding behaviors. Addressing these factors through evidence-based policies and enhanced support systems is essential to promote optimal breastfeeding practices and improve maternal and infant health outcomes.

Mother’s perception of hospital staff’s attitude and support is a significant predictor breastfeeding intention. Mothers who perceived hospital staff as neutral toward their decision to breastfeed were more likely to wean their babies off breast milk and transition to formula feeding (Radzynski & Callister, 2016b). This is attributed to mothers expectation that hospital staff including obstetricians and pediatricians would provide the necessary skills and knowledge to

assist them to address breastfeeding challenges (Radzyninski & Callister, 2016b). Healthcare professionals play a critical role in influencing breastfeeding and infant feeding practices (Beggs et al., 2021b) due to their health-related expertise, knowledge, and public's trust in their ethical and professional responsibilities (Rollins et al., 2023b).

Additionally, delayed onset of lactogenesis, particularly among primiparous mothers, is a risk factor contributing to the early introduction of formula, which can result in shortened breastfeeding duration and reduced breastfeeding effectiveness (Nommsen-Rivers et al., 2010b). Early introduction of formula is problematic and concerning because, it displaces breastfeeding and is associated with insufficient breast milk intake, shortened breastfeeding duration, and early cessation of breastfeeding (Chantry et al., 2014b; Holmes et al., 2011; Parry et al., 2013a; Stern et al., 2023). Furthermore, it deprives both the infant and the mother from the optimal health benefits associated with breastfeeding, which serves as a critical modifiable risk factor for reducing the incidence of infectious diseases (Cacho & Lawrence, 2017; Carr et al., 2021b; Lokossou et al., 2022b; A. Stuebe, 2009b; Stuebe et al., 2009; Stuebe & Rich-Edwards, 2008).

To address the low rates of exclusive breastfeeding across the United States and to delay the early introduction to infant formula within the first 2 days of life, a randomized controlled trial by Wong and Chien (2025) demonstrated that participation in a theory-based educational program significantly increased exclusive breastfeeding rates and improved breastfeeding self-efficacy at 2 months postpartum among primiparous women. This program shows potential in enhancing breastfeeding outcomes, aligns with the objectives of the Baby-Friendly Hospital Initiative (BFHI) (Patterson et al., 2018). The Theory-Based Educational program utilized in this study, known as the Real-time Online Education and Support program with Telephone Follow-

ups (REST), provided women with sustained support for breastfeeding outcomes over a 6-month postpartum period (Wong & Chien, 2025).

Research has established that a dose-response relationship between the number of BFHI Ten Steps for Successful Breastfeeding practices a mother is exposed to and improved breastfeeding outcomes for her infant (Pérez-Escamilla et al., 2016). Increased exposure to these practices is associated with a 22% higher rate of exclusive breastfeeding, independent of demographic factors (Patterson et al., 2018). A study by Tarrant et al. (2015) found that following the implementation of a BFHI policy covering the cost of infant formula, rates of breastfeeding initiation within the first hour rose from 28.7% to 45%, and in-hospital exclusive breastfeeding rates rose from 17.9% to 41.4%, potentially reducing the risk of early formula supplementation (Tarrant et al., 2016). Furthermore, the risk of weaning was higher among mothers who were exposed to fewer BFHI steps, with each additional step decreasing the likelihood of breastfeeding cessation by 8% (hazard ratio = 0.92; 95% CI, 0.89-0.95) (Tarrant et al., 2016).

Breastfeeding outcomes are influenced by a variety of support factors including the social environment and the policies and structures designed to promote and facilitate breastfeeding. In previous study (Chapter 2), statewide rates of formula introduction before 2 days among breastfed infants were negatively correlated with statewide rates of exclusive breastfeeding at 3 and 6 months. Building on these ecological findings, the purpose of this study was to examine the relationship between early formula introduction and the likelihood of early breastfeeding discontinuation at the individual level. Additionally, this study aimed to evaluate the impact of sociodemographic factors on the introduction of infant formula to breastfed infants within the first 2 days of birth.

Methods

Breastfeeding Outcomes

Demographic and infant feeding data were obtained from the Centers for Disease Control and Prevention's (CDC) 2019 National Immunization Survey (NIS – Child 2019) (CDC, 2019). The NIS – Child 2019 is a household telephone survey targeting parents and guardians of children aged 19-35 months. Households were identified for inclusion in the survey through random digit dialing (RDD), and data was collected from January 2019 through March 2020 (CDC, 2020). The NIS – Child 2019 data was downloaded as an Excel file from the CDC's website (CDC, 2019). For this study, only infants who were breastfed (i.e., breastfed for any duration), were included ($n = 29,217$, see Table 3.1).

Table 3.1 Infants in the Centers for Disease Control and Prevention's 2019 National Immunization Survey (N = 33,799)

Breastfed for Any Duration	n	%
No	4,454	13.18
Yes	29,217	86.44

Infant feeding data as shown in Table 3.1 was extracted from the CDC's National Immunization Survey – Child (NIS – Child) 2019 records.

Participants

The analytic sample included infants who were breastfed for any duration ($n = 29,217$; see Table 3.1). Cases with incomplete data on key study variables were excluded from the final

analysis. The sample was restricted to ensure consistency in evaluating breastfeeding outcomes and early infant feeding practices.

Measures

Breastfeeding outcomes and early feeding practices were the primary variables of interest. Breastfeeding at 6 months was examined as a key outcome variable. Early formula introduction was operationalized as whether infants were given formula within 2 days of birth and within 30 days of age. Sociodemographic variables, including maternal and household characteristics, were included as predictors based on theoretical relevance and prior research. These variables include the age of the mother, education, marital status, family income level, participation in the WIC program, Race of the child, gender of the child, first born status of the child, and the insurance status of the child. A summary of these variables are provided in Table 3.2.

Procedure

Data was obtained from a statewide dataset of breastfeeding outcomes and related indicators. Variables were cleaned and screened prior to analysis, including checks for missing data, outliers, and consistency across measures. Only eligible cases meeting inclusion criteria were retained for analysis.

Statistical Analysis

Demographic and breastfeeding data were summarized using descriptive analysis. Chi-squared analysis was conducted to compare the rate of breastfeeding at 6 months among infants who were given formula by 2 days or by 30 days of age and infants who were not provided formula during these early time periods (Table 3.5). Additionally, multiple regression analysis was performed to assess the association between the sociodemographic variables and the

early introduction of formula. Two binary variables were created to assess the introduction of formula. The first variable captures the introduction of formula within 2 days of birth, and the second variable captures the introduction of formula within 30 days. Since these are the dependent variables and they are modeled as binary, logistic regression is employed to estimate the associations. The odds ratios are utilized to interpret the associations. The results are reported in Table 3.6. For formula introduction within 2 days, we observe statistical significance for age of mother, WIC status, and first-born status. Specifically, older mothers are more likely to introduce formula within 2 days, receiving WIC benefits also increases the likelihood of introducing formula, and a firstborn child is more likely to be fed formula within the first two days. For the introduction of formula within 30 days, the results show that older mothers, receiving WIC benefits, being the first born, and being insured are associated with a higher likelihood of introducing formula within 30 days, while mothers who are college graduates are less likely to introduce formula within 30 days compared to respondents with a lower level of education.

The sample used for statistical analysis included only infants who were breastfed for any duration ($n = 29,217$, see Table 3.1). All analyses were performed using Stata statistical software (version 11.2, Stata Corp, College Station, Texas, USA, 2010) (StataCorp, 2010) with statistical significance level set at $p < 0.05$.

Results

The sociodemographic characteristics of the breastfed infant sample (n = 29,217) are summarized in Table 3.2. The majority of women were > 29 years of age (68.4%). In terms of maternal education, just over one-half (51.1%) of mothers had a college degree. Most of the mothers (73.1%) were married. The largest income group (45.54%) consisted of individuals with a combined family income $\geq$ 75K. Just over one-third (36%) of the mothers participated in the Special Supplemental Nutrition for women, infants, and children (WIC) program.

In terms of infant characteristics, 56% of mothers identified their infants as non-Hispanic White or Caucasian. Just over one-half (52.3 %) of the infants were male, and 39.4% were of first-born status. The analysis for insurance was based on the sample size of 14,490 respondents who indicated whether their infants were insured or uninsured. Almost all respondents who answered the health insurance questionnaire indicated their infants were insured (n = 14,055, 97%) see, Table 3.2.

Table 3.2 Sociodemographic Characteristics of Breastfed Infants and Mothers (n = 29,217)

Sample Characteristics	<i>n</i>	%
<i>Maternal Characteristics</i>		
Age		
≤ 29 years	9,232	31.60
> 29 years	19,985	68.40
Education		
College Graduate	14,927	51.09
Not a College Graduate	14,290	48.91
Marital status		
Married	21,365	73.13
Not Married	7,852	26.87
Family Income		
Below Poverty	5,286	18.09
Above Poverty ≤ 75K	8,952	30.64
Above Poverty ≥ 75K	13,306	45.54
Participation in WIC Program		
Yes	10,518	36.01
No	18,506	63.37
<i>Infant Characteristics</i>		
Race/Ethnicity		
White Only, non-Hispanic	16,417	56.19
Other & Multiple Race	12,800	43.81
Gender		
Male	15,275	52.28
Female	13,942	47.72
First Born Status		
Yes	11,523	39.44
No	17,694	60.56
Insurance Status (n = 14,490)		
Yes	14,055	97.00
No	435	3.00

Over one-quarter (27.3%) of the breastfed infants were breastfed for less than 6 months (≤ 180 days) as shown in Table 3.3.

Table 3.3 Length in Time in Days Child was Fed Breast Milk (n = 29,217)

Duration of breastfeeding	<i>n</i>	%
≤ 180 days	7,969	27.28
> 180 days	21,248	72.72

As shown in Table 10, 13.7% of the breastfed infants were introduced to formula within the first 30 days of life and 6.3% were introduced to formula before reaching 2 days of age.

Table 3.4 Age in Days When Child was First Fed Formula (n = 29,217)

Age of first formula feeding	<i>n</i>	%
≤ 2 days	1,852	6.34
> 2 days	27,365	93.66
≤ 30 days	4,022	13.77
> 30 days	25,195	86.23

Breastfeeding rates at 6 months were lower among infants provided formula at or before two days of age compared to those not provided formula by two days of age $X^2 (1, N = 29,217) = 572.59, p = < .001$. Similarly, breastfeeding rates at 6 months were lower among infants provided formula at or before thirty days of age compared to those not provided formula by thirty days of age $X^2 (1, N = 29,217) = 1,900, p = < .001$ (Table 3.5).

Table 3.5 Frequencies and Chi-Square of Breastfeeding Duration by Age at First Formula (n=29,217)

Age of first formula feeding	≤ 180 days		> 180 days		$\chi^2 (1)$
	n	%	n	%	
≤ 2 days	949	51	903	49	572.59***
> 2 days	7,020	26	20,345	74	
≤ 30 days	2,250	56	1,772	44	1,900***
> 30 days	5,719	23	19,476	77	

*** $p < .001$

A statistically significant positive correlation $r = .65$, $p = < 0.001$, was observed between the age at which a child was first fed formula and the duration of breastfeeding.

Significant predictors of early formula introduction before 2 days of age were maternal age ≥ 29 years ($OR = 1.23$, 95% $CI [1.10, 1.54]$, $p = .002$) and first-born status ($OR = 1.52$, 95% $CI [1.33, 1.75]$, $p < .001$). However, WIC program participation ($OR = 1.21$, 95% $CI [0.99, 1.49]$, $p = .066$) and Northeast region residence ($OR = 1.24$, 95% $CI [0.99, 1.54]$, $p = 0.059$) neared significance. See Table 3.6.

Similarly (see Table 3.6), significant predictors of early introduction to infant formula before 30 days of age were maternal age ≥ 29 years ($OR = 1.28$, 95% $CI [1.15, 1.45]$, $p < .001$), college graduate ($OR = 0.83$, 95% $CI [0.74, 0.94]$, $p < .003$), participation in WIC program ($OR = 1.33$, 95% $CI [1.16, 1.53]$, $p < .001$), first-born status ($OR = 1.61$, 95% $CI [1.46, 1.78]$, $p < .001$), insurance Status ($OR = 1.38$, 95% $CI [1.00, 1.91]$, $p = .04$) and survey geographic region of Northeast ($OR = 1.17$, 95% $CI [1.0, 1.37]$, $p = .04$).

Table 3.6 Social Demographic Factors and Early Introduction of Formula Within 2 and 30 Days After Birth (n = 29,217)

Sample Characteristics	Early Introduction of Formula After Birth					
	2 Days			30 Days		
	OR	95% CI	p	OR	95% CI	p
<i>Maternal</i>						
Age						
≤ 29 years	Ref.					
> 29 years	1.29	[1.10, 1.54]	0.002**	1.28	[1.15, 1.45]	<0.001***
Education						
Not College Graduate	Ref.					
College Graduate	0.87	[0.73, 1.04]	0.12	0.83	[0.74, 0.94]	0.003**
Marital status						
Not Married	Ref.					
Married	0.86	[0.72, 1.04]	0.119	0.95	[0.84, 1.08]	0.45
Poverty Status						
< Poverty level	Ref.					
> Poverty ≤ 75K	1.0	[0.84, 1.28]	0.731	1.01	[0.87, 1.18]	0.82
> 75K	1.1	[0.85, 1.42]	0.468	1.18	[0.99, 1.42]	0.06
Participation in WIC						
No	Ref.					
Yes	1.21	[0.99, 1.49]	0.066	1.33	[1.16, 1.53]	<0.001***
<i>Infant</i>						
Race/Ethnicity						
All Other Races	Ref.					
White non-Hispanic	0.9	[0.78, 1.05]	0.194	1.05	[0.95, 1.17]	0.28
Gender						
Female	Ref.					
Male	0.9	[0.86, 1.12]	0.767	0.99	[0.91, 1.09]	0.91
First Born Status						
No	Ref.					
Yes	1.52	[1.33, 1.75]	<0.001***	1.61	[1.46, 1.78]	<0.001***
Insurance Status						
No	Ref.					
Yes	1.5	[0.93, 2.43]	0.097	1.38	[1.00, 1.91]	0.04*
Geographic Region						
Midwest	Ref.					
Northeast	1.24	[0.99, 1.55]	0.059	1.17	[1.0, 1.37]	0.04*
South	1.15	[0.96, 1.40]	0.132	1.12	[0.99, 1.28]	0.07
West	0.96	[0.78, 1.19]	0.709	0.93	[0.81, 1.09]	0.39

Note: CI = confidence interval; Ref. = reference group for comparison; ***p < .001; **p < .01; *p < .05

Discussion

The present study used a large national data set to examine the association between early introduction of infant formula and discontinuation of breastfeeding. Results from this study reveal that over one-quarter of the breastfed infants were breastfed for less than 6 months. Breastfeeding rates at 6 months were lower among infants provided formula at or before two days compared to those not provided formula at 2 days. A noteworthy percentage of infants were introduced to formula early, potentially disrupting the recommended breastfeeding period. Our findings corroborate with results of other studies demonstrating that early formula introduction, whether within 2 days or 30 days, significantly reduces the likelihood of breastfeeding continuity and efficiency at 6 months (Chantry et al., 2014b; Parry et al., 2013a). For example, a longitudinal study by Chantry et al. (2014) revealed that nearly one-half of all infants in the study, about 47% received in-hospital formula supplementation within the first week of life, even though hospital policy at the time of the study incorporated all the Ten Steps of BFHI. The study by Chantry et al. (2014), also revealed that early introduction of formula was widespread in the hospital and was associated with a 1.8-fold increased risk of infants not being fully breastfed between 20 and 60 days. In addition, by day 60, infants were at a 2.7-fold increased risk of total breastfeeding cessation.

In the present study, a positive correlation was observed between the age at which a child was first fed formula and the duration of breastfeeding. This finding is consistent with results from other studies showing a ‘dose-response’ relationship between early introduction to formula and the reduction in breastfeeding continuity, duration and exclusivity (Cato et al., 2017; Chantry et al., 2014b; Lechosa-Muñiz, Paz-Zulueta, Sota, et al., 2020; Nommsen-Rivers et al., 2010b; Parry et al., 2013a). This further implies that, on average delayed introduction to formula

correlated with breastfeeding duration, emphasizing the potential impact of the timing of formula introduction. Results of the study confirm that the early introduction of formula within 2 days or 30 days to breastfed babies may be the cause of the challenge in achieving breastfeeding continuity and exclusivity and subsequent breastfeeding cessation.

Results of this study also reveal that, despite a significant number of infants being breastfed for an extended period, a noteworthy portion were introduced to formula prematurely. Our findings are consistent with results from other studies (Cato et al., 2017; Chantry et al., 2014b; Lechosa-Muñiz, Paz-Zulueta, Sota, et al., 2020; Nommsen-Rivers et al., 2010b; Parry et al., 2013a) which revealed that early introduction of formula, alongside breastfeeding, deviates from the recommended practice of exclusive breastfeeding for the initial 6 months, shortens breastfeeding duration and jeopardize breastfeeding success.

The findings also indicate that the feeding behavior observed in infants reflects a mixed feeding approach, involving a combination of breastfeeding and infant formula. It is well established that the benefits of breastfeeding are dose dependent, in that longer breastfeeding duration and exclusivity confers greater health benefits to both infant and mother (Boué et al., 2018; Chantry et al., 2014b; Parry et al., 2013b).

The findings also indicate that infant feeding practices vary across demographic groups. Specifically, significant predictors of early formula introduction within 2 days of birth included maternal age (≥ 29 years) and first-born status (i.e., primiparity or first-time mothers). These results align with previous studies that have also identified an association between early formula feeding and factors such as parity and maternal age, particularly among older women (Cato et al., 2017; Nommsen-Rivers et al., 2010b).

On the other hand, our findings revealed that early introduction to infant formulas within 30 days was associated with a broader range of demographic factors compared to formula introduction within 2 days. Significant predictors of early formula introduction within 30 days included maternal age (≥ 29 years), college education, participation in the WIC program, first-born status, having health insurance, and residence in the Northeast region. These findings align with previous studies examining maternal and infant predictors of early formula introduction (Cato et al., 2017; Li et al., 2022b; Nommsen-Rivers et al., 2010b; Odom et al., 2013b; Temple Newhook et al., 2017). While some studies have reported an association between maternal education and exclusive breastfeeding within 30 days, others, like our findings, did not observe this relationship (Cato et al., 2017).

This study has several limitations that should be considered when interpreting the findings. First, the analysis was based on an observational dataset (CDC, National Immunization Survey – Child, 2019), which limits the ability to draw causal inferences. As with all observational studies, the relationships identified are correlational, and causation cannot be established. Second, while efforts were made to control key demographic variables, the potential influence of confounding variables cannot be ruled out. Other unmeasured or unobserved factors—such as cultural beliefs, healthcare access, or individual psychological variables—may also influence infant feeding intentions and practices. These factors were not captured in the dataset and could contribute to the observed associations.

Conclusion

The observed correlation between the age at which infants were first fed formula and the duration of breastfeeding in this study underscores the importance of addressing factors that influence the timing of formula introduction. The findings reveal a significant gap and discrepancy between established breastfeeding recommendations and real-world feeding practices, which is concerning given that early formula introduction is associated with reduced breastfeeding continuity and exclusivity. Consequently, infants may miss out on the numerous health benefits associated with breastfeeding. Specifically, infants who were given formula within the first 2 or 30 days of life were less likely to be breastfed at 6 months. A growing body of evidence demonstrates that breastfeeding during the first months of life provides additional health benefits for infants compared to formula feeding (Fewtrell et al., 2007; Mantzorou et al., 2022; Roldão et al., 2024; Shipp et al., 2023; Yan et al., 2014).

Providing mothers with lactation support services after delivery can help address these challenges. Such support not only equips mothers to breastfeed exclusively for longer durations (3 to 6 months) but also contributes to achieving the Healthy People 2030 (U.S. Department of Health and Human Services, 2020) objective of increasing exclusive breastfeeding rates to 42.4%. Achieving this goal could lead to a reduction in childhood obesity and lower healthcare costs associated with not breastfeeding (Jegier et al., 2024; Santacruz-Salas, Aranda-Reneo, et al., 2020; Santacruz-Salas et al., 2021; Santacruz-Salas, Segura-Fragoso, et al., 2020; Walters et al., 2019b). These findings suggest that early formula introduction increases the risk of early breastfeeding discontinuation, emphasizing the need for targeted interventions to promote breastfeeding continuity and exclusivity.

Our analysis provides strong evidence for developing interventions to identify at-risk groups. Identifying predictors of early formula use within the first 2 and 30 days of birth may enhance public health efforts to promote optimal breastfeeding practices. Additional findings suggest that in-hospital policies and practices, such as the Baby-Friendly Hospital Initiative (BFHI), professional support for addressing breastfeeding challenges (e.g., lactation difficulties or milk-pumping issues), and maternal or infant health conditions (e.g. illness or medication use) are key factors influencing the decision to introduce formula within the first 2 to 30 days (Odom et al., 2013b; Temple Newhook et al., 2017).

This study is a large retrospective analysis spanning all four geographic regions of the United States, utilizing a widespread population-based random sampling approach. Despite its strengths, the study has notable limitations, including potential maternal or household recall bias regarding breastfeeding duration and the timing of formula introduction, which may not fully reflect actual infant feeding practices. Future research is needed to better understand the predictive factors of early formula introduction.

Chapter 4 - Infant Feeding Survey of Pregnant Women

Abstract

Introduction: Breastfeeding is crucial for the long-term health of both infants and mothers. A mother's intention to breastfeed is a strong predictor of her actual breastfeeding behaviors, while positive attitudes toward breastfeeding are closely linked to successful breastfeeding outcomes. Recent infant formula shortages have brought renewed attention to the importance of breastfeeding. Exposure to such shortages may shape mothers' attitudes and intentions, potentially fostering more positive views on breastfeeding and stronger intentions to breastfeed their infants. Understanding the factors that influence breastfeeding intentions is essential for promoting and supporting breastfeeding behaviors, including initiation and the maintenance of exclusive breastfeeding for longer periods.

Objective: The objective of this study was to measure the relationships between breastfeeding attitudes, exposure to information regarding the recent shortages of infant formula, and expectant mother's intention to breastfeed.

Methods: Online survey responses were collected from expectant mothers (n = 222) from December 21, 2022, to October 11, 2024. Prenatal intention to breastfeed was measured using the Infant Feeding Intention scale, breastfeeding attitude was measured using the Iowa Infant Feeding Attitude Scale, and frequency of exposure to information about infant formula shortages was measured using a novel scale (i.e., the Formula Shortage Exposure Scale). Multiple regression analysis was performed to assess the relationships between demographic variables, Iowa Infant Feeding Attitude Scale scores, Formula Shortage Exposure Scale scores, and Infant Feeding Intention scale scores.

Results: The mean Infant Feeding Attitude score was $M = 54.89$, $SD = 7.99$, with scores ranging from 34 to 75. The mean Infant Feeding Intentions score was $M = 11.90$, $SD = 3.93$, with a range of 0 to 16. The mean formula shortage score was $M = 28.73$, $SD = 7.77$, with scores ranging from 11 to 44. Scores on the Iowa Infant Feeding Attitude Scale were positively associated with Infant Feeding Intention scale scores ($B = 1.37$, $p < .001$). However, scores on the Formula Shortage Exposure Scale were not significantly associated with Infant Feeding Intention scale scores ($B = -0.09$, $p = 0.820$). Age category ($F(1, 219) = 15.43$, $p < .001$), education category ($F(2, 218) = 6.65$, $p < .001$), Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participation ($F(1, 220) = 16.87$, $p < .001$), and household income category ($F(2, 216) = 11.82$, $p < .001$) were associated with scores on the Formula Shortage Exposure Scale; however, these characteristics were not associated with Infant Feeding Intention scores.

Conclusion: Higher breastfeeding attitude was associated with higher breastfeeding intention, but there was no association between exposure to information about infant formula shortages and breastfeeding intention.

Key Words: Breastfeeding attitude, breastfeeding intentions, infant formula shortage

Introduction

Breastfeeding is beneficial, and attitudes towards breastfeeding are associated with important breastfeeding outcomes, including intentions, duration, and exclusivity (A. M. Stuebe & Bonuck, 2011). Breastfeeding intentions are important because they predict breastfeeding behaviors. Similarly, attitudes toward breastfeeding are significant because they influence both intentions and behaviors. Knowledge is also crucial, as it predicts intentions and behaviors. Additionally, cues to action and information on breastfeeding may influence breastfeeding knowledge, behaviors, and intentions.

Concerns about the low prevalence of breastfeeding have prompted public health advocates and breastfeeding coalitions to launch major campaigns promoting evidence-based perinatal care measures (Chantry et al., 2014). Research has shown a link between maternal breastfeeding knowledge and attitudes and the intentions of expectant mothers to initiate breastfeeding (Naja et al., 2022; Persad & Mensinger, 2008; Scott et al., 2004; Stuebe & Bonuck, 2011) and to breastfeed continuously and exclusively for a longer duration (Stuebe & Bonuck, 2011). These factors are particularly influential among first-time mothers (Persad & Mensinger, 2008). Breastfeeding counseling during the prenatal period has been shown to enhance knowledge, foster more positive attitudes, and increase rates of exclusive breastfeeding in this group (Beyene et al., 2025). It is important to note that maternal knowledge and attitudes are often developed early—before, during, and after the prenatal period—and these factors can continue to influence breastfeeding practices over time.

A lack of breastfeeding knowledge, positive attitude, and intention among expectant mothers can potentially serve as a risk factor for failure to initiate breastfeeding and may lead to the early introduction of infant formula. In the wake of the infant formula crisis, which resulted

from safety issues that caused a massive shortage in 2022 and beyond, breastfeeding initiation rates increased by 1.96% (Seoane Estruel & Andreyeva, 2025a, 2025b), with the highest increases among African American mothers, mothers of lower socioeconomic and educational status, Medicaid recipients, residents of less populated counties, and mothers who rely heavily on formula supplied through the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (Seoane Estruel & Andreyeva, 2025a, 2025b). This increase occurred because these groups relied primarily on infant formula, and the shortage forced many mothers to turn to breastfeeding. Exposure to the recent infant formula shortage may be associated with changes in attitudes or intentions to breastfeed (Imboden et al., 2023; Seoane Estruel & Andreyeva, 2025a, 2025b).

Breastfeeding offers a secure and sustainable feeding option that is not subject to commercial supply chain vulnerabilities. In times of formula scarcity, breastfeeding may reduce the impact of the crisis on infant nutrition (Seoane Estruel & Andreyeva, 2025b). However, the ability of mothers to initiate or continue breastfeeding during such crises is heavily influenced by prior breastfeeding education, workplace policies, and access to lactation support (Miranda et al., 2025).

Moreover, formula shortages often disproportionately affect low-income families, who may lack access to adequate breastfeeding resources or rely on formula provided through programs like WIC (Seoane Estruel & Andreyeva, 2025a, 2025b). For these populations, systemic barriers such as a lack of paid maternity leave, inadequate lactation support, and cultural stigmas make exclusive breastfeeding challenging, increasing vulnerability during formula shortage crises (Miranda et al., 2025). Thus, while breastfeeding can offer resilience against formula shortages, its effectiveness as a solution is conditional on broader structural

supports. Addressing these gaps is essential for improving infant feeding security, particularly in emergency contexts.

The purpose of this study was threefold: (a) to describe the attitudes and intention to breastfeed among pregnant women, (b) to measure the relationship between attitudes and intention to breastfeed and (c) to measure the relationship between exposure to media cues about the infant formula shortage and breastfeeding intention.

Methods

Study Design

This was a cross-sectional web-based survey of expectant mothers across the U.S. Data collection occurred from December 2022 to December 2023.

Subjects

A link to the online survey was distributed to Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) centers by email and via an online exhibit at an exposition aimed at expectant mothers (i.e., The Prego Expo). Inclusion criteria included survey respondents' indication they a) were over the age of 18, b) currently pregnant, and c) currently residing in the United States. The study protocol was reviewed and approved by the Research Involving Human Subjects Institutional Review Board (IRB) of Kansas State University (See Appendix A for IRB-11440).

Survey Instrumentation

The online survey was developed to

- a) screen participants for eligibility
- b) collect participant demographic information,
- c) measure breastfeeding attitudes
- d) measure breastfeeding intentions
- e) measure the frequency of exposure to media reports on infant formula shortage

Before dissemination, the survey received expert feedback from one health communication researcher and two professional health educators who reviewed the survey for readability, comprehensiveness, and relevance. The survey was then edited to reflect expert feedback and pilot-tested among nine expectant mothers contacted through the Riley County Health Department, in Manhattan, Kansas. No edits were made after the pilot as the survey was within the 10-minute time frame and was deemed legible and feasible to navigate for participants. All survey data was collected using participant ID numbers. The final survey contained three instruments to measure the primary study variables, three screening questions, one attention check question, demographic questions and two follow-up items. The survey was disseminated in Qualtrics (Version November 2023, Provo, UT), accessed online, and self-administered.

Breastfeeding Attitudes

Expectant mothers' breastfeeding attitudes were measured using the Iowa Infant Feeding Attitude Scale developed by De la Mora et al. (1999) (Mora et al., 1999) to predict choice of infant feeding method and duration of both exclusive and partial breastfeeding. The scale includes 17 items. Respondents' level of agreement with each item is recorded using a 5-point Likert scale with "1" indicating the respondent strongly disagrees and "5" indicating they strongly agree. One-half of the items on the scale are worded in a manner that favors breastfeeding, and the other half were worded in a manner favoring formula feeding. Total scores for the scale were calculated according to the instrument's guidelines. Total scores on the scale range from 17 to 85. Higher scores on the scale indicate more positive attitudes toward breastfeeding. The scale has good internal consistency and validity with Cronbach's alphas of 0.85, and above in various studies (Abdulahi et al., 2020; Dang et al., 2025; Lau et al., 2015; Twells et al., 2016).

Breastfeeding Intentions

Expectant mothers breastfeeding intentions was measured using the Infant Feeding Intention scale developed by Nommsen-Rivers & Dewey (Nommsen-Rivers & Dewey, 2009). The Infant Feeding Intention scale is a breastfeeding self-efficacy assessment tool used to assess strength and duration of intention to exclusively breastfeed prenatally, and it provides a quantitative measure of maternal breastfeeding intentions. The Infant Feeding Intention scale is a five items instrument with responses recorded on a 4-point Likert scale, with “4” indicating very much agree and “0” indicating very much disagree. Respondents are asked to read the statements about feeding their baby and choose the answer that closely matches their opinion, considering both their feeding plans and the likelihood that they will carry out those plans. The items on the scale are multidirectional, because the series of questions on the scale are all related, and the answers to each of the questions are combined and scoring is an average of all the items. This makes the scale more reliable and valid than use of a single question for an assessment. Total scores for the scale were calculated according to the instrument’s guidelines. Total score ranged from 0, indicating no intention to breastfeed to 16, indicating very strong intention to breastfeed.

Exposure to Information Regarding Infant Formula Shortages

An instrument was developed to measure frequency of exposure to information regarding the shortage of infant formula. In this set of 11 items, herein referred to as the Formula Shortage Exposure Scale, respondents were asked to indicate how often they had experienced a variety of situations (e.g., “I have heard television or radio news stories about the infant formula crises”, “I have seen empty shelves and in-store signs about infant formula being out of stock”, and “people I know have been affected by the infant formula shortage”). Frequency scale response categories were assigned a value on a 4-point Likert scale with “often” assigned 4, “sometimes” assigned 3,

seldom assigned 2, “never” assigned 1, and a frequency scale was computed based on the distribution of responses across categories.

Data Analysis

All statistical analyses were conducted using Stata (version 18.0; StataCorp, College Station, TX, USA). Statistical significance was set at $p < .05$ for all analyses.

Descriptive statistics were first computed to characterize the study sample and summarize responses across all instruments. Frequencies, percentages, means, and standard deviations were calculated for demographic variables and scale items, as shown in Tables 4.6, 4.10 and 4.14. To ensure sufficient cell sizes and improve interpretability, selected demographic variables were recorded. Self-identified ethnicity was collapsed into five categories: White non-Hispanic, Hispanic, Black non-Hispanic, Asian, and Other (including Native Hawaiian/Pacific Islander and American Indian/Alaska Native/Native American). Employment status was similarly recorded into three categories: working less than 35 hours per week, working 35 hours or more per week, and unemployed. The age of mothers was categorized into women older than 35 years and those younger than 35 years. A binary variable was also used to capture whether the mother is receiving WIC benefits or not. Similarly, a binary variable was used to capture whether the mother has had previous children and if any previous children were breastfed. Breastfeeding duration was coded as categorical, capturing 3 months or less, 4 to 6 months, and more than 6 months. Two categories were created for marital status. Married and unmarried couples are grouped into one category, and single, divorced, separated, and widowed were put in one category. A categorical variable was used to capture the mother’s level of education including high school or less, college, and a graduate degree. For income level, respondents were grouped into low-income, middle-income, and high-income.

The validity of the three instruments: the Iowa Infant Feeding Attitude Scale, the Infant Feeding Intentions Scale, and the Formula Shortage Exposure Scale, were examined using an Exploratory Factor Analysis (EFA) procedure. EFA is a data-driven technique used to uncover the underlying factor structure of a set of observed variables without imposing prior assumptions about the number or composition of factors. It helps assess whether items group together in a manner consistent with the theoretical constructs they are intended to measure. In this study, EFA was employed to evaluate the dimensionality of each scale, identify the number of latent factors, and examine factor loadings to determine how well individual items contribute to the underlying constructs. This approach provides evidence on the construct validity and internal coherence of the instruments. Factor extraction was performed using principal components analysis, and both eigenvalues and scree plots were used to determine the appropriate number of factors to retain. Specifically, the Kaiser criterion, retaining factors with eigenvalues greater than 1.0, was applied as a rule of thumb. Factor loadings were then generated, and items with low loadings (i.e., below 0.4) were dropped to improve the clarity and reliability of the factor structure. Internal consistency reliability for each scale was assessed using Cronbach's alpha coefficients. Alpha values of 0.70 or higher were considered acceptable for research purposes. Following these validation procedures, total scale scores were computed for each instrument in accordance with their established scoring guidelines, ensuring that item coding and any necessary reverse scoring were handled appropriately. Once the instruments were constructed, an Analysis of Variance (ANOVA) was conducted to examine the relationship between each scale score and the sociodemographic factors, and to also test whether there were statistically significant differences in the mean values of the continuous variable across the two or more groups defined by categorical variables. In this context, it allows for the comparison of average scale scores across different categories of the

sociodemographic variables captured in this study. A statistically significant ANOVA result indicates that at least one group mean differs from the others, suggesting that the sociodemographic characteristic in question is associated with variation in the scale scores. This analysis provides initial evidence on how breastfeeding attitudes, breastfeeding intentions, and exposure to formula shortage measures vary across different population subgroups.

Separate multivariate Ordinary Least Squares (OLS) regressions were estimated for each instrument, such that each score was treated as a dependent variable in turn. In each specification, the remaining instruments were included as explanatory variables together with the sociodemographic factors, making it possible to examine the associations among the instrument scores while controlling for the sociodemographic characteristics. Robust standard errors were employed to account for potential heteroskedasticity and enhance the reliability of the estimated coefficients.

Results

Sample Description

The study sample (n = 222) of expectant U. S. mothers had a mean age of 30.42 years (SD $\pm$ 6.12) with age ranging from 18 to 49 years. Roughly one-half of respondents were White non-Hispanic (49.8%). Nearly one-half (44.14%) had previous children, and among those with previous children, 89.80% reporting prior breastfeeding experience with 56.52% reporting they had breastfed for more than 6 months. Less than one-half of participants (42.34%) were enrolled in the WIC program. Educational attainment was relatively high, with roughly one-half of respondents having some college or graduate school. Employment was also high, with 53.64% working more than 35 hours per week. In terms of income, over one-third (36.99%) reported annual household income exceeding \$100,000. See Table 4.2 for additional sample characteristics.

Table 4.1 Characteristics of the Study Population (*n* = 222)

Participants Demographic Characteristics		<i>n</i>	%
WIC program	Yes	94	42.34
	No	128	75.66
Previous children	Yes	98	44.14
	No	124	55.86
Previous breastfeeding experience	Yes	88	89.80
	No	10	10.20
Previous breastfeeding duration	< 1 month	8	8.70
	1 month	2	2.17
	2 – 3 months	15	16.30
	4 – 5 months	6	6.52
	6 months	9	9.78
	7 – 12 months	14	15.22
	>12 months	38	41.30
Marital status	Married	153	69.23
	Single	36	16.29
	Member of an unmarried couple	27	12.22
	Divorced, separated, widowed	5	2.26
Race/Ethnicity	White, non-Hispanic	110	49.77
	Black, non-Hispanic	32	14.48
	American Indian/ AN/ NA	5	2.26
	Hispanic	42	19.0
	Asian	26	11.76
	Native Hawaiian/Pacific Islanders	1	0.45
	Other	5	2.26
Education	Not completed high school	5	2.26
	Completed high school	33	14.93
	Some college or technical school (1-3 years)	40	18.10
	Completed college	78	35.29
	Completed graduate school	65	29.41
Household Income	< \$15,000	18	8.22
	\$15,000 – 24,999	26	11.87
	\$25,000 - \$49,999	34	15.53
	\$50,000 - \$74, 4999	27	12.33
	\$75,999 - \$100,000	33	15.07
	>\$100,000	81	36.99
Employment	Yes, < 20 hours per week	19	8.64
	Yes, 20 - 35 hours per week	9	4.09
	Yes, > 35 hours per week	118	53.64
	No, I am not employed	74	33.64

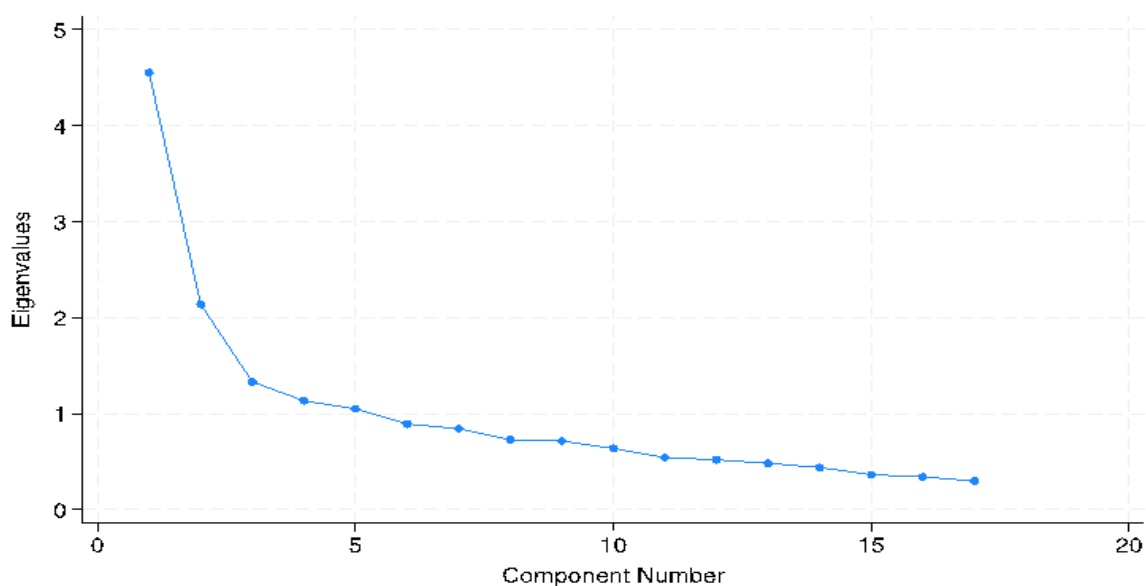
Table 4.2 Characteristics of the Study Population with Collapsed Categories (*n* = 222)

Participants Demographic Characteristics		<i>n</i>	%
Age	< 30 years	83	37.56
	≥ 30 years	138	62.44
WIC program	Yes	94	42.34
	No	128	75.66
Previous children	Yes	98	44.14
	No	124	55.86
Previous breastfeeding experience	Yes	88	89.80
	No	10	10.20
Previous breastfeeding duration	3 months or less	25	27.17
	4 – 6 months	15	16.30
	More than 6 months	52	56.52
Marital status	Married/unmarried couple	180	81.45
	Single/Divorced/Separated/Widowed	41	18.55
Race/Ethnicity	White, non-Hispanic	110	49.77
	Black or African American, non-Hispanic	32	14.48
	Hispanic	42	19.0
	Asian	26	11.76
	Other	11	4.98
Education	High school or less	38	17.19
	Some college or technical school	118	53.39
	Graduate school	65	29.41
Household Income	Low income	78	35.62
	Middle income	60	27.40
	High income	81	36.99
	≤ 35 hours per week	28	12.73
	Yes, > 35 hours per week	118	53.64
	No, I am not employed	74	33.64

Results of the Iowa Infant Feeding Attitude Scale (Iowa Infant Feeding Attitude Scale)

A confirmatory factor analysis of the Iowa Infant Feeding Attitude Scale revealed a two-factor solution consistent with findings by Abdulahi et al., (2020). Together, the two factors accounted for approximately 40% of the total variance. The first factor has an eigenvalue of 4.55 and explains about 25% of the variance, while the second factor had an eigenvalue of 2.14, explaining approximately 15% of the variance. A visual representation of this solution is provided in the scree plot (see Figure 4.1), which shows a leveling off after the second factor, confirming the two-factor structure. The first factor reflects attitudes favorable towards breastfeeding, while the second factor reflects attitudes favorable towards formula feeding. This structure aligns with the design of the Iowa Infant Feeding Attitude Scale, as half of the items on the Iowa Infant Feeding Attitude Scale are worded in manner that favors breastfeeding and the other half favors formula feeding.

Figure 4.1 Scree Plot of the 17-item Iowa Infant Feeding Attitude Scale



Based on the results of the scree plot, the factor analysis was re-estimated using a two-factor solution, applying a cutoff value of > 0.3 for factor loadings, consistent with methodologies used in similar studies by Tabachnick and Fidell (2019). Table 4.3 presents the questions associated with each factor and their corresponding factor loadings.

Table 4.3 Iowa Infant Feeding Attitude Scale Items with Principal Component Factor Loadings for Corresponding Factors ($n = 222$)

Factor	Items	Factor Loadings
Factor 1	Formula-feeding is more convenient than breast-feeding.	0.425
	Formula is as healthy for an infant as breast milk.	0.589
	Breast-feeding increases mother-infant bonding.	0.596
	Formula-fed babies are more likely to be overfed than are breast-fed babies.	0.576
	Mothers who formula-feed miss one of the great joys of motherhood.	0.754
	Babies fed breast milk are healthier than babies who are fed formula.	0.814
	Breast milk is the ideal food for babies.	0.720
	Breast milk is more easily digested than formula.	0.722
	Breast-feeding is more convenient than formula-feeding.	0.595
	Breast milk is less expensive than formula.	0.489
Factor 2	The nutritional benefits of breast milk last only until the baby is weaned from breast milk.	0.548
	Formula-feeding is more convenient than breast-feeding.	0.368
	Breast milk is lacking in iron.	0.393
	Formula-feeding is the better choice if a mother plans to work outside the home.	0.725
	Women should not breast-feed in public places such as restaurants.	0.646
	Breast-fed babies are more likely to be overfed than formula-fed babies.	0.598
	Fathers feel left out if a mother breast-feeds.	0.362
	A mother who occasionally drinks alcohol should not breast-feed her baby.	0.501

As shown in table 4.4, the Cronbach's alphas for total Iowa Infant Feeding Attitude Scale score based on the 17 attitude items of the study was $\alpha = 0.791$, indicating strong internal consistency.

Table 4.4 Iowa Infant Feeding Attitude Scale Items with Reliability Results and Principal Component Factor Loadings ($n = 222$)

Item	p	α
The nutritional benefits of breast milk last only until the baby is weaned from breast milk.	0.304	0.785
Formula-feeding is more convenient than breast-feeding.	0.493	0.772
Breast milk is lacking in iron.	0.206	0.791
Formula-feeding is the better choice if a mother plans to work outside the home.	0.296	0.786
Women should not breast-feed in public places such as restaurants.	0.257	0.788
Breast-fed babies are more likely to be overfed than formula-fed babies.	0.160	0.793
Fathers feel left out if a mother breast-feeds.	0.196	0.793
Formula is as healthy for an infant as breast milk.	0.532	0.769
A mother who occasionally drinks alcohol should not breast-feed her baby.	-0.005	0.815
Breast-feeding increases mother-infant bonding.	0.497	0.772
Formula-fed babies are more likely to be overfed than are breast-fed babies.	0.397	0.779
Mothers who formula-feed miss one of the great joys of motherhood.	0.448	0.774
Babies fed breast milk are healthier than babies who are fed formula.	0.600	0.761
Breast milk is the ideal food for babies.	0.623	0.762
Breast milk is more easily digested than formula.	0.621	0.764
Breast-feeding is more convenient than formula-feeding.	0.530	0.769
Breast milk is less expensive than formula.	0.341	0.783
Test scale		0.791
Abbreviations: α , Cronbach's alphas for total Iowa Infant Feeding Attitude Scale score based on the 17 attitude items if item deleted; p , item-rest – item-total correlations for Iowa Infant Feeding Attitude Scale items		

Table 4.5 presents expectants mothers' attitude towards breastfeeding by the Iowa Infant Feeding Attitude Scale. The average Iowa Infant Feeding Attitude Scale score was $M = 54.89$ ($SD = 7.99$), with scores ranging from 34 to 75.

Table 4.5 Expectant Mother's Attitude Towards Breastfeeding Using the Iowa Infant Feeding Attitude Scale ($n = 222$)

Item/Statement Variable ^a	<i>M</i>	<i>SD</i>	Agree (%)	Neutral (%)	Disagree (%)
The nutritional benefits of breast milk last only until the baby is weaned from breast milk ^b	3.95	.95	72.97	18.92	8.11
Formula-feeding is more convenient than breast-feeding ^b	3.27	1.04	36.49	43.24	20.27
Breast-feeding increases mother-infant bonding.	4.35	.94	85.07	9.95	4.98
Breast milk is lacking in iron ^b	3.59	.88	56.76	33.33	9.91
Formula-fed babies are more likely to be overfed than are breast-fed babies.	3.16	.93	38.01	37.10	24.89
Formula-feeding is the better choice if a mother plans to work outside the home ^b	3.46	.94	49.77	34.39	15.84
Mothers who formula-feed miss one of the great joys of motherhood.	2.49	1.16	20.27	23.42	56.31
Women should not breast-feed in public places such as restaurants ^b	4.50	.77	89.19	8.56	2.25
Babies fed breast milk are healthier than babies who are fed formula.	3.18	1.20	43.89	26.70	29.41
Breast-fed babies are more likely to be overfed than formula-fed babies ^b	3.82	.79	68.02	27.03	4.95
Fathers feel left out if a mother breast-feeds ^b	3.66	.95	63.35	22.17	14.48
Breast milk is the ideal food for babies.	3.98	.99	72.40	18.55	9.05
Breast milk is more easily digested than formula.	3.85	.91	64.71	28.96	6.33
Formula is as healthy for an infant as breast milk ^b	3.12	1.04	34.39	38.91	26.70
Breast-feeding is more convenient than formula-feeding.	3.24	1.01	37.10	42.53	20.36
Breast milk is less expensive than formula.	4.44	.76	90.54	7.21	2.25
A mother who occasionally drinks alcohol should not breast-feed her baby ^b	3.18	1.28	53.39	14.03	32.58

^a Participants were asked to indicate how strongly they agree or disagree with each of the statements of the 5-point Likert-type scale of the Iowa Infant Feeding Attitude Scale ranging from 1 (strongly disagree) to 5 (strongly agree). The scores were re-grouped into 3 categories: disagree/positive attitude towards formula feeding (scores 1 & 2), neutral (score 3), and agree/positive attitude towards breastfeeding (scores 4 & 5). Items ^b were reversed when calculating the score. *M* = Mean, *SD* = standard deviations.

Table 4.6 presents Iowa Infant Feeding Attitude Scale scores by demographic characteristics. Scores range from 17 to 85. Women with prior breastfeeding experience lasting more than 6 months had the highest Iowa Infant Feeding Attitude Scale scores ($M = 58.43, 7.68$), reflecting more favorable attitude towards breastfeeding. This was followed by women who worked < 35 hours per week, who scored $M = 56.79$ ($SD = 8.56$). A statistically significant positive correlation was identified between expectants mothers prior breastfeeding experience and their attitude towards breastfeeding ($p < 0.001$).

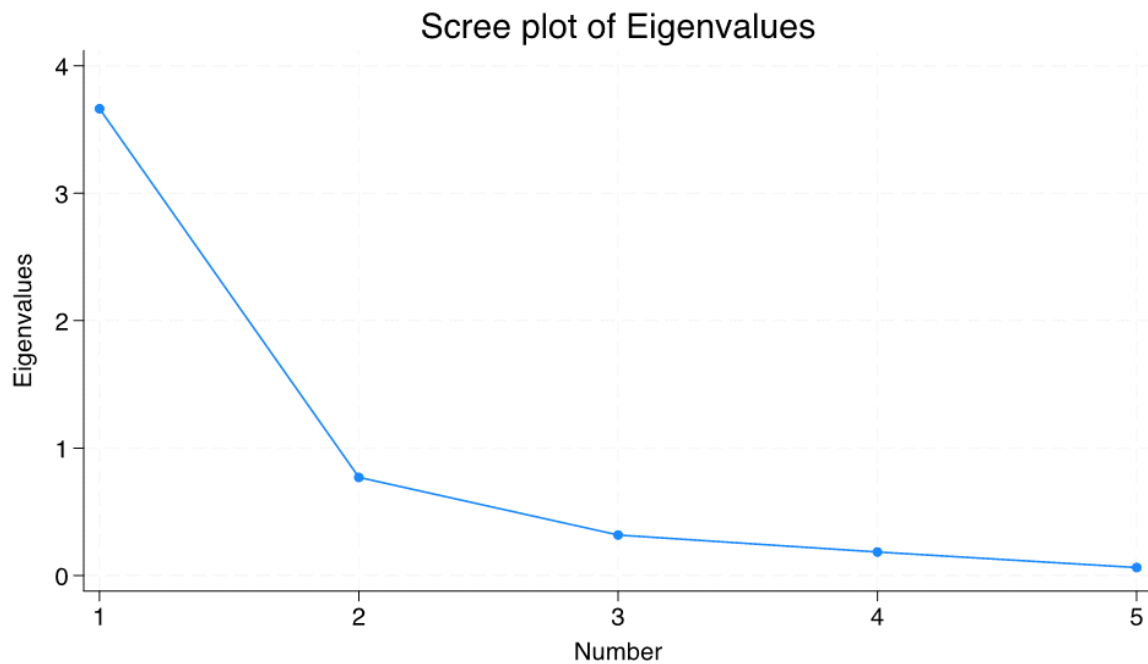
Table 4.6 Means, Standard Deviation, and One-Way Analysis of Variance Between Infant-Feeding Attitude Scale Score by Demographic Characteristics ($n = 222$)

Mean score (SD): 54.89 (± 7.99), range 34 – 75					
Demographic Characteristics		Mean	SD	<i>F(df)</i>	<i>p</i>
Age	< 30 years	54.35	8.55	0.70(1,219)	0.403
	≥ 30 years	55.28	7.66		
WIC program	Yes	56.03	8.86	3.34(1,220)	0.069
	No	54.06	7.22		
Previous children	Yes	55.43	8.23	0.77(1,220)	0.382
	No	54.48	7.80		
Previous breastfeeding experience	Yes	56.35	8.05	12.04(1,96)	< 0.001*
	No	47.30	4.94		
Previous breastfeeding duration	≤ 3 months	51.8	6.30	6.90(2,89)	<0.001*
	4 – 6 months	53.67	9.93		
	> 6 months	58.43	7.68		
Marital status	Married/Cohabiting	54.74	7.84	0.11(1,219)	0.743
	Single/Divorced/Separated/Widowed	55.20	8.56		
Race/Ethnicity	White, non-Hispanic	53.51	8.18	2.27(4,216)	0.062
	Black, non-Hispanic	56.013	7.68		
	Hispanic	57.28	7.41		
	Asian	54	7.43		
	All Others	57.09	7.85		
Education	High or less	55.82	8.63	0.48(2,218)	0.622
	College or less	54.85	7.99		
	Completed graduate school	54.23	7.53		
Household Income	Low-income (< \$50,000)	56.14	8.78	2.11(2,216)	0.123
	Middle income (\$50,000 - \$74,99)	54.90	8.30		
	High income (> \$75,000)	53.55	6.70		
Employment	< 35 hours per week	56.79	8.53	2.81(2,217)	0.062
	≥ 35 hours per week	53.71	7.59		
	Unemployed	55.96	8.14		
Statistical differences were noted with * <i>p</i> < 0.05 using One-Way ANOVA					
Mean Infant Feeding Attitude score was M=54.89, SD = 7.99, Range = 34 to 75					

Results of the Infant Feeding Intention Scale

A confirmatory factor analysis of the Infant Feeding Intention scale results indicated a one-factor solution as illustrated in the scree plot below (see Figure 4.2). This outcome aligns with the structure of the Infant Feeding Intentions scale, as all items are designed to measure prenatal maternal breastfeeding intentions.

Figure 4.2 Scree Plot of the 5-item Infant Feeding Intentions Scale



Given results from the screen plot, we re-estimate the factor analysis with one factor with a cutoff of > 0.3 as done in a similar study by Tabachnick and Fidell (2019). The table below shows the questions under one factor and their respective factor loadings (see Table 4.7).

Table 4.7 Infant Feeding Intentions Scale Items with Principal Component Factor Loadings

($n = 222$)

Item		Factor loadings
Factor 1	I am planning to only formula feed my baby.	0.8241
	I am planning to at least give breastfeeding a try.	0.6814
	When my baby is 1 month old, I will be breastfeeding without using formula or other milk.	0.9255
	When my baby is 3 months old, I will be breastfeeding without using formula or other milk.	0.9362
	When my baby is 6 months old, I will be breastfeeding without using formula or other milk.	0.8874
Infant Feeding Intention (Infant Feeding Intention) Scale, Method: principal component analysis. Rotation: orthogonal varimax (Kaiser off)		

Table 4.8, shows the reliability results and principal component factor loadings, Cronbach's alphas for total Infant Feeding Intentions scale based on the 5 breastfeeding intention items of the study, with a very high Cronbach's alphas, $\alpha = 0.908$.

Table 4.8 Infant Feeding Intentions Scale items with Reliability Results and Principal Component Factor Loadings ($n = 222$)

Item	p	α
I am planning to only formula feed my baby.	0.7276	0.8955
I am planning to at least give breastfeeding a try.	0.5594	0.9255
When my baby is 1 month old, I will be breastfeeding without using formula or other milk.	0.8698	0.8653
When my baby is 3 months old, I will be breastfeeding without using formula or other milk.	0.8869	0.8603
When my baby is 6-months-old, I will be breastfeeding without using formula or other milk.	0.8083	0.8794
Test scale		0.9078
Abbreviations: α , Cronbach's alphas for total Infant Feeding Intention score based on the 5 breastfeeding intention items if item deleted; p , item-rest – item-total correlations for Infant Feeding Intention items		

The average Infant Feeding Intention score was $M = 11.90$ ($SD = 3.92$) and range 0 to 16 (see table 4.9)

Table 4.9 Mother's Intentions Towards Breastfeeding Using the Infant Feeding Intentions Scale ($n = 222$)

Mean score (SD): 11.90 (± 3.92), range 0 - 16					
Item	Mean	SD	Agree (%)	Unsure (%)	Disagree (%)
I am planning to only formula feed my baby	3.28	1.04	78.38	16.22	5.41
I am planning to at least give breastfeeding a try.	3.63	.91	90.99	4.05	4.95
When my baby is 1 month old, I will be breastfeeding without using formula or other milk.	2.98	1.08	62.61	31.98	5.41
When my baby is 3 months old, I will be breastfeeding without using formula or other milk.	2.82	1.15	55.41	36.04	8.56
When my baby is 6-months-old, I will be breastfeeding without using formula or other milk.	2.62	1.21	50.00	36.49	13.51
Participants were asked to indicate how strongly they agree or disagree with each of the statements of 5-point Likert-type scale of the Infant Feeding Intention scale ranging from 0 (very much disagree) to 4 (very much agree). The scores ranging from 0 (no intention to breastfeed) to 16 (strong intention to exclusively breastfeed for 6 months); higher score also indicates a stronger intention to breastfeed.					

Table 4.10 displays variations in expectant mothers' intentions to breastfeed based on demographic characteristics as measured by the Infant Feeding Intentions scale. The scale ranged from 0 to 16. Women with prior breastfeeding experience lasting more than 6 months had the highest Infant Feeding Intentions scores ($M = 14.22$, $SD = 2.21$), reflecting a strong intention to breastfeed. This was followed by unemployed women, who scored $M = 12.60$ ($SD = 3.97$). A statistically significant positive correlation was identified between expectant mothers' prior breastfeeding experience and their intentions to breastfeeding ($p < 0.001$).

Table 4.10 Means, Standard Deviation, and One-Way Analysis of Variance Between Infant Feeding Intentions Score by Demographic Characteristics (n = 222)

Demographic Characteristics		Mean	SD	<i>F(df)</i>	<i>p</i>
Age	< 30 years	12.16	4.15	0.50(1,219)	0.478
	≥ 30 years	11.77	3.80		
WIC program	Yes	12.21	4.11	1.03(1,220)	0.311
	No	11.67	3.78		
Previous children	Yes	12.20	3.68	1.05(1,220)	0.307
	No	11.66	4.10		
Previous breastfeeding experience	Yes	12.81	3.02	30.70(1,96)	<0.001*
	No	6.85	4.77		
Previous breastfeeding duration	≤ 3 months	9.34	3.61	25.98(2,89)	< 0.001*
	4 – 6 months	11.6	3.29		
	> 6 months	14.22	2.21		
Marital status	Married/Cohabiting	11.92	4.03	0.10(1,219)	0.752
	Single/Divorced/Separated/Widowed	11.70	3.45		
Race/Ethnicity	White	11.69	4.02	1.87(4,214)	0.11
	Black, non-Hispanic	11.92	3.67		
	Hispanic	12.76	3.42		
	Asian	10.51	4.59		
	All Others	13.5	2.96		
Education	High or less	11.40	4.08	0.70(2,218)	0.498
	College or less	12.16	3.84		
	Completed graduate school	11.64	3.99		
Household Income	Low-income (< \$50,000)	12.16	4.08	0.62(2,216)	0.53
	Middle income (\$50,000 - \$74,99)	12.03	3.48		
	High income (> \$75,000)	11.5	4.11		
Employment	< 35 hours per week	12.05	4.64	2.14(2,217)	0.119
	≥ 35 hours per week	11.41	3.67		
	Unemployed	12.60	3.97		

*Statistical differences $p < 0.05$ using One-Way ANOVA

Mean Infant Feeding Intentions score was $M=11.90$, $SD = 3.93$, Range = 0 to 16

Results of frequency of the Formula Shortage Exposure Scale

A confirmatory factor analysis of the Formula Shortage Exposure Scale results revealed a one factor solution. A visual representation is presented in the scree plot below (see Figure 4.3).

Figure 4.3 Scree Plot of the 11-item Scale of Frequency of Exposure to Information Regarding the Shortage of Infant Formula

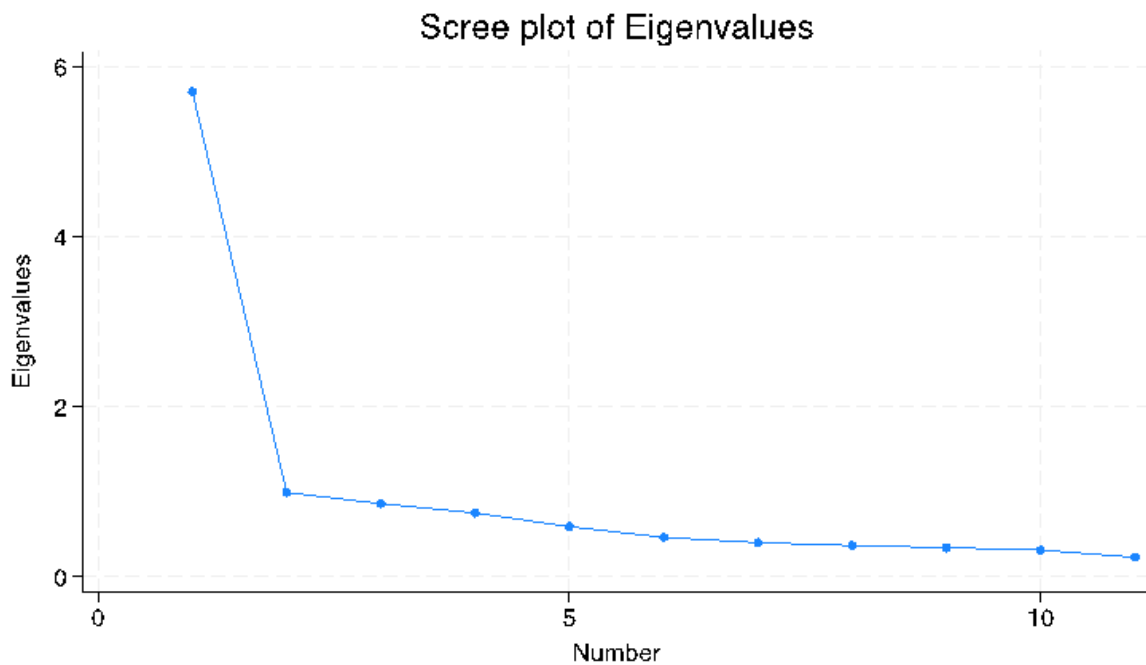


Table 4.11 Formula Shortage Exposure Scale items with Component Factor Loadings ($n = 222$)

Factor	Item	Factor Loadings
	People I know have been affected by the infant formula shortage.	0.735
Factor 1	I have seen empty shelves and in-store signs about infant formula being out of stock.	0.730
	I have heard television or radio news stories about the infant formula crisis.	0.688
	Health care professionals (doctors, nurses, pharmacists, dieticians) have mentioned the infant formula shortage.	0.730
	I have spoken with family members such as a partner, spouse, mother-in-law, sibling, or cousin about the infant formula shortage.	0.798
	I have talked with friends and co-workers about the infant formula shortage.	0.791
	I have read handouts or brochures about the infant formula shortage.	0.586
	I have seen posts about the infant formula shortage on social media (Twitter, Facebook, Instagram, Snapchat, Tik Tok, etc.)	0.715
	I have seen or read about the infant formula shortage on the internet such as newsfeeds, new stories, and blogs.	0.705
	I have read or heard about infant formula being recalled because it was unsafe.	0.661
	I have read or heard about the infant formula crisis impacting the health of babies.	0.753
Frequency of exposure to information regarding the shortage on infant formula, Method: principal component analysis. Rotation: orthogonal varimax (Kaiser off)		

Table 4.12 Formula Shortage Exposure Scale items with Reliability Results and Principal Component Factor Loadings ($n = 222$)

Item	p	α
People I know have been affected by the infant formula shortage.	0.6623	0.8973
I have seen empty shelves and in-store signs about infant formula being out of stock.	0.6598	0.8976
I have heard television or radio news stories about the infant formula crisis.	0.6144	0.9000
Health care professionals (doctors, nurses, pharmacists, dieticians) have mentioned the infant formula shortage.	0.6627	0.8973
I have spoken with family members such as a partner, spouse, mother-in-law, sibling, or cousin about the infant formula shortage.	0.7376	0.8929
I have talked with friends and co-workers about the infant formula shortage.	0.7312	0.8933
I have read handouts or brochures about the infant formula shortage.	0.5147	0.9048
I have seen posts about the infant formula shortage on social media (Twitter, Facebook, Instagram, Snapchat, Tik Tok, etc.)	0.6416	0.8984
I have seen or read about the infant formula shortage on the internet such as newsfeeds, new stories, and blogs.	0.6344	0.8988
I have read or heard about infant formula being recalled because it was unsafe.	0.5871	0.9013
I have read or heard about the infant formula crisis impacting the health of babies.	0.6897	0.8957
Test scale		0.9064
Abbreviations: α , Cronbach's alphas for total exposure to information regarding the shortage on infant formula score based on the 11 items using exposure to cues questionnaire if item deleted; p , item-rest – item-total correlations for exposure to information regarding the shortage on infant formula		

Table 4.13 Expectant Mothers' Frequency of Exposure to Information Regarding the Shortage on Infant Formula ($n = 222$)

Item	<i>M</i>	<i>SD</i>	Never (%)	Seldom (%)	Sometimes (%)	Often (%)
People I know have been affected by the infant formula shortage.	2.83	1.01	14.41	17.57	38.29	29.73
I have seen empty shelves and in-store signs about infant formula being out of stock.	3.05	.90	7.66	15.32	41.44	35.59
I have heard television or radio news stories about the infant formula crisis.	3.05	.84	6.76	12.16	50.00	31.08
Health care professionals (doctors, nurses, pharmacists, dieticians) have mentioned the infant formula shortage.	2.09	1.05	40.09	20.72	28.83	10.36
I have spoken with family members such as a partner, spouse, mother-in-law, sibling, or cousin about the infant formula shortage.	2.36	1.06	29.73	19.82	35.59	14.86
I have talked with friends and co-workers about the infant formula shortage.	2.35	1.04	28.38	22.52	35.14	13.96
I have read handouts or brochures about the infant formula shortage.	1.73	.93	55.41	21.17	18.47	4.95
I have seen posts about the infant formula shortage on social media (Twitter, Facebook, Instagram, Snapchat, Tik Tok, etc.)	2.92	1.01	12.16	18.92	33.78	35.14
I have seen or read about the infant formula shortage on the internet such as newsfeeds, new stories, and blogs.	2.83	.97	11.26	23.42	36.49	28.83
I have read or heard about infant formula being recalled because it was unsafe.	2.81	.96	12.16	20.72	41.44	25.68
I have read or heard about the infant formula crisis impacting the health of babies.	2.72	1.01	14.86	24.32	35.14	25.68
Participants were asked to indicate how often they have experienced each of the statements of 5-point Likert-type scale of the frequency of exposure to information regarding the shortage on infant formula ranging from 1 (often) to 4 (never). The scores were reverse coded. The higher the score, the higher the exposure to information regarding the shortage on infant formula, <i>M</i> = Mean, <i>SD</i> = standard deviations						

As shown in Table 4.14 below, significant differences in expectant mothers' frequency of exposure to information regarding the shortage on infant formula scores were observed based on several demographic characteristics ($p < .05$). Younger participants (< 30 years) scored significantly higher ($M = 31.34$, $SD = 7.29$) than those aged ≥ 30 ($M = 27.23$, $SD = 7.66$), $p < .001$. Higher scores were also found among WIC participants ($M = 31.15$, $SD = 7.67$) compared to non-participants ($M = 26.96$, $SD = 7.38$), and among those with previous children ($M = 31.07$, $SD = 7.88$) versus those without ($M = 26.89$, $SD = 7.19$), both $p < .001$. Education and income showed inverse trends: participants with lower education ($M = 31.16$, $SD = 7.98$) and lower income ($M = 31.25$, $SD = 7.85$) had higher scores than those with graduate education ($M = 26.05$, $SD = 7.29$) or high income ($M = 25.70$, $SD = 7.06$), $p < .001$. No significant differences were found based on marital status, race/ethnicity, employment, or previous breastfeeding experience or duration ($p > .05$).

Table 4.14 Means, Standard Deviation, and One-Way Analysis of Variance Between Infant Formula Shortage Exposure Scale Scores by Demographic Characteristics ($n = 222$)

Demographic Characteristics		<i>M</i>	<i>SD</i>	<i>F(df)</i>	<i>p</i>
Age	< 30 years	31.34	7.29	15.43(1,219)	<0.001*
	≥ 30 years	27.23	7.66		
WIC program	Yes	31.15	7.67	16.87(1,220)	<0.001*
	No	26.96	7.38		
Previous children	Yes	31.07	7.88	17.02(1,220)	<0.001*
	No	26.89	7.19		
Previous breastfeeding experience	Yes	30.83	7.93	0.81(1,96)	<0.370
	No	33.2	7.54		
Previous breastfeeding duration	≤ 3 months	32.96	8.27	1.98(2,89)	0.144
	4 – 6 months	27.87	7.37		
	> 6 months	30.96	7.75		
Marital status	Married/Cohabiting	28.63	7.59	0.34(1,219)	0.559
	Single/Divorced/Separated/Widowed	29.41	8.56		
Race/Ethnicity	White, non-Hispanic	29.3	7.87	1.16(4,216)	0.327
	Black, non-Hispanic	29.62	8.49		
	Hispanic	27.02	6.98		
	Asian	27.42	7.84		
	All Others	28.25	7.66		
Education	High or less	31.16	7.98	6.65(2, 218)	<0.001*
	College or less	29.51	7.59		
	Completed graduate school	26.05	7.29		
Household Income	Low-income (< \$50,000)	31.25	7.85	11.87(2, 216)	<0.001*
	Middle income (\$50,000 - \$74,99)	29.78	7.29		
	High income (> \$75,000)	25.70	7.06		
Employment	< 35 hours per week	29.46	9.40	2.60(2, 217)	0.076
	≥ 35 hours per week	27.69	7.19		
	Unemployed	30.24	7.85		

differences were noted with $*p < 0.05$ using One-Way ANOVA
Mean formula shortage score was $M=28.73$, $SD = 7.77$, Range =11 to 44

Linear Regression Analysis

Linear regression analysis examined the relationships between Iowa Infant Feeding Attitude Scale scores, Infant Feeding Intentions scale scores, and Formula Shortage Exposure Scale scores. The analysis revealed that the Iowa Infant Feeding Attitude Score was a significant predictor of Infant Feeding Intentions Scores ($B = 0.17, p < .001$), indicating that higher Infant Feeding Attitude Score predicts a higher Infant Feeding Intentions score. In contrast, neither the Iowa Infant Feeding Attitude Score ($B = -0.18, p = .116$) nor the Infant Feeding Intentions Scores ($B = -0.09, p = .820$) significantly predicted Formula Shortage Exposure Scale scores. See Table 4.15 for additional details. These results suggest a significant bidirectional relationship between Iowa Infant Feeding Attitude Score and Infant Feeding Intentions Scores; Formula Shortage Exposure Scale scores were not significantly associated with either variable in the regression models.

Table 4.15 Linear Regression analysis of Iowa Infant Feeding Attitude Scale score, Infant Feeding Intention score and Frequency of exposure to media report on infant formula shortage ($n = 222$)

Scale	Iowa Infant Feeding Attitude Scale Score		Infant Feeding Intention Score		Exposure to media report on infant formula shortage	
	<i>B</i>	<i>p</i>	<i>B</i>	<i>p</i>	<i>B</i>	<i>p</i>
Attitude (Iowa Infant Feeding Attitude Scale) Score	-	-	.17	<0.001*	-.18	0.116
Intention (Infant Feeding Intention) Score	1.37	<0.001*	-	-	-.09	0.820
Exposure to information on formula shortage score	-.15	0.129	-.01	0.820	-	-
*Statistical differences $p < 0.05$ using Linear regression, <i>B</i> = unstandardized regression coefficient						

Table 4.16 below provides the results of the regression analysis conducted to explore the predictors of the Infant Feeding Intentions score with both Iowa Infant Feeding Attitude Scale scores and Formula Shortage Exposure Scale scores and demographic characteristics as independent variables. The regression analysis explained a substantial portion of the variance in Infant Feeding Intentions score ($R^2 = 0.70$, $F(18, 72) = 17.95$, $p < .001$). The Iowa Infant Feeding Attitude Scale score was a significant predictor of the Infant Feeding Intentions scale score, with a positive relationship ($B = 0.18$, $p < .0001$). The Formula Shortage Exposure Scale score did not significantly predict infant feeding intention ($B = 0.002$, $p = 0.948$). Among the demographic variables, previous breastfeeding duration was a significant predictor, with those who breastfed for more than 6 months reporting higher Iowa Infant Feeding Attitude Scale scores ($B = 2.77$, $p < .001$). Additionally, race/ethnicity showed significant effects. White, non-Hispanic ($B = 2.19$, $p = 0.021$), Hispanic ($B = 1.95$, $p = 0.038$), and Black, non-Hispanic ($B = 2.32$, $p = 0.049$) participants had higher Infant Feeding Intentions scale score compared Asian's and Native Hawaiian/Pacific Islanders participants. Employment status significantly predicted intention, with participants working ≥ 35 hours per week showing a decrease in Infant Feeding Intentions scores ($B = -1.53$, $p = 0.004$). Other variables, such as age, WIC program participation, previous breastfeeding experience, marital status, education, and household income, were not significant predictors in the model.

Table 4.16 Regression Analysis Predicting Infant Feeding Intention by Attitude Scale scores, Frequency of Media Exposure Scale scores, and Demographic Characteristics ($n = 222$)

Instrument score		<i>B</i>	<i>SE B</i>	<i>t</i>	<i>p</i>	95% <i>CI for B</i>
Iowa Infant Feeding Attitude Scale		.18	.03	5.83	< .000*	[.12, .25]
Formula Shortage Exposure Scale		.002	.03	0.07	0.948	[-.07, .07]
Demographic Characteristics						
Age	< 30 years	Ref.				
	≥ 30 years	-.92	.53	-1.73	0.087	[-1.98, .13]
WIC program	No	Ref.				
	Yes	1.20	.98	1.23	0.224	[-.75, 3.17]
Previous breastfeeding experience	Yes	Ref.				
	No	-3.57	2.28	-1.56	0.123	[-8.14, .98]
Previous breastfeeding duration	≤ 3 months	Ref.				
	4 – 6 months	.81	.74	1.10	0.277	[-.66, 2.29]
	> 6 months	2.77	.51	5.37	< 0.001*	[1.74, 3.80]
Marital status	Married/Cohabiting	Ref.				
	Single/Divorced/ Separated/Widowed	-.28	.82	-0.35	0.728	[-1.92, 1.35]
Race/Ethnicity	All Others	Ref.				
	White, non-Hispanic	2.19	.93	2.35	0.021*	[.33, 4.06]
	Black, non-Hispanic	2.32	1.16	2.00	0.049*	[.01, 4.63]
	Hispanic	1.95	.92	2.11	0.038*	[.10, 3.79]
	Asian	-1.46	1.51	-0.97	0.337	[-4.48, 1.55]
Education	High or less	Ref.				
	College or less	.17	.61	0.29	0.776	[-1.05, 1.41]
	Completed graduate school	-.17	.90	-0.19	0.850	[-1.96, 1.62]
Household Income	Low (< \$50,000)	Ref.				
	Middle (\$50,000 - \$74,99)	.23	.81	0.28	0.778	[-1.39, 1.85]
	High (> \$75,000)	1.72	1.22	1.41	0.164	[-.72, 4.17]
Employment	Unemployed	Ref.				
	< 35 hours per week	.08	.61	0.13	0.894	[-1.14, 1.30]
	≥ 35 hours per week	-1.53	.51	-2.95	0.004*	[-2.56, -.49]
Statistical differences were noted with * $p < 0.05$; Ref. = reference group for comparison using Linear regression analysis; Note. $R^2 = 0.70$, $F(18, 72) = 17.95$, $p < .001$; B = unstandardized regression coefficient; $SE B$ = standard error of B ; CI = confidence interval						

Discussion

The present study examined differences in mean scores on of the Iowa Infant Feeding Attitude Scale, Infant Feeding Intentions scale, and frequency of exposure to information regarding the shortage on infant formula across various demographic characteristics in a sample of 222 participants. The overall mean scores of the Iowa Infant Feeding Attitude Scale (Iowa Infant Feeding Attitude Scale) and Infant Feeding Intention (Infant Feeding Intention) scales for many demographic variables did not yield statistically significant differences in Feeding Intention; however, prior breastfeeding experience and duration emerged as strong predictors of higher scores for both scales.

The Cronbach's alphas for total Iowa Infant Feeding Attitude Scale (Iowa Infant Feeding Attitude Scale) score based on the 17 attitude items of the study was $\alpha = 0.791$, indicating strong internal consistency. This aligns with findings from other studies that have demonstrated the scales validity and reliability in assessing maternal attitudes towards breastfeeding (Abdulahi et al., 2020; Cotelo et al., 2018; Suppiger et al., 2024). The Iowa Infant Feeding Attitude Scale for the study was 54.89, suggesting that participants generally held a positive attitude towards breastfeeding. Only expectant mothers with breastfeeding experience and longer duration of breastfeeding showed statistically significant differences in Iowa Infant Feeding Attitude Scale scores, indicating real group differences in breastfeeding knowledge and attitudes. Even though there were differences in Iowa Infant Feeding Attitude Scale mean scores among groups, the differences were not statistically significant can't among maternal age, WIC program participation, previous children, marital status, ethnicity, education, income and employment.

The study revealed a very high Cronbach's alphas, $\alpha = 0.908$ for the Infant Feeding Intentions scale, indicating that the five items scale was a reliable instrument for measuring

maternal breastfeeding intentions. The mean Infant Feeding Intentions scale score was 11.90, reflecting a strong breastfeeding intention among participants. A significant association was observed in Infant Feeding Intention (IFI) scores among expectant mothers with prior breastfeeding experience and longer prior breastfeeding duration. Other demographic variables did not show statistically significant difference in Infant Feeding Intentions scale scores. However, findings from other studies have shown that older mothers (Senghore et al., 2018), those with higher levels of education (Ayers et al., 2024; Mitra et al., 2004), and women with higher income (Mitra et al., 2004) tend to have stronger intentions to breastfeed compared to younger women, less educated and primiparous women.

This suggests that a positive maternal attitude towards breastfeeding is associated with higher likelihood to having a strong intention to breastfeed. Participants with previous breastfeeding experience reported significantly higher scores for both Iowa Infant Feeding Attitude Scale and Infant Feeding Intention scale compared to those without such experience. This substantial difference suggests that personal experience with breastfeeding may enhance knowledge, confidence, or positive attitudes towards breastfeeding. Moreover, breastfeeding duration demonstrated a clear dose-response pattern: those who had breastfed for more than six months scored highest for both Iowa Infant Feeding Attitude Scale (Iowa Infant Feeding Attitude Scale) and Infant Feeding Intention (Infant Feeding Intention) scale, followed by those who breastfed for 4–6 months, and those with three or fewer months. These findings reinforce the notion that extended engagement with breastfeeding may strengthen familiarity, competence, or favorable perceptions. Other demographic variables including age, WIC participation, previous children, marital status, race/ethnicity, education, household income, and employment status—did not demonstrate statistically significant differences in either the Iowa Infant Feeding Attitude

Scale scores or Infant Feeding Intention Scale scores. While small variations were observed (e.g., Hispanic participants had slightly higher mean scores, and unemployed individuals scored higher than those working full time), these differences did not reach significance. Employment, particularly especially working ≥ 35 hours per week was negatively correlated with infant breastfeeding intentions. This suggests that, within this sample, demographic characteristics other than breastfeeding experience may have a limited influence on the measured outcome.

Taken together, the findings highlight the critical role of prior breastfeeding exposure in shaping the measured variable. These results may inform targeted interventions or educational strategies, particularly for first-time mothers or those with limited breastfeeding history. Future research should explore the mechanisms underlying these associations and examine whether similar patterns are observed in more diverse or larger populations.

Women under 30 years of age, those participating in the WIC program, mothers with previous children, individuals with less than a high school education, and those with an income below \$75,000 had higher mean scores for the frequency of exposure to information regarding the infant formula shortage. The results indicated that the frequency of exposure to information regarding the shortage on infant formulas did not influence expectant mothers' breastfeeding knowledge, attitude and their intentions. This may be because mothers likely perceived the formula shortage as temporary, and during their pregnancy, they did not experience any actual formula shortage. Since formula shortage was viewed as short-term, it did not significantly affect their attitudes or attentions towards breastfeeding. In contrast, more permanent changes tend to have a greater impact on attitudes and intentions. Therefore, the health belief model is an ideal framework for designing programs aimed at improving maternal intentions aimed at improving exclusive breastfeeding rates. These findings however are not consistent with the

trend analysis conducted by Estruel and Andreyeva (2025), which showed an increase in average breastfeeding-initiation rates during the 2022 infant formula crisis. In their study, the increase in breastfeeding initiation was particularly pronounced among mothers with lower educational level, those participating in WIC program, residents of less populated counties, Medicaid recipients and Black mothers (who had higher reliance on formula feeding).

This study is subject to several limitations. The cross-sectional design restricts the ability to draw causal conclusions, as data were collected at a single time point and do not capture changes in attitudes, intentions, or behaviors throughout pregnancy or postpartum. While the sample was fairly representative of the U.S. population of pregnant women, many participants already had experience with breastfeeding, and many were from higher income households. The web-based survey format may have introduced selection bias, as individuals with internet access and greater health engagement were more likely to participate. As a result, findings may not generalize to all pregnant women, particularly those from underrepresented or digitally underserved populations. Finally, the reliance on self-reported data introduces potential for recall and social desirability bias, which may affect the accuracy of responses related to infant feeding attitudes and intentions.

Conclusion

This study examined the relationships between breastfeeding attitudes, exposure to information regarding the recent shortages of infant formula, demographic characteristics, and expectant mother's intention to breastfeed. The findings indicate breastfeeding attitudes, prior breastfeeding duration, race/ethnicity, and employment status are important factors in predicting the intention. While frequency of exposure to information regarding the infant formula shortage was associated with age, education level, WIC participation, and household income, it did not predict breastfeeding intention.

These findings highlight the importance of ongoing and comprehensive health literacy programs focused on breastfeeding for pregnant women, to encourage the initiation of breastfeeding for at least 3 to 6 months. Additionally, it emphasizes the need for stakeholders and healthcare providers to tailored breastfeeding interventions to better meet specific maternal needs. These findings suggest that direct breastfeeding experience, rather than demographic factors, plays a key role in influencing the measured outcome. Future interventions should focus on supporting first-time or inexperienced mothers to enhance outcomes.

Chapter 5 - Summary

Breastfeeding provides numerous health benefits for both mother and infant. However, breastfeeding rates in the U.S. fail to meet public health recommendations. The overall purpose of this dissertation was to explore the relationship between interpersonal as well as institutional factors and breastfeeding outcomes. In summary, the three studies included in this set of works highlight the critical role of breastfeeding support in prolonging breastfeeding duration, the negative impact of formula introduction before 2 days of age in increasing the risk of early breastfeeding discontinuation, and the potential influence of breastfeeding knowledge and attitude on expectant's mother breastfeeding intentions. In addition, the research emphasizes the need for targeted interventions to promote breastfeeding continuity and exclusivity.

In the statewide ecological study, the rate of breastfeeding at 6 months was significantly correlated with exclusive breastfeed at 3 months and exclusive breastfeed at 6 months. The provision of infant formula to breastfed infants before 2 days of age was negatively correlated with all statewide breastfeeding outcomes at 6 and 12 months and exclusive breastfeed at 3 and 6 months. These findings suggest that early provision of formula to breastfed infants is associated with lower breastfeeding rates, duration and exclusivity. On the other hand, Infant Nutrition and Care scores (mPINC) score was positively correlated with exclusive breastfeeding at 3 months and exclusive breastfeeding at 6 months, indicating that better maternity care practices are associated with higher exclusive breastfeeding rates. It was also interesting to note that the rate of live births occurring at Baby-Friendly Facilities (BFFB 2018) was not significantly correlated with any of the breastfeeding outcomes analyzed.

The ecological study findings also reveal a discrepancy between established breastfeeding recommendations and real-world feeding practices. This is concerning given that

infant formula was introduced to breastfed infants very early in life potentially reducing breastfeeding continuity and exclusivity. Consequently, infants may miss out on the numerous health benefits associated with breastfeeding (Fewtrell et al., 2007; Mantzourou et al., 2022; Roldão et al., 2024; Shipp et al., 2023; Yan et al., 2014). Specifically, infants who were given formula within the first 2 or 30 days of life were less likely to be breastfed at 6 months.

The second study was to determine the relationship between early introduction of infant formula and early discontinuation of breastfeeding using individual-level survey data. Results of the study showed that, while the majority of breastfed infants continued to be breastfed for at least 6 months, a noteworthy percentage were introduced to formula early, potentially shortening breastfeeding duration and jeopardizing breastfeeding success. The findings corroborate the results of other studies (including the statewide ecological study) suggesting early formula introduction, whether within 2 days or 30 days, reduces the likelihood of breastfeeding continuity and exclusivity. In addition, both maternal characteristics (i.e., older age) and child characteristics (i.e., first-born status) were strong predictors of early introduction to infant formula. These breastfeeding groups may need additional support regarding newborn feeding patterns during the early postpartum period. Our findings revealed that early introduction to infant formula within 30 days was associated with a broader range of demographic factors compared to formula introduction within 2 days. These findings align with previous studies examining maternal and infant predictors of early formula introduction. While some studies have reported an association between maternal education and breastfeeding within 30 days (Beyene et al., 2025; Tang et al., 2019) others, like our findings, did not observe this relationship.

The second study also revealed that a mixed feeding approach (i.e., a combination of breastfeeding and infant formula) was common. However, it is well established that the benefits of breastfeeding are dose dependent, in that longer breastfeeding duration and exclusivity confers greater health benefits to both infant and mother (Boué et al., 2018; Chantry et al., 2014b; Parry et al., 2013b). Providing mothers with lactation support after delivery through well implemented and monitored hospital Maternity Practices in Infant Nutrition and Care can help address breastfeeding challenges. Such support not only equips mothers to breastfeed exclusively for longer durations (3 to 6 months) but also contributes to achieving the Healthy People 2030 (Jegier et al., 2024; Santacruz-Salas et al., 2019; Walters et al., 2019b) objective of increasing exclusive breastfeeding rates to 42.4%. Achieving this goal could lead to a reduction in childhood obesity and lower healthcare costs associated with not breastfeeding (Jegier et al., 2024; Santacruz-Salas et al., 2019; Walters et al., 2019b).

Results of the third study, an online survey of expectant mothers, highlight the importance of ongoing and comprehensive health literacy programs focused on exclusive breastfeeding for pregnant women. This study found a positive correlation between breastfeeding knowledge and attitude scale scores and breastfeeding intentions scale scores suggesting knowledge and attitude may play a role in shaping breastfeeding intention and ultimately breastfeeding practices. However, frequency of exposure to information regarding the shortage on infant formula did not influence expectant mothers' breastfeeding intentions. This may be because mothers likely perceived the formula shortage as temporary, and during their pregnancy, they did not experience any actual formula shortage. These findings however are not consistent with the trend analysis conducted by Estruel and Andreyeva (2025), which showed an increase in average breastfeeding-initiation rates during the 2022 infant formula crisis (Seoane Estruel &

Andreyeva, 2025a). Additionally, the third study emphasizes the need for stakeholders and healthcare providers to tailor breastfeeding interventions to better meet specific needs of pregnant women.

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Appendix A - Institutional Review Board (IRB) Approval for Infant Feeding Survey of Pregnant Women



TO: Jennifer Hanson
Food, Nutrtn, Dietetics & Hlth
Manhattan, KS 66506

Proposal Number: IRB-11440

FROM: Lisa Rubin, Chair
Committee on Research Involving Human Subjects

DATE: 12/14/2022

RE: Proposal Entitled, "Infant Feeding Survey of Pregnant Women."

The Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University has reviewed the proposal identified above and has determined that it is EXEMPT from further IRB review. This exemption applies only to the proposal - as written - and currently on file with the IRB. Any change potentially affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects, 45 CFR §104(d), category:Exempt Category 2 Subsection ii.

Certain research is exempt from the requirements of HHS/OHRP regulations. A determination that research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means only that the regulatory requirements related to IRB review, informed consent, and assurance of compliance do not apply to the research.

Any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Committee on Research Involving Human Subjects, the University Research Compliance Office, and if the subjects are KSU students, to the Director of the Student Health Center.

Electronically signed by Phill Vardiman on 12/15/2022 10:10 AM ET
On Behalf of IRB Chair

Appendix B - Flyer used for Infeed Feeding Survey of Pregnant Women

Expectant mothers

Kansas State University wants to hear about your infant feeding plans.

To improve child health, we are interested in learning more about the intended infant feeding practices of expectant mothers. Your thoughts and ideas regarding infant feeding are important to us. After completing the survey linked below, you will have the opportunity to enter your contact information and collect a \$20 e-gift card.

RQ code to access the survey.



<https://www.publicdomainpictures.net/en/view-image.php?image=410568&picture=infant-newborn-cute-portrait-em>

Appendix C - Iowa Infant Feeding Attitude Scale

Iowa Infant Feeding Attitude Scale items					
Please indicate how strongly you agree or disagree with each of the following the statements					
Item/Statement	SD	D	N	A	SA
1. The nutritional benefits of breast milk last only until the baby is weaned from breast milk.	1	2	3	4	5
2. Formula-feeding is more convenient than breast-feeding.	1	2	3	4	5
3. Breast-feeding increases mother-infant bonding.	1	2	3	4	5
4. Breast milk is lacking in iron.	1	2	3	4	5
5. Formula-fed babies are more likely to be overfed than are breast-fed babies.	1	2	3	4	5
6. Formula-feeding is the better choice if a mother plans to work outside the home.	1	2	3	4	5
7. Mothers who formula-feed miss one of the great joys of motherhood.	1	2	3	4	5
8. Women should not breast-feed in public places such as restaurants.	1	2	3	4	5
9. Babies fed breast milk are healthier than babies who are fed formula.	1	2	3	4	5
10. Breast-fed babies are more likely to be overfed than formula-fed babies.	1	2	3	4	5
11. Fathers feel left out if a mother breast-feeds.	1	2	3	4	5
12. Breast milk is the ideal food for babies.	1	2	3	4	5
13. Breast milk is more easily digested than formula.	1	2	3	4	5
14. Formula is as healthy for an infant as breast milk.	1	2	3	4	5
15. Breast-feeding is more convenient than formula-feeding.	1	2	3	4	5
16. Breast milk is less expensive than formula.	1	2	3	4	5
17. A mother who occasionally drinks alcohol should not breast-feed her baby.	1	2	3	4	5
1= strongly disagree (SD), 2 = disagree (D), 3 = Neutral (N), 4 = Agree (A), 5 = strongly agree (SA) Note: Items marked with asterisk are reverse-scored and the scores of each item are then summed. Higher scores indicate more positive attitudes toward breastfeeding.					

Appendix D - Infant Feeding Intention Scale

Infant Feeding Intentions Scale Items					
Please read the statements about feeding your baby, and choose the answer that closely matches your opinion, considering both your feeding plans and the likelihood that you will carry out those plans.					
Item/Statement	Very much agree	Somewhat agree	Unsure	Somewhat disagree	Very much disagree
1. I am planning to only formula feed my baby.	0	1	2	3	4
2. I am planning to at least give breastfeeding a try.	4	3	2	1	0
3. When my baby is 1 month old, I will be breastfeeding without using formula or other milk.	4	3	2	1	0
4. When my baby is 3 months old, I will be breastfeeding without using formula or other milk.	4	3	2	1	0
5. When my baby is 6 months old, I will breastfeed without using formulas or other milk.	4	3	2	1	0
Numbers within grid represent the point value for each response. Total score = (mean of items 1 + 2) + (sum of items 3, 4, 5). Thus, total score ranges from 0 (very strong intentions to not breastfeed at all) to 16 (very strong intentions to breastfeed exclusively throughout the first 6 months).					

Appendix E - Exposure to Information on Infant Formula Shortage

Scale

Frequency of exposure to information regarding the shortage on infant formula					
The following questions are about information on infant formula shortage. Please indicate the answer that best describes you.					
Item/Statement		Often	Sometimes	Seldom	Never
1.	I personally know people affected by the infant formula shortage.	4	3	2	1
2.	I have seen empty shelves and in-store signs about infant formula being out of stock.	4	3	2	1
3.	I hear television or radio news stories about the infant formula shortage crisis.	4	3	2	1
4.	Health care professionals (doctors, nurses, pharmacists, dieticians) have mentioned the infant formula shortage.	4	3	2	1
5.	I have talked with family such as partner, spouse, mother-law, siblings, and cousins about infant formula shortage.	4	3	2	1
6.	I have talked with friends and co-workers about infant formula shortage.	4	3	2	1
7.	I read handouts or brochures about infant formula shortage	4	3	2	1
8.	I've seen posts about the infant formula shortage on social media (twitter, Facebook, Instagram, WhatsApp, Snapchat, Tik Tok, etc.)	4	3	2	1
9.	I have seen or read about the infant formula shortage on the internet such as newsfeeds, news stories, and blogs.	4	3	2	1
10.	I read or hear about infant formula being recalled because it was unsafe.	4	3	2	1
11.	I read or hear about babies getting sick due to the infant formula shortage.	4	3	2	1
12.	I read or hear about infant formula shortage from my women's groups.	4	3	2	1

Appendix F - Summary for Main Finding for Infant Feeding Survey of Pregnant Women (Chapter 4)

Descriptive Statistics for Key Study Instruments (variables)			
Variable	<i>M</i>	<i>SD</i>	Range
Iowa Infant Feeding Attitude Scale Score	54.89	7.99	34 - 75
Infant Feeding Intentions Scale Score	11.90	3.93	0 - 16
Information on Formula Shortage Exposure Scale	28.73	7.77	11 – 44
Note. <i>M</i> = mean, <i>SD</i> = standard deviation			

Linear Regression Analyses Among Iowa Infant Feeding Attitude Scale Score, Infant Feeding Intentions Scale Score, and Formula Shortage Exposure Scale			
Outcome Variable	Predictor	<i>B</i>	<i>p</i>
Iowa Infant Feeding Attitude Scale Score	Infant Feeding Intentions Scale Score	1.37	<.001*
	Formula Shortage Exposure Scale	-0.15	.129
Infant Feeding Intentions Scale Score	Iowa Infant Feeding Attitude Scale Score	0.17	<.001*
	Formula Shortage Exposure Scale	-0.01	.820
Formula Shortage Exposure Scale	Iowa Infant Feeding Attitude Scale Score	-0.18	.116
	Infant Feeding Intentions Scale Score	-0.09	.820
Note. <i>p</i> values less than .05 are marked with an asterisk. <i>B</i> = unstandardized regression coefficient.			

