

Psychosocial factors associated with racial disparities in exclusive breastfeeding

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Despite the well-documented benefits of exclusive breastfeeding, many childbearing people wean their infants before the recommended six months. Black child-bearing people exclusively breastfeed for a shorter time than people of other racial and ethnic groups. The reasons for these continued breastfeeding disparities are understudied and complex; therefore, it is crucial to examine how psychosocial factors contribute to this disparity.

In this dissertation, I compared exclusive breastfeeding rates obtained from the 24-hour recall and the since birth methods and estimated the magnitude of difference between both across race and demographic characteristics. I examined the influence of psychosocial factors such as perceived stress, perceived and received social support, racial and gender discrimination, and microaggressions on exclusive breastfeeding.

Data were derived from a National Heart, Lung, and Blood Institute (NHLBI) funded study (Postpartum Mobile Mothers Study -PMOMS) collected using ecological momentary assessment (EMA) for 12 months postpartum. The analyses included: 1) Mixed-effects logistic regression model with random intercepts to establish the relationship between perceived stress, social support, and exclusive breastfeeding; 2) Generalized structural equation modeling to test the hypothesized pathway through which racial and gender discrimination and microaggression would directly or indirectly influence exclusive breastfeeding through perceived stress.

The 24-hour recall exclusive breastfeeding rates were higher across the first six months postpartum than the since birth exclusive breastfeeding rates. Participants who reported higher

perceived stress were less likely to breastfeed exclusively for six months. Perception of social support moderated the relationship between perceived stress and breastfeeding. In contrast, receiving social support did not moderate the relationship between perceived stress and exclusive breastfeeding but directly increased the likelihood of exclusive breastfeeding. Black participants were less likely to exclusively breastfeed in the study. Perceived stress mediated the relationship between microaggressions and exclusive breastfeeding such that microaggressions increased stress, which in turn reduced the likelihood of exclusive breastfeeding.

This study shows that racial differences, stress, social support, and microaggressions influence exclusive breastfeeding and may contribute to the racial disparities observed in exclusive breastfeeding rates. Addressing these factors would improve exclusive breastfeeding rates among child-bearing people and bridge the racial gap.

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Preface

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1.0 Introduction

1.1 Definitions of breastfeeding terms

There is growing evidence that experiences during the early stages of human development influence health outcomes in all life stages (childhood and adulthood).¹ Nutrition plays a vital role in the first 1000 days between a woman's pregnancy and a child's 2nd birthday and can shape a child's development.² Breast milk is distinctively superior for infant feeding, and the effect of all alternative feeding options differ significantly.³

The World Health Organization (WHO) promotes breastfeeding as the best nourishment source for infants and young children up to two years. For an infant to achieve optimal growth, the WHO and the American Academy of Pediatrics recommend exclusive breastfeeding for six months, followed by continued breastfeeding with complementary foods for one year or longer.⁴ Researchers have used various terms to describe breastfeeding patterns, including exclusive breastfeeding, predominant breastfeeding, partial breastfeeding, complementary feeding, and infant formula feeding.

The duration of breastfeeding refers to the length of time a mother breastfeeds the child, and exclusivity is the measure of breastfeeding without supplementation, including (e.g., infant formula or other breast milk replacements).⁵ The WHO defines exclusive breastfeeding as feeding infants only breast milk (including milk expressed or from a wet nurse). During exclusive breastfeeding, no other food or drink, not even water, is given to the infant but allows the infant to receive vitamins, minerals, vaccines, and medicines.⁶ The duration and exclusivity of breastfeeding are crucial measures of breastfeeding patterns.

“Predominant breastfeeding” means that the infant's primary source of nourishment is breast milk (including milk expressed or from a wet nurse). However, the infant may also receive liquids (water and water-based drinks, fruit juice) and ORS, drops or syrups (vitamins, minerals, and medicines).⁶

“Partial breastfeeding” indicates that the infant is breastfed and fed with infant formula.⁷ The WHO recommends that “Complementary feeding” begins when breast milk alone is insufficient to meet infants' nutritional requirements. Children receive complementary foods between 6 to 24 months of age, along with breast milk.⁸

“Infant formula feeding” refers to an infant receiving infant formula, usually made from industrially modified cow milk or soy products. During the manufacturing process, the manufacturers adjust quantities of nutrients to make them more comparable to breast milk. However, the qualitative differences in the fat and protein cannot be altered, and the absence of anti-infective and bio-active factors remain.⁸

1.2 Benefits of breastfeeding

1.2.1 Benefits of breastfeeding in children

Breast milk is the ideal nutrition for feeding infants and young children.^{4,9} Breastmilk confers long and short term immunologic, psychological, social, economic, and environmental benefits.¹⁰ It compensates for developmental delays in neonates' immune function and reduces the intestine's permeability.¹¹ The secretory Immunoglobulin A (sIgA) present in breastmilk confers neonates immunoprotection by inhibiting pathogens from adhering or penetrating the

gastrointestinal (GI) tract.¹² Breastfeeding (BF) offers children protective factors against the severity of a wide range of diseases such as infectious diseases, malocclusion, acute otitis media, non-specific gastroenteritis, severe lower respiratory tract infections, atopic dermatitis, asthma in children, obesity, type 1 and 2 diabetes, childhood leukemia, sudden infant death syndrome (SIDS), and necrotizing enterocolitis.¹³⁻¹⁶ Globally, universal breastfeeding can avert about 823,000 child deaths and 20,000 maternal deaths each year.¹⁷

Breastfeeding has been linked with the social and emotional development of children.¹⁸ It is associated with improved mother-infant bonding.¹⁹ Compared to formula-fed children, children who were breastfed for a longer duration were more likely to report higher parental attachment.^{19,20} Narratives have it that breastfed children perceive their mothers as more caring and less overprotective.²⁰ Longer exclusive breastfeeding was associated with positive emotions in 8-month-old infants, where the infants demonstrated an increased neural sensitivity to positive (happy) body expressions.^{21,22}

Exclusive breastfeeding is one of the most significant, cost-effective public health interventions for child survival.^{23,24} While any breastfeeding can offer positive infant and maternal health outcomes, early initiation and exclusive breastfeeding in the first six months of life confers the highest benefit as observed in infant and child survival, growth, and development, and maternal health.²⁵

The Evidence-based Practice Centers of the Agency for Healthcare Research and Quality (AHRQ) of the US Department of Health Human Services conducted a meta-analysis that demonstrates a dose-response relationship between breastfeeding duration and some of its protective effects.^{3,4,16} Studies show that up to four months of exclusive breastfeeding in the first year of life reduced the risk of hospitalization for lower respiratory tract infections by 72%.^{16,26}

Exclusive breastfeeding for more than three months reduced the risk of otitis media by 50% and any breastfeeding when compared to formula feeding reduced the risk of otitis media by 23%.¹⁶ In developed countries, exclusive breastfeeding during the first six months decreased the risk of gastrointestinal tract infections, compared with exclusive breastfeeding during only the first 3 to 4 months.²⁷ A meta analysis of studies from high-income settings showed an association between more extended breastfeeding periods and lower odds of overweight or obesity in later life (a 26% reduction in the odds of overweight or obesity).^{28,29}

1.2.2 Maternal benefits of breastfeeding

Epidemiological data show an association between lactation among women and a reduced risk of type 2 diabetes, cardiovascular disease, premenopausal breast, and ovarian cancer.^{16,30,31} A meta-analysis found an association between each year of breastfeeding and a 4.3% reduction in invasive breast cancer risk.³¹ Findings from the Nurses' Health Study found that mothers who had never breastfed were 1.5 times at risk of ovarian cancer than women who breastfed for more than 18 months.³² Among African American women, parous women who have not breastfed are at increased risk of estrogen receptor-negative (ER-) and triple-negative breast cancer.³³ Breastfeeding increases oxytocin levels, causing less postpartum bleeding and more rapid uterine involution.³⁴ There is an observed inverse relationship between postpartum maternal obesity, postpartum depression, and breastfeeding duration.^{16,35} These positive effects of breastfeeding on infant and maternal health outcomes are consistent both in the industrialized and developing world.⁴

Breastfeeding is associated with enhanced maternal bonding and sensitivity.³⁶ Maternal sensitivity refers to “the synchronous timing of a mother's responsiveness to her child, her

emotional tone, flexibility in her behavior, and her ability to read her child's cues".³⁶ Breastfeeding mothers, when compared to mothers who fed their children with formula, scored higher on positive maternal interactions when feeding and playing with their infants.³⁷⁻³⁹ In addition, breastfeeding mothers displayed more maternal touch and spent significantly more time with their children in mutual gaze during feedings than in bottle-feeding dyads.^{37,40} In a longitudinal study conducted in Wisconsin, breastfeeding decreased mothers' negative affect, whereas bottle feeding decreased their positive affect.⁴⁰

Breastfeeding could be a protective factor for some of these disparate racial health outcomes, including postpartum hemorrhage and obesity and infant morbidity and mortality.⁴¹ The infant mortality among Blacks is 1.3 times higher than Whites; some researchers argue that if the barriers that prevent Black women from breastfeeding were removed, and more Black women breastfed exclusively and longer, the racial gap in infant mortality would narrow.⁴²

1.2.3 Economic benefits of breastfeeding

Besides the direct maternal and child health outcomes, exclusive breastfeeding provides significant social and economic benefits to the mother and the nation, such as cost-saving and reduced employee absenteeism for care attributable to child illness.³ As of 1993, direct cost saving from purchasing infant formula was estimated at \$855 for a year per infant in the US.³ Lack of breastfeeding is associated with losses of about \$13 billion annually in the United States and US\$302 billion or 0.49% of world annual gross income; breastfeeding could lower these losses through reduced healthcare costs and hospital visits.^{17,43} A recent study in the United States compared suboptimal breastfeeding with optimal breastfeeding, which refers to 6 months of exclusively breastfeeding, with continued breastfeeding for at least one year.⁴⁴ The annual excess

deaths attributable to suboptimal breastfeeding total 3,340, 78% of which are maternal due to myocardial infarction (n = 986), breast cancer (n = 838), and diabetes (n = 473).⁴⁴ Excess pediatric deaths total 721, mostly due to Sudden Infant Death Syndrome (n = 492) and necrotizing enterocolitis (n = 190).⁴⁴ Medical costs amount to \$3.0 billion, 79% of which are maternal, and premature death costs total \$14.2 billion.⁴⁴ Other economic benefits associated with breastfeeding include higher cognition and intelligence quotient (IQ),^{45,46} leading to greater school attainment resulting in better economic opportunities in adulthood.⁴⁷

Interestingly, as much as breastfeeding is advantageous to most mothers, there are some conditions in which breastfeeding is not in the infant's best interest. These include infants with galactosemia, infants whose mothers use contraindicated drugs, mothers with untreated active tuberculosis, or those infected with the human immunodeficiency virus (HIV not contraindication in some other LMICs where water supply is a concern).^{3,48,49}

Numerous studies have found an association between breastfeeding and improved child and maternal health outcomes; however, causal inference is a usual challenge in breastfeeding studies because most studies are observational by necessity.⁵⁰ Also, randomizing women to breastfeed or formula-feed is not ethically or practically feasible. Nonetheless, many studies and scientific literature suggest that breastfeeding contributes to a significant difference in maternal and child health outcomes.

1.3 Epidemiology of breastfeeding

In many developed countries, achieving the WHO breastfeeding recommendation remains a challenge. Breastfeeding duration and exclusivity are shorter in high-income countries than in

those that are resource-poor.¹³ Globally, 41% of infants less than six months of age are exclusively breastfed, far short of the 2030 global target of 70%.⁵¹ According to UNICEF, there are wide variations in the proportions of breastfed babies among high-income countries.⁵¹ In some countries, such as Oman (98%), Sweden (98%), and Uruguay (98.7%), almost all babies are breastfed, but in others, rates are lower, like in the United States where 84 percent of babies ever received breastmilk.^{52,53} In these countries, even though almost all babies were ever breastfed, very few babies are exclusively breastfed for six months (Oman, 23.4%, Sweden, 11%, Uruguay, 65% and the US, 25.9%).⁵³⁻⁵⁵

From the National Immunization Survey 2018–2019, among infants born in 2017 in the United States, 84.1% were ever breastfed; at 6 months and 12 months, 58.3% and 35.3% of infants were breastfed, respectively.⁵³ Only 46.9% of children were exclusively breastfed through three months, and 25.6% were exclusively breastfed up to 6 months.⁵³ Among infants born in 2017 in Pennsylvania, about 82.9% of infants were ever breastfed; 47.9% of women exclusively breastfed their children up to 3 months and 25.9% up to 6 months. In Allegheny County, among infants born in 2017, about 80.3% of infants were ever breastfed, which is lower than the state and country's average proportion of infants who were ever breastfed.⁵⁶

Every decade, the Healthy People initiative develops a new set of data-driven, evidence-based, 10-year national objectives to improve US population health.⁴³ The Healthy People 2030 objectives include two breastfeeding goals on exclusivity and duration of breastfeeding. The objectives are:

- To increase the proportion of infants who are breastfed exclusively through 6 months of age to 42.4%⁵⁷
- To increase the proportion of infants who are breastfed at one year to 54.1%.⁵⁷

Over the past decades in the United States, breastfeeding initiation rates have risen slowly and steadily. However, this increase in breastfeeding rates is not equitably distributed across all breastfeeding people in the United States.^{58,59} The difference in breastfeeding indicators among Black and White infants by states continues to be substantial. Black/African Americans represent 12.6% of the US population (38.9 million people) and have the lowest breastfeeding initiation rates, exclusive breastfeeding, and breastfeeding duration than all other racial/ethnic groups.^{41,58,60} Apparent racial disparities exist in these breastfeeding rates, with the proportion of Black/African American mothers to initiate breastfeeding at 73.7%, exclusive breastfeeding at three months (33.7%) and six months (21.2%) compared to White mothers who initiated breastfeeding (86.7%), exclusively breastfed for three months (52.4%) and six months (28.7%).⁵³ These disparities, as shown in **Table 1**, reflect the need to achieve health equity in infant feeding.

Table 1: Rates of Any and Exclusive Breastfeeding by Race Among Children Born in 2017 (Percentage +/- 95% Confidence Interval)⁵³

| | Any breastfeeding | | | Exclusive breastfeeding | | | |
|--|-------------------|----------------|-----------------------|-------------------------|-------|--|--|
| | | Ever Breastfed | Breastfed at 6 Months | Breastfed at 12 Months | | Exclusive Breastfeeding through 3 Months | Exclusive Breastfeeding through 6 Months |
| Race/Ethnicity | n | %± 95% CI | %± 95% CI | %±95%CI | n | % ± 95% CI | % ± 95% CI |
| US National | 20016 | 84.1±1.0 | 58.3±1.4 | 35.3±1.4 | 9417 | 46.9±1.4 | 25.6±1.2 |
| Hispanic | 4376 | 84.1±2.4 | 55.4±3.3 | 33.9±3.3 | 282 | 41.5±3.3 | 21.5±2.7 |
| Non-Hispanic White | 11112 | 86.7±1.2 | 61.9±1.7 | 38.2±1.7 | 10765 | 52.4±1.8 | 28.7±1.5 |
| Non-Hispanic Black | 1851 | 73.7±3.5 | 47.8±3.7 | 26.1±3.3 | 805 | 38.7±3.7 | 21.2±3.4 |
| Non-Hispanic Asian | 855 | 90.0±3.3 | 73.5±5.0 | 50.0±6.7 | 811 | 47.7±6.9 | 26.8±6.7 |
| Non-Hispanic Hawaiian/Pacific Islander | 105 | 85.2±9.6 | NA | NA | 00 | NA | NA |
| Non-Hispanic American Indian/Alaska Native | 257 | 80.7±8.5 | NA | NA | 52 | NA | NA |
| 2 or more races | 1460 | 83.7±3.3 | 56.5±5.5 | 31.0±5.4 | 402 | 43.9±5.8 | 26.6±6.0 |

1.4 Factors associated with breastfeeding disparity using the Social Ecological Model

Various factors are inextricably linked to the disparity in breastfeeding patterns. The long-standing racial and ethnic differences in breastfeeding duration and exclusivity result from interrelated historical, cultural, social, economic, political, and psychosocial factors (See Figure 1).^{41,50}

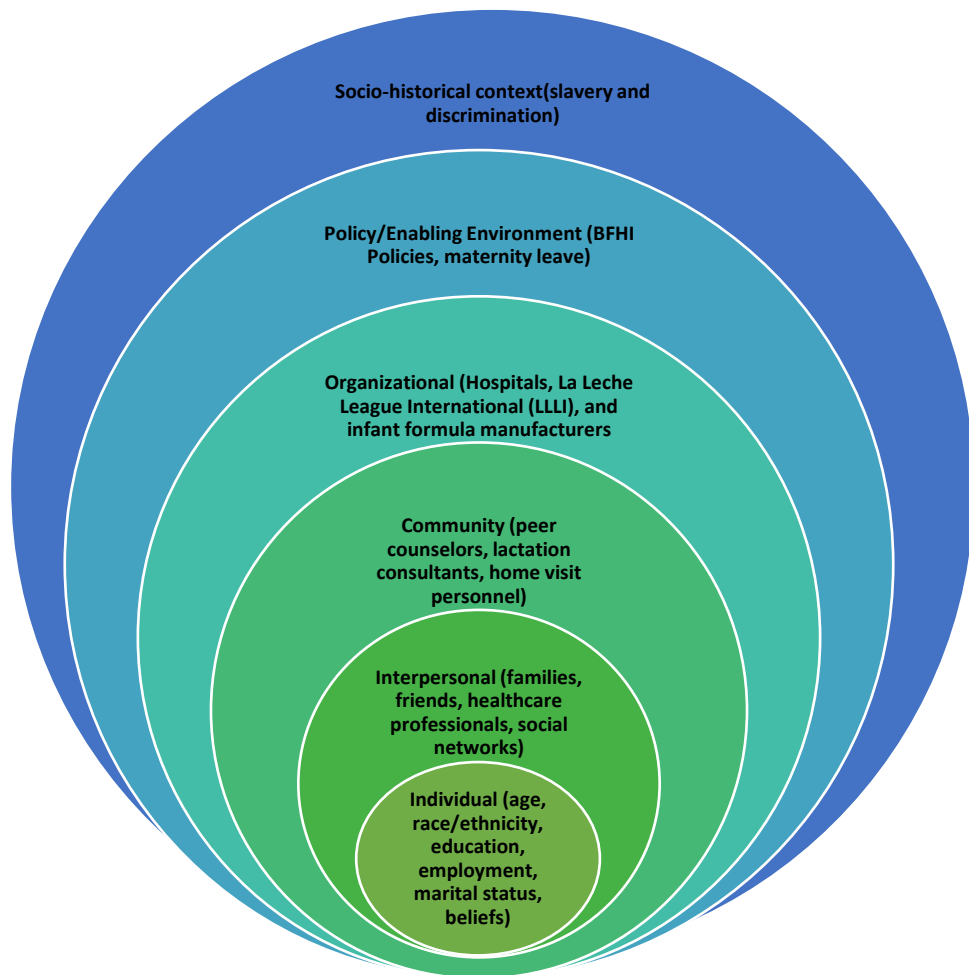


Figure 1: Social-ecological framework underpinning psychosocial factors influencing breastfeeding (BF) among African American mothers⁶¹

The Social-Ecological Model (SEM) guides public health interventions through a theoretical understanding of the relationship of multiple factors at the individual, interpersonal, community, organizational, and policy levels and their influence on health and health behavior. The model illustrates how the characteristics of the environment influence individual health behavior and outcomes and how individuals are nested within multiple levels of influence.⁶²

Factors that influence breastfeeding are multifaceted, and the SEM provides a holistic approach to understanding factors that affect a woman's decision to initiate, breastfeed exclusively for six months, and continue breastfeeding .⁶³

1.4.1 Social, Cultural, and historical influences on African American women's breastfeeding

Cultural beliefs about breastfeeding and breast milk play an important role in Black women's infant feeding choices and behaviors. Some of these cultural beliefs have roots in the era of slavery when slave owners forced African women to breastfeed and care for their owners' children, often excluding their own children.⁶⁴ Nineteenth-century slavery commodified every aspect of a slave's life and even controlled the woman's own breastmilk's rights. In some cases, slaveholders willingly denied the slave infants their own mothers' milk when needed to feed white babies, who were inevitably prioritized over enslaved infants.⁶⁵ Wet-nursing has always involved women in unequal power structures over centuries, whereby wealthier women use women from a lower economic status as wet nurses.⁶⁶ Slaveholders utilized this opportunity as an economical window whereby they did not need to pay a wet nurse when they had one for free.

Prior to transatlantic slavery, European travelers had a notion of "Black women's superior ability to suckle".⁶⁷ Travelers frequently described the Black women's breasts as large and droopy

and compared them to goats' udders.⁶⁷ Based on this premise, slaveholders rationalized both the sexual exploitation of enslaved women and their care for white offspring.⁶⁶ The lives of wet nurses, like other slaves, followed strict guidelines according to their owners. Slaveholders would not allow infants born to slaves, especially the wet nurses, to breastfeed for more than six months so that their mothers could preserve their milk for the White infants who continue to breastfeed until two years of age.^{68,69} Wet nurses, when allowed to be with their children, were allowed only about 45 minutes to feed their children and then return to complete a full day of work. Since their body was not meant to nurse many children, the wet nurses were often exhausted and in extreme pain and usually unable to create a bond between mother and child.⁶⁸

Taking away powerless slave mothers' right to breastfeed their children for the benefit of White infants entrenched the way Black mothers perceive breastfeeding, which in addition to other factors, has affected breastfeeding rates among Black mothers. When not wet nursing, breastfeeding on demand was challenging as slave owners also wanted mothers to take as little time off from labor as possible, which would interrupt the flow of milk but encouraged a communal approach to nursing.⁷⁰ Some narrators argue that refusing to breastfeed for a Black woman after abolition of slavery felt like a way to reject an act that signified re-enslavement and assert control over her own body.⁷⁰ With the end of slavery and the great migration, Black mothers had to work outside their homes, often menial labors making it challenging to breastfeed.^{70,71} Overall, the institution and effects of slavery dismantled traditional breastfeeding practices for Black women.⁷²

By the early twentieth century, breastfeeding practices had decreased, bottle-feeding had replaced wet nurses, breastfeeding had become unfashionable for White women, while almost impossible for Black women due to the type of jobs they did.^{65,70} This led to the growth of artificial infant feeding, which also coincided with an era where infant mortality was rising and a source of

concern.⁷³ By 1960, scientific research began to demonstrate that breastfeeding was associated with infant survival,⁷³ public health reformers started campaigns to persuade women to breastfeed more. However, public health advocates targeted White women for breastfeeding promotion, eventually leading to a behavior change toward infant care.⁷⁰ When White mothers started equating breastfeeding to good parenting, Black mothers could not imitate this behavior due to the exigencies of work and ramped up Black race-targeted marketing of formula by manufacturers.^{74,75} Manufacturers sold the message that formula was just as healthy as, or healthier than, breast milk, making it easier for them to succumb to a host of external pressures, not to breastfeed.⁷⁰

Racism also contributes to the lower breastfeeding rates among Black mothers. Griswold and colleagues adapted a conceptual framework by Williams and Mohammed⁷⁶ to demonstrate how cultural and institutional racism may influence breastfeeding.⁷⁷ In their conceptual framework, cultural racism refers to the *transfer of negative stereotypes that can affect members of marginalized groups using intricate emotional processes such as psychological stress.*^{77,78} Historically, notions of black inferiority and white superiority have been embedded in the American culture.⁷⁶ The 1990 General Social Survey shows that Blacks in the US are negatively stereotyped, where 29 % of whites viewed blacks as unintelligent, 45% saw them as lazy, 57% believed that blacks prefer to live off welfare.⁷⁹ According to Andrea Freeman, stereotypes are dangerous and eliminate the need to know people as individuals.⁸⁰ The Long-standing historical discrimination and stereotypes about Black mothers and their breastfeeding practices conceal the cultural racism that influences low breastfeeding rates in Black communities.^{70,80} There is a collective stereotype in the existence of the “Bad Black Mother” who does not breastfeed.⁸⁰ This leads to low or no investment in breastfeeding Black mothers' resources with health care professionals assuming that Black women do not require nursing support or education.^{70,80}

Institutional racism then refers to “social environments and organizations that systematically constrain resources essential to the achievement of health and well-being”.^{77,78} Workplace racism and residential segregation by race are critical examples of institutional racism.⁷⁶ Griswold and colleagues, performed a secondary analysis of the Black Women's Health Study using data collected from 1995 to 2005. The study demonstrates that racism in the job setting was associated with lower breastfeeding duration.⁷⁷ The intersection of race and gender discrimination makes it risky for many Black mothers to exercise their rights to breastfeed when they return to work. This is usually fueled by fear of demotion, loss of work, or reduction of work hours. Living in a segregated neighborhood or a predominantly Black neighborhood as a child was associated with decreased breastfeeding initiation and duration.⁷⁷ The stress of managing competing life demands with not many resources and support postpartum occasionally induced by institutional racism lowers the breastfeeding rate among the Black community.⁸¹

Discrimination and racism also manifest as implicit bias where patients of color receive substandard care and attention compared with white counterparts.⁸² Demirci et al. posit that breastfeeding conversations between physicians and their patients irrespective of race are infrequent, brief, and ambivalent.⁸³ Infrequent breastfeeding conversations with providers, structural and information barriers Black women face in the health system make breastfeeding challenging for Black women. In a qualitative research among international board-certified lactation consultants (IBCLCs), irrespective of race, most IBCLCs in the study reported witnessing breastfeeding discrimination in the form of implicit bias toward African American women.⁸² The research shows that health care workers assume that most Black mothers would not breastfeed, resulting in fewer requests for lactation support for Black mothers.⁸²

1.4.2 Policy level

In the United States, mothers' legal entitlement for parental leave after the birth of a child is only twelve weeks and is unpaid. As a result, many mothers, especially Black mothers, make considerable personal sacrifices to continue breastfeeding since they are not covered by laws that promote breastfeeding support in the workplace.⁶¹ Many low-income jobs that Black mothers are likely to have are not covered under the Family and Medical Leave Act.⁴¹ This forces Black mothers to return to work sooner than other women.⁴¹ Findings from a survey of 712 mothers showed that each week of maternity leave increased the breastfeeding duration by almost half of a week (0.5 week).⁸⁴

Globally, there have been some policies and strategies designed to improve breastfeeding. The Baby-Friendly Hospital Initiative (BFHI) is a global strategy that promotes and fosters breastfeeding, and BFHI designated hospitals implement the Ten steps to successful breastfeeding.⁸⁵ Studies demonstrate that exclusive breastfeeding initiation and duration increase when infants are born in Baby-Friendly hospitals.^{86,87} Over the past decade, there has been a tenfold increase from 60 to 600 BFHI designated hospitals in the US.⁸⁸ However, only about 28% of births in the US in 2019 occurred in these BFHI facilities.⁸⁸ Facilities in zip codes with more black residents are less likely to implement the ten steps to successful breastfeeding than hospitals in zip codes with fewer black residents.⁸⁹

The WHO International Code of Marketing of Breast-milk Substitutes (1981) stipulates that manufacturer should not market substitutes in ways that interfere with breastfeeding. However, the United States was the only nation to vote against the adoption of the Code in 1981.^{86,90} Formula manufacturers in the USA seek to create partnerships and brand loyalty with hospitals by providing free formula for use in the hospital, support for fellowships and conferences,

and funds to support supplies.⁹¹ This negates the WHO International Code of Marketing of Breast-milk Substitutes and the principles of BFHI. There is a negative relationship between receiving commercial hospital discharge packs and breastfeeding duration and exclusivity.⁹¹

Some government policies, such as the distribution of free formula to new mothers through the United States Department of Agriculture's (USDA) Special Assistance to Women and Children (WIC) program, in which Black women participate disproportionately, continues to widen the racial disparity in breastfeeding.⁷⁰ A cross-sectional survey of a nationally representative sample of mothers found that Black mothers were more likely to report having received formula-feeding advice from physicians and WIC counselors than their white counterparts.⁹² Also, the Community and Child Health Network study results show that Black mothers were nine times more likely to be given formula in the hospital than white mothers.⁹³

1.4.3 Organizational level

Organizations such as La Leche League International (LLLI), the African-American Breastfeeding Alliance (AABA), and infant formula manufacturers can have a robust macro-level influence on breastfeeding.⁹⁴ However, many Black women live in areas that lack support for breastfeeding women. Andrea Freeman refers to these areas as the "first food deserts" because they lack weekly support groups, breastfeeding cafes, strong La Leche chapters, board-certified lactation consultants, or community support for public breastfeeding among Black mothers.⁹⁵ Hospital practices such as rooming-in promote breastfeeding, whereas the provision of free infant formula discourages breastfeeding.⁹⁶ Black mothers occasionally receive suboptimal or no lactation support from institutions such as hospitals, schools, workplaces.⁹⁷ Patient profiling, experienced by some Black mothers, has been shown to affect breastfeeding choices.⁹⁸ Lactation

problems such as sore nipples, engorged breasts, and mastitis often prevent women from breastfeeding, especially when they do not receive early professional support from an expert.⁹⁹ The US surgeon general's report in 2011 identified increasing access to Lactation consultants as an action step to support breastfeeding, yet Black Lactation consultants consistently face barriers to getting certified and employed.⁹⁹ Black mothers are less likely to receive breastfeeding instruction and support from healthcare professionals while in the hospital and WIC nutrition counselors.^{92,98,100} Maternal perceptions of negative attitudes of hospital staff are predictive of breastfeeding failure at six weeks postpartum.¹⁰¹

Black women are less likely to receive breastfeeding support from their workplace due to the type of jobs they did. The patient protection and Affordable Care Act (ACA) of 2010 require employers to provide break time and a private location to breastfeed, yet many employers fail to comply with this policy.¹⁰² This is common in low-wage jobs, of which a disproportionate number of workers are Black women.^{102,103} Most working women breastfeeding their babies have no access to a private place to pump milk, a refrigerator to store milk or breastfeeding breaks for nursing a nearby infant.¹⁰⁴ Many return to non-flexible work conditions with no accommodations for breastfeeding, eight weeks postpartum.^{99,105} This is usually earlier than when mothers of other racial groups return to work and can probably lead to early breastfeeding discontinuation.¹⁰⁵ A recent study estimated the associations of neighborhood disadvantage and neighborhood affluence with breastfeeding practices at hospital discharge, by race-ethnicity.¹⁰⁶ Results show that neighborhood disadvantage decreases the odds of exclusive breastfeeding among nonwhite women.¹⁰⁶

1.4.4 Community level

Community-based breastfeeding resources, including peer counselors, lactation consultants, home visit personnel, and women in the community, have been identified as social influences affecting Black women's decision to breastfeed.^{72,107} Local support groups such as Black mothers breastfeeding circle provide emotional support and information on breastfeeding. This local lactation support group augments peer support from other social networks and improves self-efficacy among Black mothers.⁶¹ Negative perceptions of breastfeeding in the African American community deter mothers living in these communities from breastfeeding.⁴¹ Griswold and colleagues postulated an association between living in a predominantly Black neighborhood as a child and decreased breastfeeding initiation and duration.⁷⁷

1.5 Interpersonal level

Social support plays a significant role in the continuation or early cessation of breastfeeding because a woman's decision to breastfeed or not may arise from their interaction with or reliance on members of her formal or informal social network.^{108 109} Mothers tend to initiate breastfeeding and continue breastfeeding when adequate and appropriate social support is available.^{64,108} Among Black mothers, members of their social network play an important role in shaping their breastfeeding decisions.¹¹⁰ A study of first-time African American mothers demonstrated that fathers, grandmothers, church members, and healthcare professionals are an integral part of the social network that influences a mother's decision to initiate and continue breastfeeding.^{72,108} Researchers posit that a Black mother is likely to breastfeed if she has a close relative or family

friend who also breastfed a baby.^{111,112} Also, spousal support is a significant predictor of both initiating breastfeeding and continuing breastfeeding once initiated.¹¹³

Some other important factors contributing to breastfeeding success among Black mothers are family opinions, values, and beliefs about breastmilk.⁷² Black mothers from families with a history of breastfeeding were more likely to breastfeed than mothers who did not see any close relative breastfeed.¹¹⁴ The opinions of grandmothers and fathers are predictors of maternal intention to breastfeed.⁹⁴ Therefore, fathers, especially romantically involved partners, have a significant influence on breastfeeding success and maintenance.^{94,115} Despite the apparent benefits of social support in promoting positive breastfeeding behavior¹¹⁶, African American mothers are less likely than other women to have this need met.⁶¹

In the American culture today, the sexualization of the female breast rivals, and in some cases, surpasses its biological significance.¹¹⁵ In a qualitative study of the African American population in Tennessee, the women were vivid with negative stories and comments they received from the fathers of their babies or other men about breastfeeding.¹¹⁷ As long as breasts are seen as solely sexual objects by partners, a mother's decision to breastfeed may be unsuccessful.¹¹⁷

1.5.1 Individual level

Maternal characteristics such as age, race/ethnicity, education, employment, socioeconomic status, marital status, maternal perceptions of Insufficient milk supply, parity, beliefs, and attitudes have been widely reported as essential factors in breastfeeding.^{61,94,118} In the US, Black mothers continue to have the lowest BF initiation, exclusive breastfeeding (EBF) rate at six months, and the rate at 12 months compared with mothers of other races and ethnicities.^{97,109,119} Higher breastfeeding rates have been positively associated with increasing

income levels .⁶⁴ Black mothers with high incomes were more likely to breastfeed than those with low incomes. However, Black mothers were less likely to breastfeed than other racial counterparts, regardless of socioeconomic status.⁶⁴ Many Black women in the United States were aware that breastfeeding is the best nutrition source for most infants.⁹⁹ Still, they seemed to lack knowledge about its specific benefits and cannot cite the risks associated with not breastfeeding.⁹⁹

The literature has highlighted numerous factors that act as barriers to breastfeeding; unfortunately, Black women are more likely to experience or be exposed to these breastfeeding obstacles. Chronic illness, stress, depression contribute to lower breastfeeding rates in the United States.^{120 121,122} Black women experience these factors more often than any other race.¹²²⁻¹²⁴ The effects of negative life experiences and events can also play a part in the differences in postpartum care practices like breastfeeding among low-income Black/African American women.^{61,125} Health behaviors such as smoking and overnutrition, predominantly seen among Black women, are associated with low EBF rates.¹²⁶ Other deterrents to breastfeeding among Black mothers include the history of sexual abuse and substance abuse, use of prescription medications, fear of pain, and not trusting one's body to make enough milk.¹²⁷

The above multilevel factors influence African American women's breastfeeding choice, including social, cultural, and historical factors. The strength of the Social-Ecological Model goes beyond diagnosing a problem or barrier; SEM helps “*to inform the development of comprehensive intervention approaches that can systematically target mechanisms of change at several levels of influence.*”¹²⁸

1.6 Theories, framework, models, and conceptual framework

This section will consider some theories and models such as the Stress Theory (in particular, the Minority Stress Theory), Critical Race Theory, and Life Course Theory. These theories consider the substantial role of structural inequities and do not promote an "individual responsibility" model of health behavior change. The above-listed theories and models will guide the conceptual framework design that will explain why racial breastfeeding disparity exists in the US.

1.6.1 Minority stress theory

According to Hans Selye, stress is the body's non-specific response to any demand. In behavioral sciences, he defines stress as the “perception of threat, with resulting anxiety, discomfort, emotional tension, and difficulty in adjustment.”¹²⁹ Over time, researchers have conceptualized the relationship of stress to health.¹³⁰ Stress affects health through two pathways; first, it can influence the psychophysiological mechanisms implicated in pathology and host vulnerability, reducing resistance to pathogens or directly stimulating disease mechanisms.¹³¹ Second, life stress may alter patterns of health-related behaviors such as smoking, alcohol consumption, physical activity, sexual practices, and food choice, which have direct effects on health risk.¹³¹

Meyer defined minority stress as the additional stress members of marginalized social groups experience because of their minority status and disconnection with the dominant social environments and values of predominant racial groups.¹³² Members of racial minority groups are at a heightened risk for adverse health, including mental health outcomes, because of stress caused

by marginalization.¹³² Poor physical and psychological well-being, including chronic stress among Blacks in the United States, are due to persistent racism, prejudice, stigmatization, and perceived discrimination at the workplace, gender discrimination, and sexual orientation.^{122,133,134 132,135,136} Minority stress theory argues that the oppressed communities experience more adverse health outcomes than majority group communities, leading to significant health disparities.¹³⁶ Research supports the theory of minority stress by demonstrating the relationship between perceived racial discrimination and increased risk of preterm delivery and low birth weight, often mediated by stress.^{133,137,138} African American women are more susceptible to perinatal stress due to the high allostatic load their bodies have accumulated over time from stressful life events resulting in worse health outcomes or status.¹²¹ Among African American women, even when measured in various ways, stress remains associated with an increased risk of preterm birth after controlling for known risk factors.^{139,140} Stress is also linked to unhealthy behaviors, such as smoking, substance use, sleep problems, and eating disorders.^{141,142} Studies illustrating the relationship between stressful life events and breastfeeding outcomes are limited. Also, when stressful life events are measured, they are typically used as confounders and not as the primary exposure.¹⁴³ The minority stress theory provides a useful framework to explain and examine racial disparity in breastfeeding rates.

1.6.2 Critical Race Theory

Researchers can explore racial disparity in breastfeeding rates using the Critical Race Theory (CRT) lens. Critical Race Theory clarifies contemporary racial phenomena, expands the vocabulary to discuss complex racial concepts, and challenges racial hierarchies¹⁴⁴ It has its foundations in legal scholarship; Richard Delgado and Jean Stefancic developed this theory

between the 1970s and 1980s as the civil rights era's advances were rapidly reversing.¹⁴⁵ The CRT's background in jurisprudence scholarship limits its use in Public Health.

On this premise, Ford and Arihenbuwa developed the Public Health Critical Race (PHCR) praxis, which provides steps for approaching health disparities research to allow for the uncovering and disrupting of the processes of systemic racism.¹⁴⁶ PHCRP, therefore, applies CRT concepts and methods to studies of racial/ethnic disparities and allows researchers who focus on racial inequality to pay attention to upholding social justice while conducting research, learning, and practice.¹⁴⁴ As a framework, PHCRP can be used to examine the causes of racial/ethnic patterns of health, disease and the deconstruction of ways in which racism affect minority health.¹⁴⁴

Applying CRT principles, PHCRP has three functional components: its race-conscious orientation to research, four major focus areas, and CRT-derived lexicon.¹⁴⁷

Race-Conscious Orientation to Research: The PHCRP posits that every research and study, whether focused on racism or not, should occur within a racial context. To do this, researchers will need to explain how aspects of the racial context may influence the immediate study and refine the study based on what is learned.

PHCRP focuses on four areas, namely, contemporary race relations (Focus 1), knowledge production (Focus 2), conceptualization and measurement (Focus 3), and action (Focus 4).¹⁴⁷ Each focus targets a major sphere of influence through which racism can unknowingly influence a study.

Focus 1 (contemporary race relations): Under this focus, researchers need to clarify how racism is relevant in the study's time period and account for this in the conceptual model.¹⁴⁷ In Focus 2 (knowledge production), researchers should identify specific implications the knowledge produced by their study has for the subject or field of study. By doing this, they may challenge the initial understanding of the subject.¹⁴⁷ In Focus 3 (conceptualization and measurement),

researchers should build on the information gained while working in Focuses 1 and 2 to operationalize the study's racism-related and non-racial (e.g., health outcomes) variables.¹⁴⁷ Focus 4 emphasizes action, which supports the notion that the findings should go beyond providing research information to bridging the gap between professional researchers and the racialized health disparity populations under study.¹⁴⁷

A vital strength of the PHCRP framework is that it focuses on institutional factors that perpetuate health disparity rather than individual-level factors. Hence, PHCRP can provide the tools for examining the breastfeeding racial disparity that has persisted over the years in the US, considering the history of slavery and systemic racism and its effects.

1.6.3 Social support Theory

Social relationships, including social networks, social integration, and social interactions, influence mental health,¹⁴⁸ health behavior, physical health, and mortality risk.^{149,150 151} The quality and quantity of these social relationships matter.¹⁵¹ Individuals live within webs of social ties, often referred to as social networks, and characteristics of an individual's social network may help individuals maintain strong social relationships as they progress through the life course.¹⁵² Hence, social networks provide a context in which individuals interact with each other, leading to perceptions of being socially connected.¹⁵²

Social relationships can be measured in various ways. In most cases, they are measured as the degree of integration in social networks, the social interactions that are intended to be supportive (received social support), and the perceptions of available support (perceived social support).¹⁵¹ Social integration reflects individuals' embeddedness (or involvement) in various social ties or relationships, social roles, and social activities.^{153,154} It is rooted in Durkheim's

seminal work, indicating that suicide was most prevalent among the unmarried and those who lacked close ties in the community and church.¹⁵⁵ Durkheim argued that social integration could protect people from committing suicide through social attachment, social control, and social support.¹⁵⁵ According to Thoits, social integration often leads to social support, thereby protecting the person against the uncertainty and despair that may lead to disordered functioning.¹⁵⁶ Social Integration represents a crucial structural aspect of the social network perspective and determines other network-based factors, particularly social support.^{151,154,157}

While social integration represents the structural aspects of social relationships, social support represents social relationships' functional aspects.¹⁵¹ According to Cobb, one of the social support theory originators, social support is *defined as information leading the subject to believe that he is cared for and loved, esteemed, and a member of a network of mutual obligations.*¹⁵⁸ Social support is said to have a resistance factor that reduces "breakdown" and enhances coping throughout the life cycle.¹⁵⁹ The stress and coping perspective propose that support contributes to health by protecting people from adverse effects of stress.¹⁶⁰ Some researchers have demonstrated the relationship between social support and well-being using either the main-effect or buffering models.¹⁶¹ The main-effect model claims that social support produces a direct and beneficial effect on well-being independent of stressors. In comparison, the buffering model asserts that social support protects individuals by buffering the adverse effects of stressors.¹⁶¹ In addition, social support is more salutogenic (health-promoting) for individuals with lower income than those with higher income.¹⁶²

Barrera organized social support concepts and their operationalizations into three broad categories: social embeddedness, perceived social support, and enacted support.¹⁶³ Social embeddedness concept in social support refers to individuals' connections to significant others in

their social environments.¹⁶⁴ The assumption is that social connections ensure that support is being provided.¹⁶³ Perceived social support also illustrates social support as the cognitive appraisal of being reliably connected to others.¹⁶³ To measure perceived social support, researchers incorporate two dimensions: perceived availability and adequacy of supportive ties. These dimensions attempt to capture individuals' confidence that adequate support would be available if needed or characterize an environment as helpful or cohesive.^{163,165} The third social support concept, enacted support, refers to the social support mobilized or received during stressful events.¹⁶⁶ It promotes effective coping when it matches the demands of the stressor.¹⁶⁶

The availability and quality of social relationships may buffer the impact of exposure to life stress.^{158,167} This implies that the effect of stress may be more significant among those who lack social ties compared to those who have supportive relationships with others. During pregnancy, stressful life events negatively affect maternal and infant outcomes, including breastfeeding initiation.¹⁶⁸ Social support in the form of emotional (involves love, trust, caring, and concern), instrumental (money, time, or help), appraisal (affirmation and feedback), and informational support (advice, suggestions, and information) from both informal (male partner, mother, family/friends) and formal social network members (health care professionals, lactation consultants) can influence breastfeeding behavior by mitigating stressors that can prevent mothers from breastfeeding.¹⁰⁸

1.6.4 Life Course Theory

The Life Course Theory (LCT) is a conceptual framework that helps explain health and disease patterns, especially health disparities across populations and over time (see Figure 2).¹⁶⁹ In the Life Course Theory, health is considered an integrated continuum from infancy, childhood,

adolescence, child-bearing years to old age, and not as disconnected stages that are unrelated to each other.¹⁷⁰ LCT demonstrates a complex interplay of biological, behavioral, psychological, social, and environmental factors that contribute to health outcomes across the course of a person's life.¹⁷¹ LCT corroborates social science and public health literature that suggests that each life phase influences the next and that the environment present at conception, during fetal development, in the first few years of life and the cumulative life experiences can either improve or impair the health of an individual and the community at large.^{170,171}

Elder and colleagues proposed at least five defining principles that guide researchers using the Life Course Theory. The first is the principle of life span development, which asserts that health is a lifelong process that can only be fully understood within the context of experiences across a person's lifespan.^{172,173} Second is timing, and this suggests that one's health is shaped not only by the exposures they receive but also by when they are exposed, the duration and sequencing of such exposures.¹⁷¹⁻¹⁷³ Third is human agency that emphasizes personal control & behavior in health & illness.¹⁷¹⁻¹⁷³ Fourth is linked lives, which posits the notion of interdependent lives, and the fifth is historical time and place, which highlights how period, cohort, and contextual factors influence the life course.¹⁷⁰⁻¹⁷²

Life Course Theory is widely used by public health researchers, including maternal and child health researchers, to examine why health disparities persist across population groups, even in instances where there has been significant improvement in incidence, prevalence, and mortality rates for a specific disease or condition across all groups.^{169,170} Additionally, MCH scholars use the Life Course Theory to study the factors that influence individuals or populations' capacity to reach their full potential for health and well-being.¹⁶⁹ Building on the five principles discussed

above, MCH researchers use the following key concepts in LCT to examine persistent health disparities and factors that influence mothers and children's well-being.

- **Pathways or Trajectories:** Health pathways or trajectories can be built or diminished over the lifespan. Also, individual trajectories can be predicted for populations and communities based on social, economic, and environmental exposures and experiences.¹⁶⁹⁻¹⁷¹
- **Early Programming:** Early experiences can determine or program an individual's future health and development.¹⁶⁹⁻¹⁷¹
- **Critical or Sensitive Periods:** Adverse events and exposures can affect any point in a person's life course; however, the effect is most significant at specific critical or sensitive periods of development.¹⁶⁹⁻¹⁷¹ The sensitive period can be referred to as a period during which a developmental process is occurring, or a developmental milestone is typically reached.¹⁷⁴
- **Cumulative Impact:** Cumulative impact can be referred to as "weathering" or "allostatic load." Lu and Halfon posit that cumulative experiences can determine "program" an individual's future health and development. Also, the cumulative impact of multiple stresses over time may significantly affect health and development directly and indirectly via associated behavioral or health service seeking changes.¹⁶⁹⁻¹⁷¹
- **Risk and Protective Factors** – Throughout the lifespan, protective factors improve health and contribute to healthy development. In contrast, risk factors diminish health and make it more difficult to reach full developmental potential. Furthermore, risk and protective factors are not limited to individual behavioral patterns or receipt of medical care and

social services but also include family, neighborhood, community, and social policy factors.¹⁶⁹⁻¹⁷¹

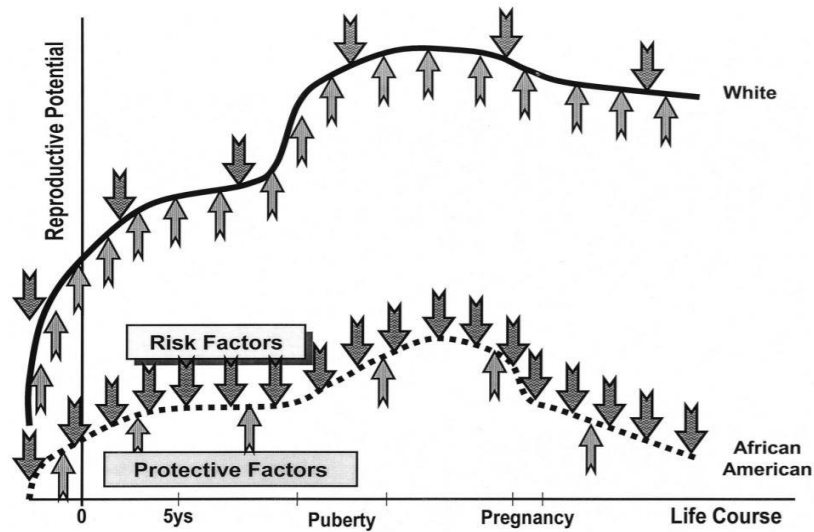


Figure 2: Racial and ethnic disparities in birth outcomes-a life course perspective¹⁷⁰

1.7 Conceptual Framework

In this section, I will describe the conceptual framework that will guide my research. The conceptual framework was derived from the Public Health Critical Race (PHCR) praxis, Life Course Theory, Social Support Theory, and Minority Stress Theory.

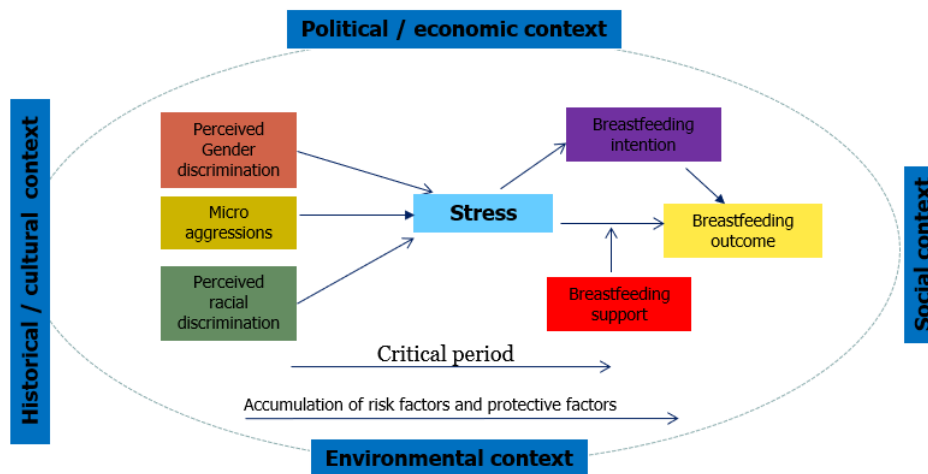


Figure 3: Conceptual Framework for research study

The research will be guided using the lens of the Critical Race Theory. While CRT refers to the social science approach to study race and racism in the society, PHCRP uses CRT concepts and methods for racial/ethnic health equity research. Following Borrell's recommendations on how to apply CRT in research using the four major focus areas of the PHCRP, I will use these four focus areas as a guide in this ethnic equity research.¹⁷⁵

Using the four major focus areas, first, I will link the low breastfeeding rate observed among Black and African Americans to the embodiment of the psychosocial stress associated with the racism they have and continued to experience (Focus 1: Contemporary race relations). Second, this research would challenge any biases around biological or genetic factors associated with the findings (Focus 2: Knowledge Production). Third, the findings would be explained in the context of the multidimensional social construction of race and the history of oppression for African

Americans (Focus 3: Conceptualization and Measurements). Fourth, rather than using the findings to state the well-known and established disparities, I would use them to call attention to interpersonal and structural racism Blacks/African Americans face day in and day out, which could inform interventions to increase breastfeeding rates among Blacks in the United States. (Focus 4: Action).

The Life Course Theory asserts that disparities in health outcomes, and the psychosocial factors contributing to them are present early in life and are expressed and compounded during a person's lifetime¹⁷¹ Unlike most theories, LCT presupposes that an individual is not only the product of her surroundings and her unique social address, but she is embedded in a system of contexts, including her personal history.¹⁷⁶ The conceptual framework above suggests that ecological levels and contexts such as historical, cultural, environment, policy, social, and economic contexts in which a mother is embedded influence her infant feeding decision and practice. This implies that breastfeeding initiation and exclusive breastfeeding are not done in a vacuum but within a context. These contextual factors determine the risk and protective factors women are exposed to throughout their lives, especially during the critical period of preconception to postpartum (See Figure 2).

The framework considers how risk factors, protective factors, and early-life experiences can influence a person's breastfeeding behavior. Research suggests that several risks and protective factors accumulate in one's lifetime and during those of previous generations can influence breastfeeding behavior.^{177,178,65,78,81} I will examine how stress mediates the relationship between racial discrimination, gender discrimination microaggression, and breastfeeding behavior. Black women frequently cite stressful life events and risk factors that act as a deterrent

to breastfeeding.^{177,178} Similarly, I will examine how protective factors like social support can moderate stress on breastfeeding behavior.

2.0 Conclusion

There is a glaring racial inequity in breastfeeding rates in the United States. Despite an improvement in breastfeeding rates in the US, disparities in breastfeeding rates between Black and White mothers remain substantial. The reasons for these continued breastfeeding disparities are unclear; however, what is known is that the disparities reflect a pattern of unfavorable health differences for Black women compared with other groups, on outcomes for which breastfeeding may provide protection. Given the overwhelming evidence that breastfeeding gives children an early advantage and, for child-bearing people, improved health in current and subsequent life stages, it is crucial to examine how psychosocial factors contribute to this disparity.

Perceived stress is a psychosocial factor associated with adverse perinatal outcomes such as gestational diabetes, low birth weight and preterm birth, behavior problems for the infant later in life, and maternal depression. However, there is little information on how perceived stress among women who experienced racial and gender discrimination and microaggression influences breastfeeding behavior. Most studies examining stress and breastfeeding explore the relationship between stressful life events and breastfeeding, not the role stress plays among women Black women at the risk of heightened discrimination. Stress may be exacerbated by racial and gender discrimination and microaggression and maybe buffered by social support. Guided by the Life Course Theory, Minority Stress theory, and Social Support theory, I will explore the role these psychosocial factors play in the relationship between perceived stress and breastfeeding. Perceived stress, discrimination, social support, and breastfeeding will be measured using Ecological Momentary Assessment and Mobile technology, a novel and rigorous approach that calls for daily participation over an average of 15 months per woman.

Breastfeeding is a critical opportunity for health equity since early initiation, and continued breastfeeding can play an important part in decreasing health disparities among Black mothers. This study will provide evidence that would inform tailored breastfeeding promotion programs. With increased information on breastfeeding's health, developmental, and economic benefits, it is essential to close the breastfeeding racial gap. Interventions that aim to close the racial disparity in breastfeeding are limited and understanding the role stress plays in breastfeeding will help develop or refine interventions that could remove the stressors deterring Black people from breastfeeding.

3.0 Methods

This dissertation includes 3 distinct manuscripts. The three manuscripts are presented within the results section. The first manuscript assesses the magnitude of differences in exclusive breastfeeding rates between the 24-hour recall/current status and since-birth methods using a single data set from an intensive longitudinal study conducted in Allegheny County, Pennsylvania. The second manuscript examines the relationship between perceived stress and exclusive breastfeeding and the moderating effects of perceived and received social support on this relationship. The third manuscript examines the direct and indirect effects of various forms of discrimination- racial discrimination, gender discrimination, and microaggressions on exclusive breastfeeding.

3.1 Research Aims and Hypotheses

Aim 1: To assess the magnitude of differences in exclusive breastfeeding rates between the 24-hour recall/current status and since-birth methods.

Hypothesis 1.1: 24-Hour recall or current status method of estimating exclusive breastfeeding will overestimate the exclusive breastfeeding rates compared since- birth method.

Aim 2: To measure the extent stress and various forms of social support influence exclusive breastfeeding

Hypothesis 2.1: Child-bearing people who experienced stress are less likely to breastfeed exclusively.

Hypothesis 2.2: Child-bearing people who reported having less social support are less likely to breastfeed exclusively.

Hypothesis 2.3: Black child-bearing people who experienced high stress are less likely exclusively breastfeed than White participants who experienced high stress.

Aim 3: To estimate the direct, indirect, and total effects of discrimination on exclusive breastfeeding

Aim 3.1: Direct effects

Hypothesis 3.1.1: Black child-bearing people who experienced racial discrimination are less likely to exclusively breastfeed.

Hypothesis 3.1.2: Black child-bearing people who experienced microaggressions are less likely to exclusively breastfeed.

Hypothesis 3.1.3: Child-bearing people who experienced gendered discrimination are less likely to exclusively breastfeed.

Aim 3.2: Indirect effects (Mediation effects)

Hypothesis 3.2.1: Perceived stress will mediate the relationship between racial discrimination and exclusive breastfeeding among Black child-bearing people.

Hypothesis 3.2.2: Perceived stress will mediate the relationship between gender discrimination and exclusive breastfeeding among Black child-bearing people.

Hypothesis 3.2.3: Perceived stress will mediate the relationship between microaggressions and exclusive breastfeeding among Black child-bearing people.

3.2 Design

I used data from a National Heart, Lung, and Blood Institute (NHLBI) funded study (Postpartum Mobile Mothers Study -PMOMS). PMOMS recruited birthing people from the Comparison of Two Screening Strategies for Gestational Diabetes (GDM²) Trial conducted at a maternity hospital in Pittsburgh, PA.^{179,180} The PMOMS is a longitudinal study designed to understand the contextual, behavioral, psychosocial, and clinical factors related to racial disparities in postpartum weight and cardiometabolic health using the Ecological Momentary Assessment (EMA).^{179,180}

3.2.1 Recruitment

Postpartum Mothers Mobile Study (PMOMS) recruited participants from a parent study: the Comparison of Two Screening Strategies for Gestational Diabetes (GDM²) Trial conducted at a maternity hospital in Pittsburgh, PA.¹⁸¹ The GDM² study began recruitment in 2015 and required two study visits for each eligible and enrolled participant.¹⁸² PMOMS team used these two study visits to recruit eligible individuals for the PMOMS and began recruitment in December 2017.^{179,180} Eligible individuals were of any race, between 18 and 28 weeks gestation and between 18 and 45 years old and without a history of related comorbidities or risk factors (e.g., multiple gestation and hypertension requiring medication).^{179,180} At the GDM² first visit, PMOMS team recruited and obtained consent if the eligible participant agreed to be part of the study.¹⁷⁹ If a participant was not recruited during the first visit, the team approached the participant again during the second visit.¹⁷⁹ The second visit was also used for technology set up for study participants.

3.2.2 Data Collection

Ecological Momentary Assessment (EMA) via mobile device/smartphone was the primary data collection method for PMOMS.¹⁷⁹ EMA data collection occurs in real time and participants complete surveys capturing momentary states, behavior and conditions multiple times or as repeated measures.^{183,184} EMA as a data collection method minimizes recall bias which is common in most retrospective studies.¹⁸³

Researchers have used EMA across diverse research topics and population.¹⁸⁵⁻¹⁸⁹ With the widespread availability of mobile devices and over 60% of adults owning a smartphone, EMA has become more common in collecting data and measuring behavior and people's experiences in their natural environments.^{188,190} Studies that utilized EMA as a data collection method have demonstrated high satisfaction among participants and have high completion or compliance rates of between 80% to 89%.^{186,189,191} A recent study demonstrated the feasibility of EMA as an alternate method to track breastfeeding behavior with 38% completion rate and a partial completion rate of 24%.¹⁹²

The PMOMS used this novel and rigorous approach that reduces recall bias to assess breastfeeding practices, stress, and perceived discrimination, including daily racism and sexism experiences, by providing insight into participants' experiences in real-time that may not be captured with other methods.¹⁸⁰

According to the PMOMS protocol, PMOMS administered surveys to participants using two EMA data collection types: signal-contingent and time-contingent prompts.¹⁷⁹ *Signal-contingent responses*, also known as random, were prompted according to a random sampling design to obtain a representative sample of the study participants.¹⁷⁹ *Contingent responses* were prompted at fixed times during the day; they are described either as the beginning of day (BOD)

or end of day (EOD) prompts.¹⁷⁹ Time-contingent prompts were programmed according to participant preference in the PMOMS, with the only requirement being that the BOD prompt occurs at least 9 hours before the EOD prompt.¹⁷⁹

All women recruited into PMOMS are followed through 12 months postpartum. The follow-up measures include telephone-administered surveys completed at 3, 6, and 9 months postpartum and the 12-month postpartum follow-up visit at the clinic.¹⁷⁹

The Human Research Protection Office at the University of Pittsburgh approved the PMOMS study protocol in October 2017 under #PRO16100117. Protocol and Methods have been previously published.¹⁷⁹

3.3 Analysis

3.3.1 Analytic sample

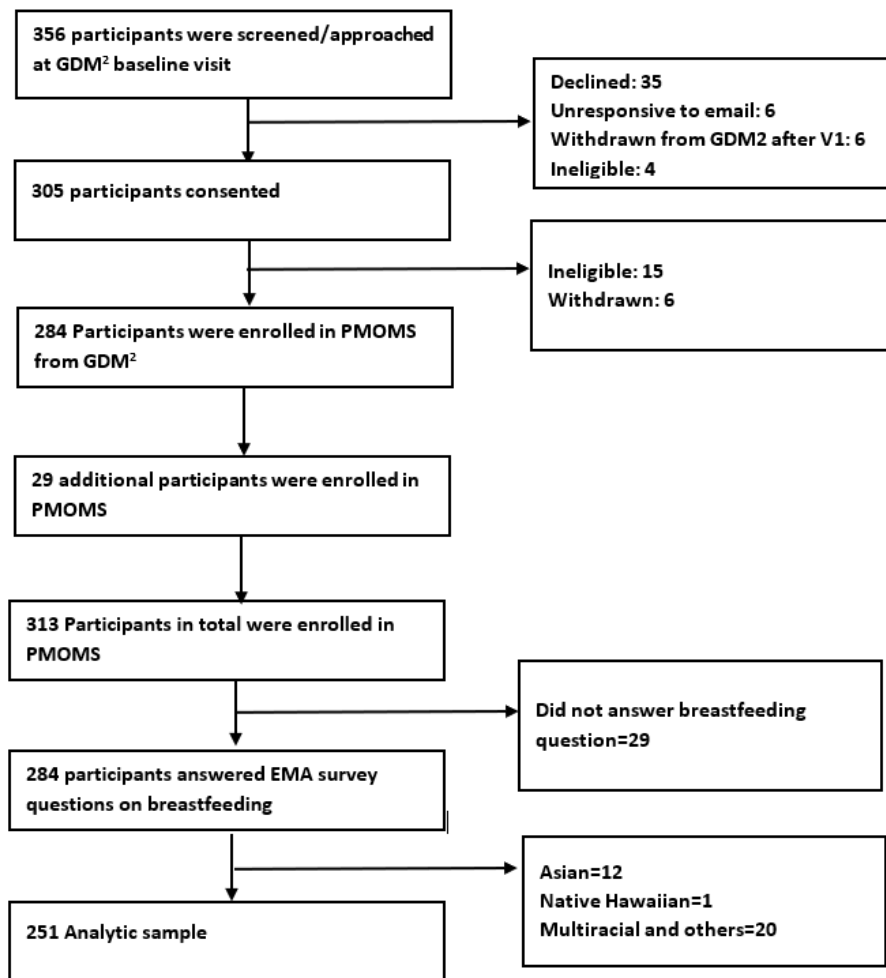


Figure 4: Analytic Sample

The overall PMOMS population included 313 participants. Of these, 284 answered EMA survey questions on breastfeeding. Since our primary aim was to compare psychosocial factors that influence exclusive breastfeeding between White and Black participants, we excluded participants that identified as Asian (n=12), Native Hawaiian (n=1) or multiracial and others

(n=20); this resulted in 78 Blacks and 173 Whites and a total of 251 participants in the final analytic sample.

3.3.2 Manuscript 1 Analysis

Manuscript 1 aims to assess the magnitude of differences in exclusive breastfeeding rates between the 24-hour recall/current status and since-birth methods. The magnitude of differences between the 24-hour recall and the since birth measures of exclusive breastfeeding rates assessed the same day were compared. I conducted a two-sample test of proportions and set the level of statistical significance at 5%. Using the Royston's ptrend and the Cochran–Armitage test¹⁹³, trend analyses were performed for 24-hour recall and since birth method to determine the presence of a temporal trend and the magnitude of any such trend. All statistical analyses were conducted by using STATA/S.E 16.0.¹⁹⁴

3.3.3 Manuscript 2 Analysis

Manuscript 2 aims to examine the relationship between perceived stress and exclusive breastfeeding and the moderating effects of perceived and received social support on this relationship. I hypothesized that childbearing people who reported perceived stress would less likely breastfeed exclusively. For those who reported perceived stress, perceived and received social support will moderate the relationship between stress and exclusive breastfeeding. I also hypothesized that Black birthing people who reported stress will exclusively breastfeed less than their White counterparts.

I conducted a descriptive analysis of the demographic characteristics of participants and generated individual panel plots for repeated measures of exclusive breastfeeding and perceived stress. To establish the relationship between exclusive breastfeeding (a dichotomous variable), perceived stress, and social support, I conducted a mixed-effects logistic regression model with random intercepts and unstructured covariance matrices to address clustering of individual responses (panel-data regression).

I tested the moderation effect of the two forms of social support that is perceived and received social support on perceived stress. The interaction term between perceived social support and perceived stress was included in Model 1, while model 2 has an interaction term between received social support and perceived stress. I graphically illustrated the interaction between perceived stress and the two forms of social support using the `marginplot` command in STATA. The goodness of fit was ascertained using log-likelihood, Bayesian Information Criterion (BIC), and Akaike's Information Criterion (AIC). STATA/S.E 16.0 was used to conduct all statistical analyses.¹⁹⁴

3.3.4 Manuscript 3 Analysis

Manuscript 3 examines the direct and indirect effects of various forms of discrimination-racial discrimination, gender discrimination, and microaggressions on exclusive breastfeeding using a longitudinal data from an Ecological Momentary Assessment. I hypothesized that Black childbearing people who experienced racial discrimination, gender discrimination, and microaggressions would less likely exclusively breastfeed. I also hypothesized that perceived stress would mediate the relationship between these forms of discrimination and exclusive breastfeeding.

Descriptive statistics were computed to understand the sample characteristics and the differences across race categories. Generalized structural equation modeling (GSEM) was used to test the hypothesized pathway of influence through which racial discrimination, gender discrimination, and microaggression would affect exclusive breastfeeding directly or indirectly through perceived stress.

I fitted a full model that estimated the path coefficients (β) of the direct and indirect effects. The direct effects estimated the associations between the different forms of discrimination and exclusive breastfeeding without the contribution of intermediate variables, and the indirect effects estimated the associations between the various forms of discrimination and exclusive breastfeeding through perceived stress. Based on previous exploratory analysis, I assumed that the relationship between race and discrimination also depends on some socio-demographic factors; as such, I included interaction terms between race and employment and race and education. In addition, this model included person-specific random intercepts, which account for unobserved, between-person heterogeneity, a key confounder in longitudinal data.

A re-specified parsimonious model was fitted by retaining the complete paths with direct and indirect effects that have statistical significance $\alpha \leq 5\%$. The indirect effect was estimated as the product of the contributing coefficients in that pathway, and the total effects were calculated by summing the effects of direct and indirect effects. The “gsem” command in STATA was used to fit the generalized structural equation model. STATA/S.E 16.0 was used to conduct all statistical analyses.¹⁹⁴

4.0 Results

4.1 Manuscript 1: The ambiguity of interpretation: comparative assessment of exclusive breastfeeding rates from 24-hour recall and since birth methods

4.1.1 Background

Disparate definitions of exclusive breastfeeding (EBF) and how its duration is measured exist among breastfeeding researchers.¹⁹⁵⁻¹⁹⁸ Yet researchers, clinicians, and policymakers need consistent and valid definitions of exclusive breastfeeding and accurate measurement of EBF duration to ensure valid, replicable, and comparable results in breastfeeding research. Over the years, there have been efforts towards achieving consistency in breastfeeding definitions. In 1990, Labbok and Krasovec, in their seminal paper, provided a definitional schema that laid the groundwork for definitions and categories used by breastfeeding and lactation researchers.¹⁹⁹

In the definitional schema that was created by Labbok and the ad hoc Interagency Group for Action on Breastfeeding (IGAB), breastfeeding was categorized as “full,” “partial,” and “token” breastfeeding.¹⁹⁹ IGAB further classified “full breastfeeding” as “exclusive” and “almost exclusive” breastfeeding, where “exclusive breastfeeding” is defined in the strictest sense- that is, no other liquids or solids are given to the infant.¹⁹⁹ The group described “almost exclusive” breastfeeding as giving vitamins, minerals, water, infrequent ritualistic feeds in addition to breastfeeding.¹⁹⁹

Subsequently, in 1991, the World Health Organization (WHO) proposed modifications to the definitions as developed by IGAB. Exclusive breastfeeding (EBF) was defined as feeding

infants only breast milk (including milk expressed or from a wet nurse).²⁰⁰ In 2008, WHO changed exclusive breastfeeding to infants receiving only breast milk, with the possible addition of oral rehydration salt drops and/or syrups that contain vitamins, minerals, and medicines.²⁰¹ The WHO and the American Academy of Pediatrics recommend exclusive breastfeeding for the first six months of the infant's life for maximal maternal and infant health benefits, followed by continued breastfeeding with complementary foods for one year or longer.^{4,200,201}

To evaluate breastfeeding patterns in infants, standardized, valid, and reliable measurements of breastfeeding practices and indicators are needed. The duration and exclusivity of breastfeeding are crucial measures of breastfeeding patterns. While the duration of breastfeeding refers to the length of time a mother breastfeeds the child, exclusivity is the measure of breastfeeding without supplementation (e.g., infant formula).⁵ Although exclusive breastfeeding remains the gold standard and is required for optimal growth in children, there is a lack of clarity on measuring and reporting of this indicator.¹⁹⁵ The ambiguity in the measurement of exclusive breastfeeding duration stems from factors related to definitions, timing, duration of recall, methods of data collection and analysis, and sample biases.¹⁹⁵

The WHO developed core indicators to measure the prevalence of EBF among children under six months. To calculate the prevalence of EBF in cross-sectional studies, WHO recommends that exclusive breastfeeding duration be measured using the 24-hour recall method, also called point-in-time or current status measurement. The 24-hour recall method is often used to compare infant feeding patterns between different countries and describe trends over time in national demographic health surveys.^{195,200} Mothers of infants less than six months of age are asked what they fed the infant the day before the survey to measure EBF.²³

Measuring exclusive breastfeeding based on a 24-hour recall may not capture the usual feeding pattern of an infant.²⁰² Several scenarios play out in real life when a parent is exclusively breastfeeding. A parent might be sick for a few days, and infant formula is introduced but exclusive breastfeeding is resumed afterward. Some children receive infant formula at the hospital and transition to exclusive breastfeeding upon getting home. A prevalent practice across several cultures is prelacteal feeding, where children receive other fluids or food before breastfeeding is initiated. With these different scenarios, asking mothers what they fed their infants the day before the survey will not provide valid exclusive breastfeeding data.

The 24-hour recall method for measuring exclusive breastfeeding rates, therefore, fails to consider that some infants who have been exclusively breastfed the day prior to the survey may have received other nutrition before then.²⁰³ Other studies have also noted this possibility of misclassification of exclusively breastfed children using the 24-hour recall method.^{204,205} Nevertheless, the 24-hour recall method is commonly used in national demographic health surveys, which are mostly cross-sectional studies. The method reduces the apparent risk of recall bias and is valuable in low-resource countries, and allows for consistency across countries or surveys using the same measure.¹⁹⁵

In contrast to the 24-hour recall or current status EBF, the duration of exclusive breastfeeding can be measured by obtaining life-long or since birth exclusive breastfeeding indicator commonly referred to as "recall since birth" or "since birth".¹⁹⁸ In this case, an infant is categorized as being exclusively breastfed if the infant has not received any food or drink other than breastmilk since birth. This method requires a more extended recall period but strictly emphasizes the WHO recommendation of exclusive breastfeeding for the first six months of life.¹⁹⁸ This is similar to how the Center for Disease Control and Prevention estimates exclusive

breastfeeding duration in the United States. The CDC calculates exclusive breastfeeding rate using two survey questions from the National Immunization Survey (NIS): the age of the child when he/she was first fed formula and the age of the child when he/she was first fed anything other than breast milk or formula (including water).⁵³ Exclusive breastfeeding duration from the NIS is based on recall of infant age at introduction of any food or beverage besides human milk²⁰⁶, which can be fraught with recall bias and less reliable.^{207,208}

In 2015, the WHO used data from the NIS to estimate U.S. progress on the Global target 2025 for exclusive breastfeeding.²⁰⁶ The Global targets monitor progress toward the targets at the national and global levels for WHO member states. Most of the member states use the 24-hour recall method to track and measure EBF prevalence. The exclusive breastfeeding duration rate obtained from the NIS data cannot be compared to WHO 24-hour recall EBF rates since the NIS data are collected among mothers of children 19 to 35 months of age²⁰⁶ and there can be possible overestimation or underestimation from the 24-hour recall method.

Within the United States, some studies report EBF with no clear explanation of the method utilized to measure exclusivity (24-hour recall or since birth method), while comparing results to CDC's breastfeeding report.^{209,210} It is imperative to show the potential difference that can arise from calculating EBF rates using the two different methods to ensure that these rates are reported appropriately, compared to similar data, and utilized efficiently for decision-making. Most studies describing the pattern of EBF or reporting EBF rates are cross-sectional surveys or longitudinal studies with long time intervals between interviews, which is subject to maternal recall bias.²¹¹ This demonstrates that the duration of exclusive breastfeeding is best measured prospectively using cohort methodology with short recall intervals that minimize recall bias.^{203,212}

Studies across different countries and regions have reported discrepancies in exclusive breastfeeding rates when results from cross-sectional surveys which use the 24-hour recall method were compared with data prospectively collected in separate studies using the since birth recall method.^{213,214} Researchers have also noted that studies comparing EBF rates using 24-hour recall and since birth with same data source is rare.²⁰⁷

The deuterium oxide dose-to-the-mother (DTM) technique is the gold standard for determining exclusive breastfeeding²¹⁵. However, it is costly, labor-intensive, and impractical in population surveys or large studies²¹⁶ hence the need for continued use of the 24-hour recall or the since birth method for determining exclusive breastfeeding. To our knowledge, there has not been any published study in the United States comparing since-birth EBF rate and 24-hour recall or current status EBF rate using the same data source and intensive longitudinal data.

Our study, therefore, aims to assess the magnitude of differences in exclusive breastfeeding rates between the 24-hour recall/current status and since-birth methods using a single data set from an intensive longitudinal study conducted in Allegheny County, Pennsylvania. Our research findings will fill important gaps in the literature and inform breastfeeding researchers and other stakeholders of the potential differences that may exist between both methods.

4.1.2 Methods

4.1.2.1 Study Design

Postpartum Mothers Mobile Study (PMOMS) is an ancillary study to the Comparison of Two Screening Strategies for Gestational Diabetes (GDM2),^{179,180,182} a randomized controlled trial conducted in a single birthing hospital in Southwestern Pennsylvania. The GDM(2) study began recruitment in 2015 and required two study visits. Beginning in December 2017 at these visits,

participants were approached, screened, and enrolled in PMOMS .^{182 179,180} PMOMS recruited 284 participants from the GDM2 clinical trial and directly recruited an additional 29 participants. The study participants were recruited between 18-28 weeks of gestation and followed to 1 year postpartum. Once participants consented to the study, they completed baseline surveys. Participants completed Ecological Momentary Assessment surveys assessing physical activities, diet, breastfeeding behaviors, stress, and other psychosocial factors for the duration of the study. Data collection for the PMOMS ended in August 2021. The Human Research Protection Office at the University of Pittsburgh approved the PMOMS study.

4.1.2.2 Data collection

EMA via mobile device/smartphone was the primary data collection method for PMOMS.¹⁷⁹ Participants used a smartphone to complete daily EMA surveys via a web-based app at the beginning of day, end of day, and random times throughout the day. Participants chose the timing of the beginning of day and end of day surveys. There were at least nine hours between these two surveys. Random EMA surveys were delivered 0-3 times per day between the beginning of day and end of day survey times, targeting a mean of one random assessment per day over a 7-day period.¹⁷⁹ Demographic data were collected at baseline in the GDM(2) study.

4.1.2.3 Measurements

4.1.2.4 Exclusive Breastfeeding Indicators

For every 42-day block, breastfeeding questions were asked in the EOD surveys on ten randomly selected weekdays and four randomly selected weekend days.¹⁷⁹ Participants were asked if they were exclusively breastfeeding or not with answer options of yes or no. The definition of

exclusive breastfeeding (*exclusive BF includes only breastmilk (including expressed/pumped milk) with the exception of medicine, vitamins, or oral rehydration*) was included in the question to ensure clarity. We calculated exclusive breastfeeding using the 24-hour recall or current status method based on participants responses on the following days: 30th (Month 1), 60th (Month 2), 90th (Month 3), 120th (Month 4), 150th (Month 5) and 180th (Month 6) day. As a result of the randomized block designs implemented in each EOD survey, some participants were not asked breastfeeding question on selected days. We imputed the nearest breastfeeding response from within seven days before the selected days. We calculated since birth EBF by reviewing each participant's entire record of the EMA breastfeeding questions up until the point of assessment (month 1 to month 6) or a "no" response (whichever came first). It is therefore assumed that a participant stops exclusive breastfeeding the first time they responded no to the exclusive breastfeeding question.

4.1.2.5 Maternal and Child Characteristics

Maternal characteristics included in the analysis were race, marital status, educational attainment, annual income, and employment. The only child characteristic included in our study was child age. Participants identified as Asian, Native Hawaiian/Other Pacific Islander, White, Black/African American, Multi-racial, and other race. In our comparison of the two methods across race, we excluded racial categories other than White or Black for this analysis due to the insufficient numbers. We operationalized marital status as single/never married and married or partnered, educational attainment as less than a college degree, and some college degree and above. Annual income was categorized as less than \$30,000, \$31,000-\$70,000 and more than \$70,000. Participants identified as working part-time, full time and unemployed. We grouped working part-time and full as employed.

4.1.2.6 Analysis

We estimated and compared the magnitude of differences between the 24-hour recall and the since birth measures of exclusive breastfeeding rates assessed same day. We reported the percentage change between the two measures across child age and maternal characteristics. We further conducted a two-sample test of proportions to determine if differences observed in the proportions were significant. The level of statistical significance was set at 5%. Using the Royston's ptrend and the Cochran–Armitage test¹⁹³, trend analyses were performed for 24-hour recall and since birth method to determine the presence of a temporal trend, and the magnitude of any such trend. The trend analysis was further stratified by race across 24-hour recall and since birth methods and slopes calculated for each race category. All statistical analyses were conducted by using STATA/S.E 16.0.¹⁹⁴

4.1.3 Results

Table 2 shows the characteristics of the respondents in the study. The mean age of the study participants was 29.9 years. Over 68% of the participants were White and 31% Black. More than half of the participants were employed (69.5%). Participants with some college education (78.2%) were more than participants with less than a college degree. Married participants comprised 58.9% of the sample.

Table 2: Characteristics of Analytic Sample

| Sociodemographic variables | N | Mean/% |
|-----------------------------------|----------|---------------|
| Maternal age in years | 285 | 29.9* |
| ^aRace | | |
| Black/African American | 78 | 31.1 |
| White | 173 | 68.9 |
| Employment status | | |
| Employed | 198 | 69.5 |
| Unemployed | 87 | 30.5 |
| Marital status | | |
| Unmarried | 117 | 41.1 |
| Married or Partnered | 168 | 58.9 |
| Income level | | |
| Less than \$30,000 | 105 | 36.8 |
| \$31,00-\$70,000 | 64 | 22.5 |
| \$71000 and above | 116 | 40.7 |
| Education level | | |
| Less than college degree | 62 | 21.8 |
| College degree or higher | 223 | 78.2 |

*Mean maternal age

^aRace: other races were excluded

Exclusive breastfeeding rates using 24-hour recall and since birth methods

The 24-hour recall EBF rates were higher than the since birth EBF rates across all ages. Table 3 shows that the 24-hour recall EBF rates were 52.2%, 50.9%, and 27.3% at 1, 3, and 6 months, respectively, while the corresponding rates for the since birth EBF at those same time points were 35.7%, 25.1%, and 10.1%, respectively. The results also indicate that the proportion of exclusively breastfed infants decreased as the age of infants increased regardless of the method used.

Absolute difference between 24-hour recall EBF and the since birth EBF rates by age

There were significant differences between the 24-hour recall and the since birth EBF rates. The difference between the two methods ranges from 16% to 26%. At 1 month, the magnitude of

difference between 24-hour recall EBF and the since birth EBF was 16.7% (95% CI: 6.2%, 27.2%) at 3 months, 21.9% (95% CI: 11.0%, 32.8%), and at 6 months, 12.7% (95% CI: 3.3%, 22.1%).

Table 3: Difference between 24-hour recall and since birth by child age

| Exclusive breastfeeding | | | | |
|-------------------------|-----------------------------------|--------------------------------|------------------------------------|---------|
| Month | 24-hour recall EBF % (95% C.I) | Since birth EBF % (95% C.I) | Percentage difference (95% C.I) | P-value |
| 1 | 52.4 (43.6, 61.2) | 35.7 (30.0, 41.4) | 16.7 (6.2, 27.2) | 0.002 |
| 2 | 52.2 (43.0, 61.4) | 30.2 (24.7, 35.7) | 22 (11.3, 32.7) | <0.001 |
| 3 | 47.1 (37.5, 56.7) | 25.1 (19.9, 30.5) | 21.9 (11.0, 32.8) | <0.001 |
| 4 | 46.4 (39.7, 59.3) | 23.8 (18.5, 29.1) | 25.7 (14.5, 36.9) | <0.001 |
| 5 | 43.7 (33.2, 54.0) | 17.4 (12.7, 22.1) | 26.2 (14.7, 37.6) | <0.001 |
| 6 | 22.8 (14.2, 31.4) | 10.1 (6.3, 13.9) | 12.7 (3.3, 22.1) | 0.003 |

Absolute difference in 24-hour recall EBF and the since birth EBF by maternal characteristics

Tables 4 and 5 show the differences between 24-hour recall EBF and since birth EBF across maternal characteristics at 3 months and 6 months. Stratified by race, the 24-hour recall EBF rate at 3 months for Black participants was 16.2%, while the rate for White participants was 63.2%. The since birth EBF rate for Blacks was 4% and that of Whites, 36.3%. Comparing the difference in rates across the two EBF estimates, the difference for Whites was 26.9% (95% CI: 15.0, 38.8, P value= <0.001) while the difference between the two estimates for Blacks was 12.2% (95% CI: 0.4, 24.8, P value=0.025). The results also show that no Black participant exclusively breastfed at 6 months using the since birth EBF method. Conversely, 7.4% of Blacks exclusively breastfed at 6 months using the 24-hour recall method.

Comparing the 24-hour recall EBF and since birth, EBF rates by household income, 77.0% of participants with a household income of \$71,000 exclusively breastfed by 24-hour recall estimate while using the since birth method, 44.2% exclusively breastfed. The difference between

the two estimates was 32.8% (95% CI: 19.3, 46.3, P-value <0.001). The 24-hour recall EBF rate among participants with a household income of less than \$30,000 was 18.9%, while the rate for since birth was 7.0%.

Using both 24-hour recall and since birth EBF methods, more college-educated participants in the study exclusively breastfed compared to non-college-educated participants. At 3 months, the difference between 24-hour recall and since birth EBF rates for college educated participants was 28.0% (95% CI: 17.4, 38.6, P-value <0.001) while at 6 months, while the difference between 24-hour recall and since birth EBF rates was 19.3% (95% CI: 10.3, 28.3, P-value <0.001).

The 24-hour recall EBF rate at 3 months for married participants was 67.7%, while the rate for unmarried participants was 22.9%. The since birth EBF rate for married participants was 36.7%, and that of unmarried, 8.6%. Comparing the difference in rates across the two EBF estimates at 3 months, the difference for married participants was 31.0% (95% CI: 19.2, 42.8, P-value<0.001) while the difference between the two estimates for unmarried was 14.5% (95% CI: 2.7, 26.3, P-value=0.009). At 6 months, the difference between the two methods of estimating EBF among married participants was 21.5% (95% CI: 10.3, 32.7, P-value<0.001).

At 3 months, the 24-hour recall EBF rate for employed participants was 59.3%, while the rate for the since birth method was 30.9%, with a significant difference of 28.4% (95% CI:17.3, 39.5, P-value<0.001). Among the unemployed, the 24-hour recall and since birth EBF rates were 28.9% and 12.4%, respectively, and the difference between the two was 16.5% (95% CI: -1.4, 31.6, P-value=0.022).

Table 4: Difference in 24-hour recall EBF and the since birth EBF by maternal characteristics at 3 months

| At 3 months | | | | |
|--------------------------|---|--|------------------------------------|---------|
| | 24 Hour recall Exclusive Breastfeeding % (95% C.I) | Since birth Exclusive Breastfeeding % (95% C.I) | Percentage difference (95% C.I) | P-value |
| Race | n=143 | n=232 | | |
| White | 63.2 (54.0, 72.4) | 36.3 (28.7, 43.8) | 26.9 (15.0, 38.8) | <0.001 |
| Black | 16.2(4.3, 28.1) | 4.0 (0.4, 8.4) | 12.2 (0.4, 24.8) | 0.025 |
| Income | n=163 | n=262 | | |
| Less than \$30,000 | 18.9 (8.4, 29.4) | 7.0 (2.0, 12.0) | 11.9 (2.3, 23.5) | 0.026 |
| \$31000-70,000 | 44.4 (28.1, 60.6) | 22.4 (11.7, 33.1) | 22.0 (2.5, 41.5) | 0.025 |
| \$71,000 or higher | 77.0 (67.4, 86.6) | 44.2 (34.6, 53.7) | 32.8 (19.3, 46.3) | <0.001 |
| Education | n=163 | n=262 | | |
| Less than college degree | 24.2 (9.5, 38.8) | 10.0 (2.4, 17.5) | 14.2 (-2.3, 30.6) | 0.066 |
| College degree or higher | 57.7 (49.2, 66.2) | 29.7 (23.4, 36.0) | 28.0 (17.4, 38.6) | <0.001 |
| Marital status | n=163 | n=262 | | |
| Single/never married | 22.9 (12.3, 33.4) | 8.4 (3.1, 13.7) | 14.5 (2.7, 26.3) | 0.009 |
| Married | 67.7 (58.6, 76.8) | 36.7 (29.1, 44.3) | 31.0 (19.2, 42.8) | <0.001 |
| Employment status | n=163 | n=262 | | |
| Working | 59.3 (50.4, 68.2) | 30.9 (24.2, 37.6) | 28.4 (17.3, 39.5) | <0.001 |
| Unemployed | 28.9 (15.7, 42.1) | 12.4 (5.2, 19.6) | 16.5 (1.4, 31.6) | 0.022 |

Table 5: Difference in 24-hour recall EBF and the since birth EBF by maternal characteristics at 6 months

| | At 6 months | | | |
|--------------------------|---|--|------------------------------------|---------|
| | 24-hour recall Exclusive Breastfeeding % (95% C.I) | Since birth Exclusive Breastfeeding % (95% C.I) | Percentage difference (95% C.I) | P-value |
| Race | n=125 | n=213 | | |
| White | 30.6 (21.5, 39.7) | 15.5 (9.5, 21.4) | 15.1 (4.2, 26.0) | 0.005 |
| Black | 7.4 (2.5, 17.3) | 0.0 | 7.4 (2.5, 17.3) | 0.021 |
| Income | n=143 | n=238 | | |
| Less than \$30,000 | 20.0 (7.1, 32.9) | 2.5(0.7, 5.7) | 17.5 (4.2, 30.7) | 0.001 |
| \$31000-70,000 | 30.6 (15.5, 45.6) | 7.5 (0.5, 14.7) | 23.0 (6.3, 39.7) | 0.005 |
| \$71,000 or higher | 37.1 (25.8, 48.4) | 18.8 (11.0, 26.6) | 18.3 (4.5, 32.1) | 0.008 |
| Education | n=143 | n=238 | | |
| Less than college degree | 20.0 (2.5, 37.5) | 3.9 (1.4, 9.2) | 16.1 (2.2, 34.4) | 0.028 |
| College degree or higher | 28.5 (20.5, 36.5) | 9.2 (5.0, 13.4) | 19.3(10.3, 28.3) | <0.001 |
| Marital status | n=143 | n=238 | | |
| Single/never married | 6.8 (-0.6, 14.2) | 3.1 (-0.3, 6.4) | 3.8 (-4.3, 12.0) | 0.300 |
| Married | 36.4 (26.9, 45.9) | 14.9 (9.0, 20.7) | 21.5 (10.3, 32.7) | <0.001 |
| Employment status | n=143 | n=238 | | |
| Working | 27.9 (19.6, 36.2) | 12.5 (7.5, 17.5) | 15.4 (5.7, 25.1) | 0.001 |
| Unemployed | 25.0 (9.9, 40.0) | 4.3 (0.5, 9.0) | 20.7 (5.0, 36.4) | 0.002 |

Monthly trend of 24-hour recall and since birth exclusive breastfeeding

The monthly trends for 24-hour recall EBF rate and the since birth EBF among participants are depicted in Figure 6. The 24-hour recall EBF trend showed a significant downward linear trend (Slope= -4.33, P-trend<0.001). At 6 months, 24-hour recall EBF rate was 27.3%, with a 24.9% decline from 52.2% at 1 month. The since birth EBF rate showed a 10.6% decline from month 1 to month 3 and a 25.6% decline from month 1 to month 6 with a significant linear downward trend (Slope= -4.77, P-trend<0.001).

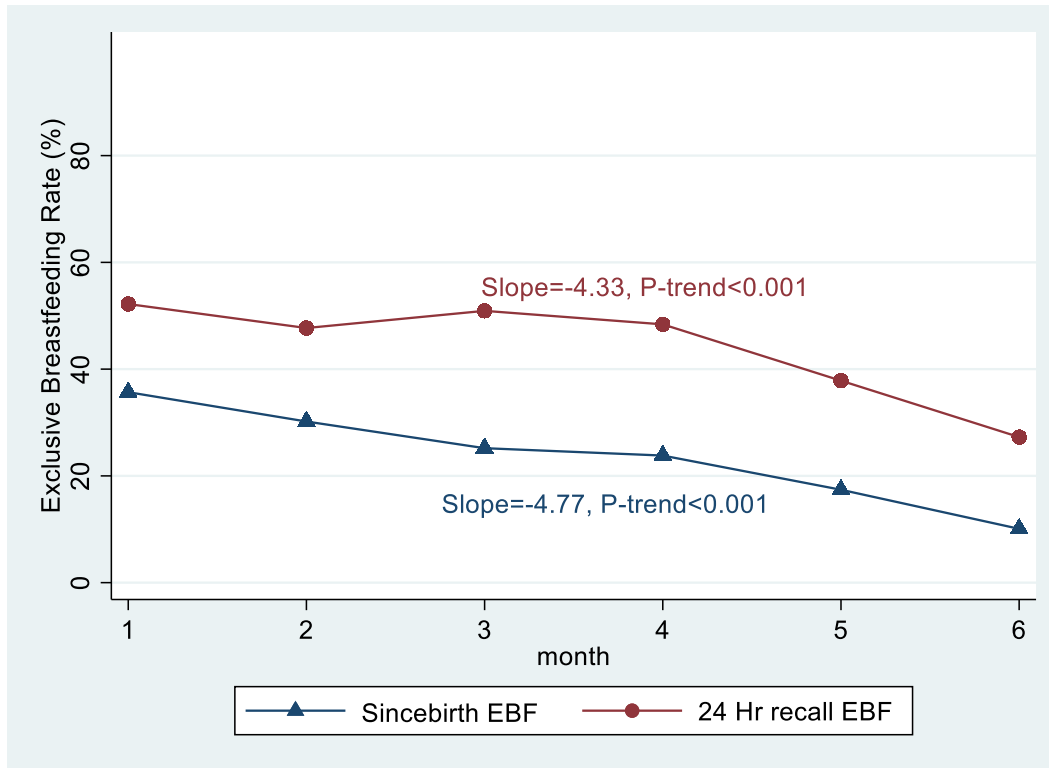


Figure 5: Monthly trend of 24-hour recall and since birth exclusive breastfeeding

Monthly trend of 24-hour recall and since birth exclusive breastfeeding by race

Figure 7 illustrates the monthly trend for 24-hour recall EBF rate stratified by race. The monthly 24-hour recall EBF for White participants in the study showed a consistent downward linear trend (Slope=-5.62, P-trend<0.001). Conversely, the observed monthly trend (Slope =-2.36, P-trend= 0.123) among Black participants was not significant, which means it was constant.

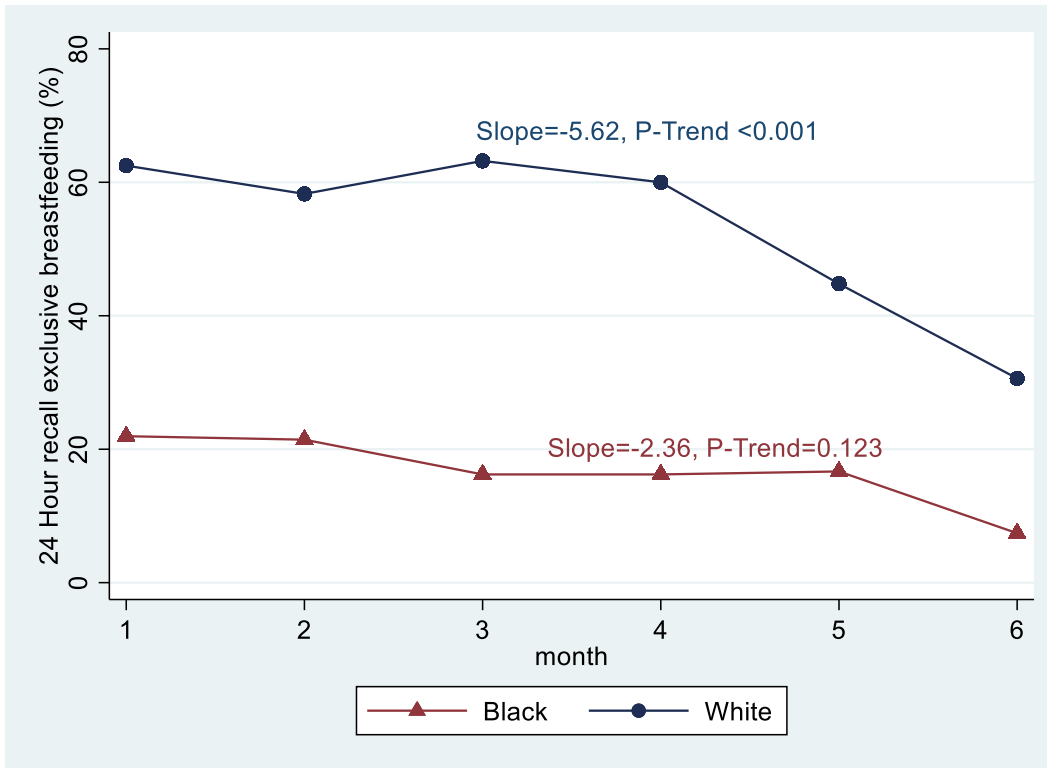


Figure 6: Monthly trend of 24-hour recall EBF rate by race

EBF rates calculated using since birth methods were lower than the EBF rate calculated with the 24-Hour recall method. As shown in Figure 8, the since birth monthly trend (Slope=-5.76, P-trend<0.001) and 24-hour recall trend (Slope=-5.37, P-trend<0.001) are similar for White participants. Although the steepness of the slope associated with the monthly trend of since birth EBF rate among Black participants is less than others (Slope=-2.41, P-trend<0.001), the downward linear trend observed was significant.

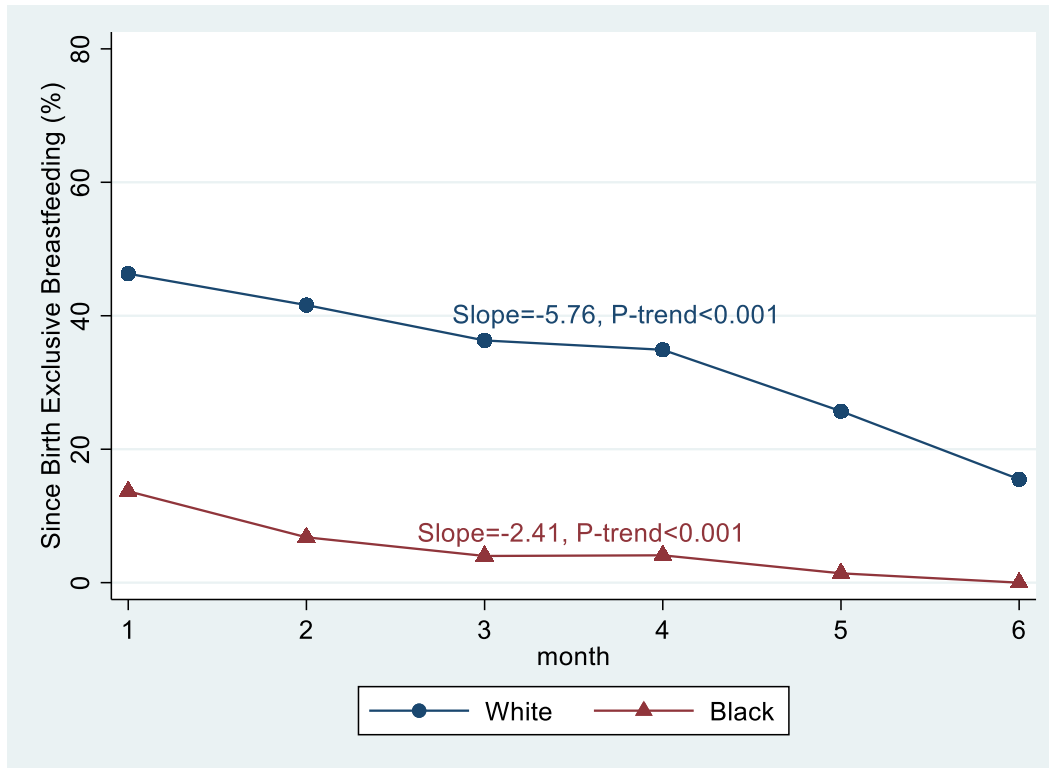


Figure 7: Monthly trend of since birth EBF rate by race

4.1.4 Discussion

This study examined the differences between two methods calculating exclusive breastfeeding—24-hour recall and since birth, assessed concurrently within the same population. There was notable disparity between the two methods, which are used widely and interchangeably by researchers in estimating exclusive breastfeeding across various populations and countries.

Across the first six months postpartum, the 24-hour recall EBF rates were higher than the since birth EBF rates. Monthly differences by assessment method ranged from 16.5% to 25.7%, with the highest difference occurring in month 5 and the lowest in month 6. The observed difference between the 24-hour recall and since birth EBF rates were also seen across race, income, education, marital status, and employment status. Irrespective of the method used to measure EBF

rates, the proportion of White participants who exclusively breastfed was consistently higher than Black participants. Participants with a household income of \$71,000 and above, a college degree, are employed and married, exclusively breastfed more than their counterparts. Although the methods provided different estimates with the largest discrepancies occurring in income and marital status, the pattern in maternal characteristics described above is seen in both EBF rates calculated using the since birth and 24-hour recall approach,

These differences across child's age and maternal characteristics can be attributed to either overestimating the EBF practice using the 24-hour recall approach or underestimating it by using the since birth method or both. Several other studies have demonstrated that using the 24-hour recall approach produces large overestimations in the prevalence of exclusive breastfeeding compared with the since birth approach.^{203,204,217,218} The observed differences between 24-hour recall and since birth method is often a result of switching back and forth across the different breastfeeding assessment methods.

Using the 24-hour recall, a study conducted in Uganda reported that 50% of the study participants exclusively breastfed; however, when since birth recall method was used, 0% of the study participants reported having exclusively breastfed at 6 months.²¹⁷ In a longitudinal study conducted in Sweden that compared the two methods using the same data source; they reported a significant difference between the two methods of more than 40 percentage points at two and four months of age.²⁰³ In addition, the 24-hour recall of EBF was compared with since birth EBF recall rates in Sir Lanka, and a 28.3% difference was reported.¹⁹⁸

The differences observed in our study and many other studies reflect the complexities of infant feeding patterns and behavior. The since birth method of calculating EBF rates mirrors the strict definition of exclusive breastfeeding; however, it precludes the realities of infant feeding.

Researchers have posited that even under optimum conditions, it is challenging to achieve exclusive breastfeeding in its strictest form for many reasons like postpartum complications, medication taken by the parent, or child sickness, which leads to sometimes brief periods of formula supplementation.^{195,211}

The monthly trend for EBF rates showed a steady downward decline where the EBF rate for months 1 and 6 was 52.2% and 27.3% for the 24-hour recall method and 35.7% at month 1 and 10.1% at month 6 for since birth method. The observed early cessation of EBF is consistent with the national data, where 46.9% of children were exclusively breastfed through three months, and 25.6% were exclusively breastfed up to 6 months.⁵³

One of the major contributions of our study is demonstrating the significant difference between 24-hour recall and since birth EBF rates in a longitudinal study using daily assessments. Other studies that have attempted the comparison of 24-hour recall and since birth EBF are mostly cross-sectional with none situated in the United States. Obtaining since birth EBF rate in a cross-sectional has the limitation of a potential recall bias, as parents may forget when they introduced a food item. The measurement of exclusive breastfeeding with a valid and consistent definition is essential for accurately monitoring trends and interpreting results. Longitudinal data collection is recommended to address the potential recall bias often seen while obtaining EBF rates from since birth methods.

A 24-hour recall EBF rate can be misleading since it tends to overestimate the exclusive breastfeeding practice. It may give Public Health implementers a false feeling of achievement, and as such, they will not focus on improving breastfeeding practices. On the other hand, the since birth method can underestimate the EBF rate in a population. For example, a child is classified as

ending exclusive breastfeeding if the child fails to breastfeed exclusively for a day; this status remains even if the child resumes exclusive breastfeeding the next day.

Limitations

Our sample has a higher income and education level than the general birth population of the study area. In addition, the sample was drawn from one county served by one maternity hospital in Pennsylvania, and as such, our findings may not be generalizable to other settings.

4.1.5 Conclusion

Our findings show that using 24-hour recall and since birth methods to calculate EBF rates to six months of age produce different estimates with wide margins even within the same population. This difference was consistent across maternal characteristics and child age. However, we argue that neither 24-hour recall nor since birth methods are perfect methods of estimating EBF. Both have advantages and disadvantages, and as such, we recommend that the best approach to calculating EBF rates should depend on the purpose and goals of the study. Finally, we suggest that researchers should clearly define how EBF is operationalized in their research studies to avoid misrepresentation and misinterpretation of EBF rates. Furthermore, qualitative studies are needed to explore how parents view and define exclusive breastfeeding.

4.2 Manuscript 2: Stress, social support, and racial differences: dominant drivers of exclusive breastfeeding in Allegheny County, Pennsylvania

4.2.1 Background

Exclusive breastfeeding is one of the most significant, cost-effective public health interventions for child survival.^{23,24} While any breastfeeding can offer positive infant and maternal health outcomes, early initiation and exclusive breastfeeding in the first six months of life confers the highest benefit as observed in infant and child survival, growth and development, and maternal health.²⁵ Despite the well-documented benefits of exclusive breastfeeding,^{31,219} many childbearing people in the United States wean their infants from breastmilk early or fail to exclusively breastfeed for six months, as recommended by the World Health Organization and the American Academy of Pediatrics.^{4,6,44,53}

From the US 2018–2019 National Immunization Survey of infants born in 2017, 84.1% were ever breastfed. This survey also reported that the percentage of breastfed infants was 58.3% at 6 months, and 35.3% at 12 months.⁵³ Only 46.9% of children were exclusively breastfed through three months and this reduced to 25.6% at 6 months.⁵³ Comparing infants born in 2017 to those born in 2011, exclusive breastfeeding rates at 3 and 6 months have risen slowly and steadily by 6.2% and 6.8%⁵³ due to increased breastfeeding promotion.²²⁰ However, this increase is not equitably distributed across the United States.^{58,59} Among Blacks, 33.7% of infants were exclusively breastfed at three months and 21.2% at 6 months, while the rates were considerably higher among Whites (i.e., 52.4% for 3 months and 28.7% at 6 months).⁵³

Breastfeeding practices have been widely considered to be influenced by historical, socioeconomic, cultural, physiological, and psychosocial factors.^{221,222} Sociodemographic factors

and maternal characteristics such as age, race/ethnicity, education, employment, income, marital status, perceptions of insufficient milk supply, beliefs, knowledge, attitudes, and parity have been widely reported as important factors associated with breastfeeding.^{61,94,118} Structural barriers such as suboptimal maternity care practices in hospitals, lack of workplace breastfeeding support, infant formula manufacturers can also influence breastfeeding practices and duration.^{61,91} In addition, physiological barriers such as nipple pain, breast engorgement can increase stress levels which can lead to breastfeeding discontinuation.^{222,223}

Researchers have shown that maternal psychosocial factors such as stress and social support are major determinants of breastfeeding.²²⁴⁻²²⁶ Maternal stress is associated with adverse perinatal outcomes, including breastfeeding.^{138,227,228} The relationship between stress and breastfeeding appears complex, and the directionality is unclear.²²⁹⁻²³¹ Experimental studies demonstrate that maternal stress seems to interfere with the release of oxytocin, the hormone responsible for the milk ejection reflex and if prolonged, can lead to reduced breastmilk production.²³² Others have also demonstrated that breastfeeding is associated with self-reports of decreased stress and negative mood.²³³ This beneficial effect of breastfeeding is said to be mediated by oxytocin and prolactin, hormones necessary for breastfeeding, and linked to reducing depression and stress.^{234,235}

Exposure to stress is common to all; however, in the United States, Blacks are more susceptible to chronic stress, including perinatal stress compared to Whites.^{133,236} Chronic stressors activate the hypothalamic–pituitary–adrenal axis, sympathetic, immune, and cardiovascular systems releasing higher levels of stress hormones such as proinflammatory cytokines and cortisol in the effort to restore allostasis.²³⁷⁻²³⁹ Repeated allostatic responses activated during those stressful situations cause ‘wear and tear’ to the body and inadvertently lead to allostatic overload.²³⁹ High

allostatic load has been posited to contribute to worse health outcomes, including adverse birth outcome and unhealthy behavior among Blacks in the United States.^{121,240}

Social support is one of the essential resources for navigating stressors during the postpartum phase,²³⁰ and its role in breastfeeding promotion is well established.¹⁰⁸ Sources of breastfeeding support may be members of the childbearing person's informal social network such as family and friends or their formal social networks such as medical professionals, peer groups, and lactation consultants.¹⁰⁸ Social support depends on the availability and quality of social relationships, which may moderate the impact of exposure to life stress.^{158,167} This implies that the effect of stress may be more significant among those who lack social ties compared to those who have supportive relationships with others. In a study conducted in Bangladesh, maternal stress and social support were associated with exclusive breastfeeding, and postpartum depression.²³⁰ Other studies have also demonstrated a lack of significant relationship between stress, social support and exclusive breastfeeding.^{241,242} While the disparate results may be attributed to differences in the study population, it may be necessary to examine the relationship between stress and the different types of social support and their effect on exclusive breastfeeding.

Researchers have described the relationship between social support and well-being using either the main-effect or buffering models.¹⁶¹ The main-effect model suggests that social support produces direct and beneficial effects on well-being independent of stressors. Alternatively, the buffering model asserts that social support protects individuals by mitigating the adverse effects of stressors.¹⁶¹ This has led to categorizing social support into two major types- perceived and received social support.^{150,243,244} Perceived social support assesses the extent to which people believe support is available to them, while received support assesses specific supportive acts that have occurred.²⁴³

Previously, researchers have examined which of the two types of social support impacts health. Several studies posit that the perception of support is associated with reduced mortality and seems to be a better predictor of health outcomes than the actual receipt of support.^{161,165,245-247} In contrast, other studies have shown that received support has a more significant effect than perceived support following a stressful event, especially if a single stressor is examined and the support is specific to the stressor.²⁴⁸ The conflicting evidence makes health intervention challenging. The distinction between perceived and received social support in the relationship between stress and exclusive breastfeeding is limited. It is then essential to examine if protective factors like perceived or received social support can moderate the effect of stress on breastfeeding.

To our knowledge, limited studies have examined the association between perceived stress and exclusive breastfeeding. Studies that have examined the relationship between stress and exclusive breastfeeding were cross-sectional^{143,249} and as such, the temporal association between stress and breastfeeding patterns cannot be established. Some of these studies had insufficient statistical power²²⁸ or limited their scope to only stressful life events (i.e., financial, emotional, traumatic, and partner associated).^{143,249} Others have focused on a particular group, such as low-income childbearing people.¹⁴³ Notably, measuring individual stress through stressful life events is complex because of lack of consistency in its definition.²⁵⁰ Therefore, it has necessitated the use of standardized tools for quantifying stress, such as the Perceived Stress Scale.^{250,251} In addition, no published study has demonstrated the role of perceived or received social support in the relationship between perceived stress and exclusive breastfeeding using an Ecological Momentary Assessment.

The objective of the study, therefore, is to examine the relationship between perceived stress and exclusive breastfeeding and the moderating effects of perceived and received social

support on this relationship. We hypothesized that childbearing people who reported perceived stress would less likely breastfeed exclusively. For those who reported perceived stress, perceived, and received social support will moderate the relationship between stress and exclusive breastfeeding. We also hypothesize that Black birthing people who reported stress will exclusively breastfeed less than their White counterparts.

4.2.2 Methods

4.2.2.1 Study design

The Postpartum Mothers Mobile Study (PMOMS) is longitudinal study designed to understand the contextual, behavioral, psychosocial, and clinical factors related to racial disparities in postpartum weight and cardiometabolic health.^{179,180,182} It is an ancillary study to the Comparison of Two Screening Strategies for Gestational Diabetes (GDM-2),¹⁸¹ a randomized controlled trial conducted in a single birthing hospital in Southwestern Pennsylvania that supports nearly 10,000 births each year and accounts for 45 percent of all births in Allegheny county. As of the 2020 census, the population of Allegheny County was 1,250,578, making it the second-most populous county in the state.²⁵²

The GDM-2 study began recruitment in 2015 and required two study visits. Starting in December 2017, participants were approached at these visits, screened, and enrolled in PMOMS.^{179,180,182} PMOMS recruited 284 participants aged 18-44 years from the GDM-2 clinical trial and directly recruited an additional 29 participants. The study participants were recruited between 18-28 weeks of gestation and followed up to 1 year postpartum. Once participants consented to the study, they completed baseline surveys, received smartphones and a smart scale, and downloaded a companion app to weigh themselves. Participants completed Ecological

Momentary Assessment (EMA) surveys assessing physical activities, diet, breastfeeding behaviors, stress, and other psychosocial factors through 12 months postpartum.¹⁷⁹ Data collection for the PMOMS ended in August 2021. A detailed description of the study methodology is published somewhere else.¹⁷⁹ The Human Research Protection Office at the University of Pittsburgh approved the PMOMS study.

4.2.2.2 Data collection

Participants used a smartphone to complete daily EMA surveys via a web-based app at the beginning of the day, end of the day, and random times throughout the day. Participants chose the timing of the beginning and end of day surveys, and there were at least nine hours between these two surveys. Random EMA surveys were delivered 0-3 times per day between the beginning of the day and end of the day survey times, targeting a mean of one random assessment per day over a 7-day period beginning at recruitment (18 weeks to 36 weeks) through 12 months postpartum.¹⁷⁹ Demographic data were collected at baseline in the GDM-2 study

Ecological Momentary Assessment (EMA) via mobile device/smartphone was the primary data collection method for PMOMS.¹⁷⁹ EMA data collection occurs in real time and participants complete surveys capturing momentary states, behavior and conditions multiple times or as repeated measures.^{183,184} EMA as a data collection method minimizes recall bias which is common in most retrospective studies.¹⁸³

4.2.2.3 Measures

Outcome variable

Exclusive breastfeeding. Exclusive breastfeeding data were collected at the end of the day. For every 42-day block, breastfeeding questions were prompted eight weekend days and 20

weekdays. Participants receive these breastfeeding questions till 12 months postpartum. To determine if a participant exclusively breastfed, the following question was asked “Are you exclusively breastfeeding?” with answer options of “yes” or “no”. Participants selected “yes” if they breastfed exclusively that day or selected “no” if they did not breastfeed exclusively that day. The WHO definition of exclusive breastfeeding (*exclusive BF includes only breastmilk (including expressed/pumped milk) with the exception of medicine, vitamins, or oral hydration*) was included in the question to ensure that participants understood the operational definition. Following the WHO recommendation for the duration of exclusive breastfeeding, we analyzed exclusive breastfeeding data collected in the first six months post-delivery.

Independent variables

Demographic characteristics. Self-reported demographic characteristics collected at baseline included maternal age at baseline (18-44 years), race categorized as (Black and White), educational attainment (less than a college degree and some college degree and above), employment (employed and unemployed), income (less than \$30,000 and \$31,000 and above). We excluded racial categories other than White or Black for this analysis due to small sample size.

Perceived stress. The random EMA measure of stress was adapted from the widely used and validated Perceived Stress Scale 10 and 4.^{251,253} We used three items from the Cohen’s PSS4 and one item from PSS10. Cronbach alpha for PSS 10 and PSS 4 are 0.78 and 0.60 respectively.²⁵⁴ In this study, the reliability test for the adapted PSS showed high internal consistency of Cronbach’s alpha 0.81. The PSS has also been used among Black postpartum people in the United States and also has been validated among perinatal populations.^{255,256} Random EMA prompts are delivered 0-3 times per day, targeting a mean of one random assessment per day over a 7-day period.¹⁷⁹ We used the PSS as a continuous variable to determine the degree to which participants

appraise situations in their lives as stressful, uncontrollable, unpredictable, and difficult. The items were scored on a 5-point Likert scale, with responses ranging from never (0) to a lot (4). The Perceived Stress Scores were obtained by reversing the responses of the positive item, e.g., 0=4, 1=3, 2=2, etc., and then summing across all four items with scores ranging from 0 to 16.

Moderating variables

Social Support. Perceived social support was measured using the Multidimensional Scale of Perceived Social Support (MSPSS).²⁵⁷ MSPSS has three subscales that measure an individual's perception of support from 3 sources: family, friends, and significant other. The widely validated MSPSS scale has 12 items and a Cronbach's alpha of 0.88. However, we used 11 items to reduce survey burden on the respondents and the reliability test for the adapted MSPSS showed high internal consistency of Cronbach's alpha 0.95. On a 4-point Likert scale, the respondents indicated the extent to which each statement described their current relationships with their friends, family, and significant other. Responses ranged from 0 (strongly disagree) to 4 (strongly agree). We recoded MSPSS as a dichotomous variable, grouped as: no (0-2 points) and yes (3 and 4 points). To measure received social support, participants completed a single-item measuring received breastfeeding support. The question was, "Is there a person/group/organization (e.g., family, professionals) that is helping you or providing any support (e.g., resources, emotional) to continue to breastfeed?" Responses were either "Yes" or "No".

4.2.2.4 Statistical Analyses

We calculated the internal consistency of the adapted Cohen Perceived scale and the Multidimensional Scale of Perceived Social Support using Cronbach's alpha. We conducted a descriptive analysis of the demographic characteristics of participants and generated individual panel plots for repeated measures of exclusive breastfeeding and perceived stress. We also tested

for multicollinearity among the sociodemographic factors and the independent variables. The variance inflation factor (VIF) of all the variables ranged from 1.07-2.10, while the mean VIF was 1.35. All independent and sociodemographic variables since their VIFs were less than 5.

To establish the relationship between exclusive breastfeeding (a dichotomous variable), perceived stress, and social support, we conducted a mixed-effects logistic regression model with random intercepts and unstructured covariance matrices to address clustering of individual responses (panel-data regression). This approach allowed each subject to deviate from the overall mean response by a person-specific constant that applies equally over time. First, we identified covariates included in the final model by conducting a bivariate test of association between exclusive breastfeeding and sociodemographic factors and independent variables. Next, we specified a null and two full models with random intercepts.

Multilevel formulation – We assume a model with one level-1 variable x_{ij} and a level-2 variable x_i . In the case of repeated measure data, level-1 covariates are time-variant and level-2 covariates time-invariant. Time variant variables included in the analyses were exclusive breastfeeding, perceived stress, received social support. In addition, time-invariant variables included in the analyses were perceived social support, educational attainment, race, employment status, and maternal age. It is important to note that all demographic characteristics were measured at baseline (pregnancy stage).

The level-1 model can be expressed in terms of the log odds as:

$$\text{Log} \left[\frac{P_{ij}}{1 - P_{ij}} \right] = \beta_{0i} + \beta_{1j}x_{ij}$$

The level-2 model, assuming a random intercept only, is written as:

$$\beta_{0i} = \beta_0 + \beta_{2j}x_i + \zeta_{0i}$$

$$\beta_{1i} = \beta_1$$

Substituting level 2 in the level 1

$$\text{Log} \left[\frac{P_{ij}}{1 - P_{ij}} \right] = \beta_0 + \beta_1 x_{ij} + \beta_2 x_i + \zeta_{0i}$$

Where:

Y_{ij} = dichotomous response of subject i at timepoint j

x_{ij} = $(p + 1) \times 1$ vector of covariates

β = $(p + 1) \times 1$ vector of regression coefficients

$\beta_0 + \beta_1 x_{ij} + \beta_2 x_i$ = Fixed effects

ζ_{0i} = Random effects

To test for the moderation effect of the two forms of social support (i.e., perceived and received social support) on perceived stress, we generated the interaction between received social support and perceived stress and perceived social support and perceived stress. Perceived support model (Model 1) has an interaction term between perceived social support and perceived stress, while model 2 has an interaction term between received social support and perceived stress. We graphically illustrated the interaction between perceived stress and the two forms of social support using the `marginplot` command in STATA. We used log-likelihood, Bayesian Information Criterion (BIC), and Akaike's Information Criterion (AIC) to ascertain model goodness-of-fit. In addition, we calculated the Proportional Change in Variance (PCV) to estimate the total variance attributable to the independent variables in the models. STATA/S.E 16.0 was used to conduct all statistical analyses.¹⁹⁴

4.2.3 Results

Sociodemographic factors

Table 6 shows the characteristics of the respondents in the study stratified by race. Over 67.3% of the participants were White and 32.3% Black. More than half of the Black participants

were unemployed, while about a third of White participants were unemployed. Slightly more than 90% of White participants had a college degree. Overall, White participants in our study were more educated, employed, and had higher incomes. **Table 7** shows the mean stress scores of participants across races, and the stress scores for White participants were similar to that of Black participants.

Table 6: Characteristics of the respondents stratified by race (White and Black)

| Sociodemographic variables | All (N=251) | Mean/% | White (n=173) | Mean/% | Black (n=78) | Mean/% |
|-----------------------------------|--------------------|---------------|----------------------|---------------|---------------------|---------------|
| Maternal age in years | 251 | 29.9* | 173 | 31.0 | 78 | 27.5 |
| Employment status | | | | | | |
| Employed | 175 | 69.7 | 137 | 79.2 | 38 | 48.7 |
| Unemployed | 76 | 30.3 | 36 | 20.8 | 40 | 51.3 |
| Marital status | | | | | | |
| Unmarried | 128 | 42.5 | 45 | 26.0 | 14 | 18.0 |
| Married or partnered | 173 | 57.5 | 128 | 74.0 | 64 | 82.0 |
| Income level | | | | | | |
| Less than \$30,000 | 96 | 38.3 | 32 | 18.5 | 64 | 82.1 |
| \$31000 and above | 155 | 61.8 | 141 | 81.5 | 14 | 17.9 |
| Education level | | | | | | |
| Less than college degree | 55 | 21.9 | 17 | 9.8 | 38 | 48.7 |
| College degree or higher | 196 | 78.1 | 156 | 90.2 | 40 | 51.3 |

*Mean maternal age

Table 7: Mean stress levels stratified by race

| Race | Mean Stress scores | Standard Deviation | Minimum | Maximum |
|-------------|---------------------------|---------------------------|----------------|----------------|
| All | 3.30 | 2.59 | 0 | 13.85 |
| White | 3.37 | 2.60 | 0 | 13.85 |
| Black | 3.14 | 2.60 | 0 | 9.07 |

Reliability of perceived stress and perceived social support measures

The adapted Cohen's Perceived Stress and the Multidimensional Scale of Social Support showed high internal consistency of Cronbach's alpha 0.81 and 0.95, respectively.

Factors associated with exclusive breastfeeding

Table 8 shows bivariate analyses of psychosocial and maternal characteristics associated with odds of exclusive breastfeeding. In this unadjusted model, one point increase in perceived stress score decreases the likelihood of exclusive breastfeeding by 8% (OR: 0.92, 95%CI: 0.88-0.95). Overall, compared to White participants, Black participants were less likely to exclusively breastfeed. Participants who "received social support" and who perceived that they had social support were twice and 4 times more likely to exclusive breastfeed, respectively. Participants with a college education, high income, employed and older were more likely to breastfeed exclusively.

Table 9 shows an adjusted mixed-effect model examining the relationship between exclusive breastfeeding and maternal characteristics. In this adjusted model, perceived stress and being Black were the factors associated with exclusive breastfeeding. Participants who reported higher stress were less likely to exclusively breastfeed.

Table 8: Unadjusted Model examining maternal psychosocial factors and characteristics on repeated report of exclusive breastfeeding

| | Unadjusted Model | |
|--------------------------|-----------------------|---------|
| Fixed effect | Odds ratio (95% CI) | P Value |
| Perceived stress | 0.92 (0.88-0.95) | <0.001 |
| Received support | 2.09 (1.63-2.67) | <0.001 |
| Perceived Social Support | 4.42(1.01-19.30) | 0.047 |
| Race | | |
| White | Reference | |
| Black | 0.01(0.002-.023) | <0.001 |
| Education | | |
| Less than college degree | Reference | |
| College degree or higher | 96.25(25.61-361.66) | <0.001 |
| Income | | |
| Less than \$30,000 | Reference | |
| \$31,000 and above | 315.28(105.26-944.36) | <0.001 |
| Employment status | | |
| Employed | Reference | |
| Unemployed | 0.02(0.01- 0.07) | <0.001 |
| Maternal age | 1.28(1.12-1.46) | <0.001 |

^aPerceived Stress: Adapted Cohen’s perceived stress scale

^bReceived support: Is there a person/group/organization (e.g., family, professionals) that is helping you or providing any support (e.g., resources, emotional) to continue to breastfeed?

^cPerceived social support: Adapted Multidimensional Scale of Perceived Social Support

Table 9: Adjusted Model examining maternal psychosocial factors and characteristics on self report of exclusive breastfeeding

| Fixed effect | Adjusted Model | |
|---------------------------------------|----------------------------|------------------|
| | Odds ratio (95% CI) | P Value |
| Perceived stress ^a | 0.88 (0.83-0.92) | <0.001 |
| Received support ^b | 1.48 (1.04-2.11) | 0.032 |
| Perceived social support ^c | 2.54 (0.50- 13.10) | 0.263 |
| Race | | |
| White | Reference | |
| Black | 0.16 (0.02-1.40) | 0.098 |
| Education | | |
| Less than college degree | Reference | |
| College degree or higher | 0.94 (0.06-13.11) | 0.962 |
| Employment status | | |
| Employed | Reference | |
| Unemployed | 0.58 (0.09-3.90) | 0.578 |
| Maternal age | 0.96 (0.77-1.16) | 0.642 |
| Random effects | | |
| | Estimate (95% CI) | |
| Variance | 5.67(4.99-6.43) | 4.65 (3.89-5.57) |
| PCV ^d (%) | | 5.49 |
| ICC ^e | 0.91(0.88-0.93) | 0.86 (0.82-0.90) |
| Maximum Likelihood Estimate | | |
| AIC ^f | | 3660.86 |
| BIC ^g | | 3721.89 |

^aPerceived Stress: Adapted Cohen's perceived stress scale

^bReceived support: Is there a person/group/organization (e.g., family, professionals) that is helping you or providing any support (e.g., resources, emotional) to continue to breastfeed?

^cPerceived social support: Adapted Multidimensional Scale of Perceived Social Support

^dPCV: Proportional Change in Variance expresses the change in the area level variance between the empty model and the individual level model, and between the individual level model and the model further including the area level covariate

^eICC: Intraclass correlation

^fAIC: Akaike's Information Criterion

^gBIC: Bayesian Information Criterion

Effect of race and EMA reports of stress on exclusive breastfeeding.

Tables 10 and 11 show results from the mixed-effects logistic regression examining the effect of stress, race, and the moderation effect of perceived and received social support. Adjusting for potential confounders and moderating effects of perceived social support (model 1) and received social support (model 2), perceived stress is associated with decreased odds of exclusive breastfeeding. In the model with the interaction terms between perceived social support and stress (model 1), with one unit increase in perceived stress score, there was a 19% reduction in the likelihood of exclusive breastfeeding. Similarly, in the model with the interaction terms received social support and stress (model 2), a unit increase in perceived stress score is associated with a 13% decrease in the likelihood of exclusive breastfeeding. Black participants were 99% less likely than White participants to breastfeed exclusively in adjusted Model 1 (OR: 0.01, 95%CI: 0.001-0.072) and 94% less likely to breastfeed exclusively compared with Whites in adjusted Model 2 (OR: 0.06, 95%CI: 0.01-0.40). In models 1 and 2, examining the interaction terms between stress and race, White participants with increased levels of stress were less like to exclusively breastfeed than Black participants. In only model 1 (perceived support model), unemployed participants were nine times less likely to breastfeed exclusively when compared with employed participants.

Moderating effects of perceived social support and received social support on stress

Table 10 shows that perceived social support significantly moderated the relationship between perceived stress and exclusive breastfeeding (OR: 1.18, 95%CI:1.07- 1.30). Model 2 (**Table 11**) shows no significant moderating effect of received social support on perceived stress (OR: 0.96, 95%CI: 0.89- 1.04). While there was no significant moderating effect of received social support on perceived stress, received social support had a significant association with exclusive

breastfeeding (OR: 2.26, 95%CI: 1.49- 3.42). The interaction between perceived social support and stress is presented in Figure 9A. In Figure 9A, there was no remarkable difference in EBF among individuals who perceived or did not perceive social support for participants with zero perceived stress scores. However, as the stress scores increased, those who perceived they had social support were more likely to report exclusive breastfeeding than those who did not perceive social support.

Measures of variation

The null model (model 0), model 1, and model 2 have high intraclass correlation (ICC) of 0.91, 0.89, and 0.88, respectively, implying good reliability in individual responses for exclusive breastfeeding. The observed ICC also indicates that the proportion of the total variance observed in our outcome, exclusive breastfeeding due to mean differences between subjects is high. We further calculated the proportional change in variance (PCV), which estimates the total variance attributable to the independent variables in the Models. In the perceived social support model (model 1), only 5% of the observed variation can be attributed to perceived stress, perceived social support, and sociodemographic factors. Also, 13% of the total variance observed in the received social support model (model 2) was accounted for by received stress, perceived social support, and sociodemographic factors.

Table 10: Longitudinal mixed-effect logistic model of exclusive breastfeeding, stress, perceived social support and race

| | Intercept only model | Model 1 (Perceived Social support as interaction term) | |
|--|--------------------------|--|---------|
| | Odds ratio (95% CI) | Odds ratio (95% CI) | P Value |
| Fixed effects | | | |
| Perceived stress ^a | | 0.81(0.76-0.87) | <0.001 |
| Perceived social support ^b | | 0.89(0.16-4.84) | 0.889 |
| Race | | | |
| White | | Reference | |
| Black | | 0.01(0.001-0.072) | <0.001 |
| Perceived social support*stress ^c | | 1.18(1.07- 1.30) | 0.001 |
| Perceived stress*race ^d | | 1.19(1.04-1.35) | 0.011 |
| Education | | | |
| Less than college degree | | Reference | |
| College degree or higher | | 4.55(0.44-47.79) | 0.206 |
| Employment status | | | |
| Employed | | Reference | |
| Unemployed | | 0.11(0.02-0.64) | 0.014 |
| Maternal age | | 1.00(0.81-1.24) | 0.982 |
| Random effects | | | |
| | Estimate (95% CI) | Estimate (95% CI) | |
| Variance | 5.67(4.99-6.43) | 5.41(4.59-6.39) | |
| PCV (%) ^e | Ref | 4.59 | |
| ICC ^f | 0.91(0.88-0.93) | 0.89(0.86-0.92) | |
| Maximum Likelihood Estimate | | | |
| AIC ^g | 8793.79 | 4370.14 | |
| BIC ^h | 8809.48 | 4441.24 | |

^aPerceived Stress: Adapted Cohen’s perceived stress scale

^bPerceived social support: Adapted Multidimensional Scale of perceived social support

^cPerceived social support*stress: Interaction term between perceived social support and perceived stress

^dPerceived stress*race: Interaction term between perceived stress and race

^ePCV: Proportional Change in Variance expresses the change in the area level variance between the empty model and the individual level model, and between the individual level model and the model further including the area level covariate

^fICC: Intraclass correlation

^gAIC: Akaike’s Information Criterion

^hBIC: Bayesian Information Criterion

Table 11: Longitudinal mixed-effect logistic model of exclusive breastfeeding, stress, received social support and race

| | Intercept only model | Model 2 (Received Social support as interaction term) | |
|---|--------------------------|---|---------|
| | Odds ratio (95% CI) | Odds ratio (95% CI) | P Value |
| Fixed effects | | | |
| Perceived stress ^a | | 0.87(0.82-0.93) | 0.001 |
| Received social support ^b | | 2.26(1.49- 3.42) | <0.001 |
| Race | | | |
| White | | Reference | |
| Black | | 0.06(0.01-0.40) | 0.004 |
| Received social support*stress ^c | | 0.96(0.89- 1.04) | 0.323 |
| Perceived stress*race ^d | | 1.26(1.11-1.45) | 0.001 |
| Education | | | |
| Less than college degree | | Reference | |
| College degree or higher | | 1.30(0.13-13.2) | 0.827 |
| Employment status | | | |
| Employed | | Reference | |
| Unemployed | | 0.37(0.06-2.31) | 0.289 |
| Maternal age | | 0.99(0.83-1.19) | 0.924 |
| Random effects | | | |
| | Estimate (95% CI) | | |
| Variance | 5.67(4.99-6.43) | 4.93(4.19-5.81) | |
| PCV (%) ^e | | 13.1 | |
| ICC ^f | 0.91(0.88-0.93) | 0.88(0.84-0.91) | |
| Maximum Likelihood Estimate | | | |
| AIC ^g | | 4258.98 | |
| BIC ^h | | 4328.27 | |

^aPerceived Stress: Adapted Cohen's perceived stress scale

^bReceived support: Is there a person/group/organization (e.g., family, professionals) that is helping you or providing any support (e.g., resources, emotional) to continue to breastfeed?

^cReceived social support*stress: Interaction term between perceived social support and perceived stress

^dPerceived stress*race: Interaction term between perceived stress and race

^ePCV: Proportional Change in Variance expresses the change in the area level variance between the empty model and the individual level model, and between the individual level model and the model further including the area level covariate

^fICC: Intraclass correlation

^gAIC: Akaike's Information Criterion

^hBIC: Bayesian Information Criterion

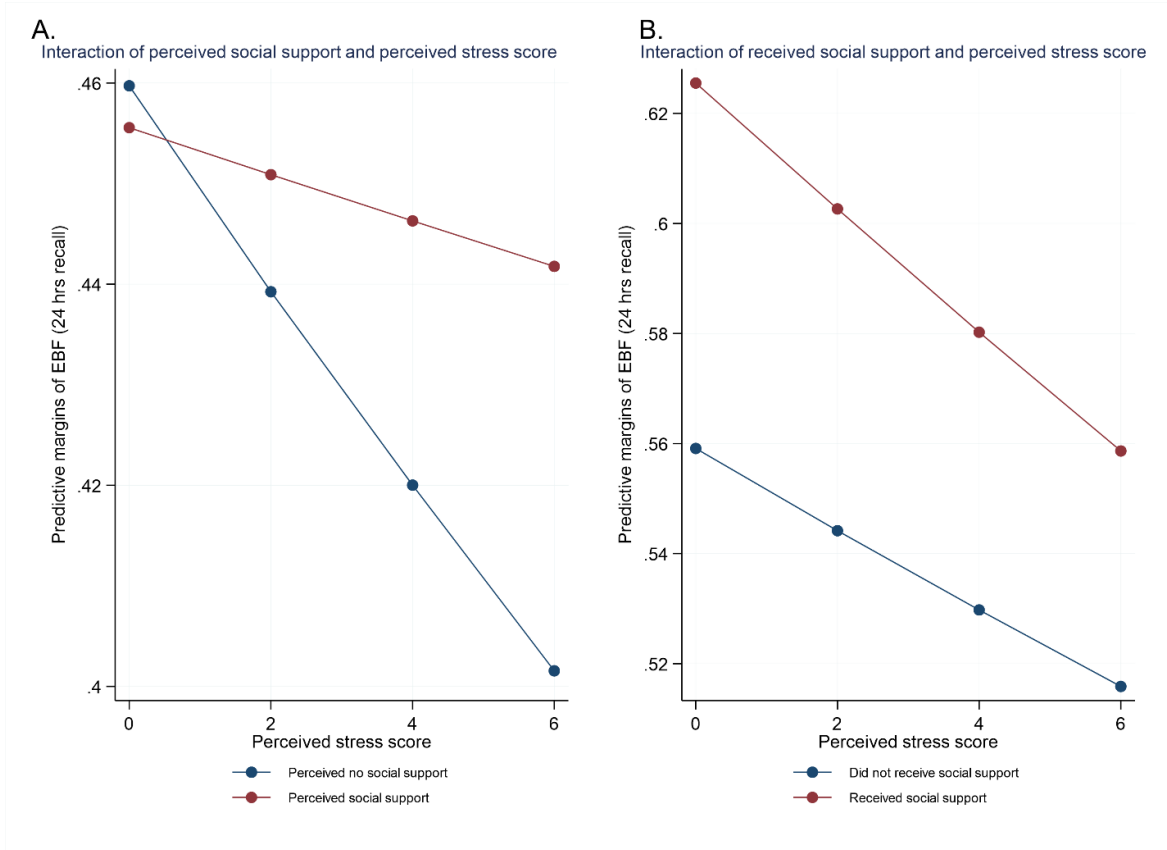


Figure 8: Interaction plots of perceived stress scores and exclusive breastfeeding A. perceived social support
B. received social support

4.2.4 Discussion

The primary objective of this study was to examine the influence of perceived daily stress on exclusive breastfeeding. In addition to establishing the relationship between perceived stress and exclusive breastfeeding, we sought to test whether perceived and received social support moderate this relationship. A key finding in the study is that participants who reported higher levels of perceived stress were less likely to breastfeed exclusively for 6 months. Our study results also show that perception of social support moderated the relationship between perceived stress and

breastfeeding. In contrast, received social support did not moderate the relationship between perceived stress and exclusive breastfeeding but directly increased the likelihood of exclusive breastfeeding. Black and unemployed birthing people were less likely to breastfeed exclusively within the study population. These findings have important implications for public health interventions that can modify psychosocial factors that deter exclusive breastfeeding.

Pregnancy and postpartum stages involve complex processes that may compound daily stress,²⁵⁸ making exclusive breastfeeding difficult. Despite methodological differences, our results corroborate studies that highlight the influence of stress on exclusive breastfeeding.^{143,249} Although these studies operationalized stress as stressful life events rather than perceived stress, they demonstrated a significant relationship between stressful life events and decreased likelihood of exclusive breastfeeding. Others have cited possible reasons for the negative relationship between perceived stress and exclusive breastfeeding. Some researchers posit that elevated stress may induce hormonal responses that can reduce prolactin and oxytocin secretion, leading to inadequate milk supply or preventing the milk letdown reflex, thus causing exclusive breastfeeding cessation.^{228,233,241,259} An alternative explanation from a recent prospective cohort study in Japan suggests that stress negatively affects exclusive breastfeeding through psychological burden and associated behavioral changes.²²² Our findings reinforce mounting evidence that perceived stress is significantly associated with non-exclusive breastfeeding.

In our study, participants who experienced higher stress levels but also perceived social support were more likely to breastfeed exclusively, compared to their counterparts without perceived social support. This finding is consistent with studies that have demonstrated the role of perceived social support from family, friends, and significant others in moderating the effect of stress on health behavior.^{131,260,261} Similarly, several studies have shown that partners, friends, and

family members provide psychological support, which may not necessarily be tangible support (for instance, receiving a breast pump from a breastfeeding support group) needed to sustain exclusive breastfeeding.²⁶²⁻²⁶⁶ This relationship can be linked to assertions that childbearing people who perceive they have social support from important persons in their lives adapt better to the postpartum period and cope with stress better in this period^{267 268} all of which can lead to increased exclusive breastfeeding.²⁶⁶

In contrast to the buffering role of perceived social support on participants with elevated perceived stress scores, receipt of breastfeeding support as reported by our study participants did not buffer their perceived stress. However, it directly increased the likelihood of exclusive breastfeeding among our study participants. This finding is similar to previous studies that showed that parents who received social support from health professionals, family, antenatal groups, or postpartum breastfeeding support groups have increased breastfeeding self-efficacy and, in turn, exclusively breastfed longer.²⁶⁹⁻²⁷¹ Breastfeeding is a learned behavior²⁷², and childbearing people can learn to breastfeed from lactation support providers (informational support). Learning to breastfeed can improve breastfeeding efficacy, which would increase exclusive breastfeeding. As shown in our study, breastfeeding support such as support from health care professionals and lactation consultants may not necessarily buffer general stress, especially if the stress is not specific to the postpartum period and breastfeeding.

Black childbearing people in our study were significantly less likely to exclusively breastfeed when compared to their White counterparts. Our finding confirms previous studies that have highlighted the racial gap and disparity in breastfeeding in the United States.^{41,58,60,273-275} Blacks have the lowest breastfeeding initiation rates, exclusive breastfeeding, and breastfeeding duration than all other racial/ethnic groups. Researchers have also suggested that the long-standing

racial and ethnic differences in breastfeeding duration and exclusivity result from historical, cultural, social, economic, political, and psychosocial factors, including stress which disproportionately affects Black birthing people.^{41,50,123}

We hypothesized that Black participants who experienced high stress will less likely exclusively breastfeed than White participants who experienced similar high stress. However, our findings demonstrate that Black participants who experienced stress were more likely to exclusively breastfeed. In our study, the stress scores between White and Black participants were not significantly different as seen in (Table 7) and as demonstrated in one of the study's publications.²⁷⁶ This finding does not corroborate other research studies that suggest that Black people may face an increased risk for stress which impairs breastfeeding and contributes to the disparity observed in adverse birth outcomes.^{121,277} This can be attributed to heightened stress experienced by the US public, especially during the early stages of the COVID-19 Pandemic, a non-normative event for everyone.

During the pandemic, there were instances where stress among White people was unusually higher than that of Black people. For example, in a study conducted by the CDC, White adults were more likely to report stress and worry about the health of family members and loved ones than Black adults.²⁷⁸ It is important to note that many PMOMS' participants contributed significant data to the study during the COVID-19 Pandemic. The concept of coping and resiliency among Black people in the United States could have contributed to the observed disparate result from the norm where Black people exclusively breastfed more than White people with similar stress scores. Coping and resilience models suggest that some Black people in the US have over time developed coping strategies and resilience that have enabled them to overcome difficulties, the negative consequences of their environments, and experience a healthy quality of life.²⁷⁹ While Black

people who experienced stress were more likely to exclusively breastfeed compared to White people who had similar stress scores; overall, in the study, Black people were less likely to exclusively breastfeed. This suggests that factors influencing breastfeeding are multifaceted and the need to develop breastfeeding interventions that address the different factors.

Our study found that employed birthing persons were more likely to breastfeed exclusively than unemployed participants. Returning to work is often one of the reasons for exclusive breastfeeding cessation. Our result is inconsistent with studies that showed that employment can be a barrier to exclusive breastfeeding and the need for extended maternity leave and family-friendly workplace policies.²⁸⁰⁻²⁸³ It is assumed that unemployed birthing persons get to stay with their children and can breastfeed longer; however, this was not the case in our study. Employed participants in our study represent persons who worked either part-time or full-time. Studies that examined the effect of employment status on breastfeeding in the United States showed that study participants who worked part-time were more likely to breastfeed longer than those who worked full-time or were unemployed.^{282,284} In addition, our sample has a higher income and education level than the general birthing population of the study area, with over 39% having a household income of \$71,000 and above. Employment status is positively associated with income and educational level, so there is a possibility that our employed participants work in organizations or positions that have better maternity leave policies and workplace breastfeeding facilities, as has been described in other studies.^{285,286}

Our study has several strengths and limitations. One of the strengths is the use of ecological momentary assessment (EMA), a novel data collection method that samples subject experiences in real-time, minimizing recall bias. The observed variation in stress and exclusive breastfeeding allowed us to examine the effect of daily reports of perceived stress and exclusive breastfeeding.

Another strength is the use of standardized and reliable scales to measure perceived stress and perceived social support. The Perceived Stress Scale (PSS), and Multidimensional Scale of Perceived Social Support (MSPSS) used for the study were adapted or abridged versions of the original validated scales. However, the reliability test of the adapted PSS and MSPSS showed high internal consistency of Cronbach's alpha 0.81 and 0.95, respectively.

Previous studies that examined the relationship between stress and exclusive breastfeeding operationalized stress as stressful life events.^{143,249} However, not all stressful events can impact exclusive breastfeeding,¹⁴³ and some stress that can, may not qualify as stressful life events. A limitation of the study is our use of a single question to measure receipt of social support (i.e., breastfeeding support) rather than a multi-item scale. This type of question was likely chosen to reduce respondent burden and fatigue.

Another limitation is that the MSPSS was administered only once during the study, unlike other variables measured repeatedly to reduce respondent burden. We believe, however, that perception of social support should not fluctuate substantially during this time period. A longitudinal validity (test-retest) of MSPSS scale conducted in a study provides evidence of the scale's stability over time.^{287,288} In a study among postpartum mothers, perceived social support was stable for a period of 15 weeks.²⁸⁸ We also note that our sample was drawn from one county served by one maternity hospital in Pennsylvania, and as such, our findings may not be generalizable to other settings.

4.2.5 Implication for practice

To our knowledge, this study is the first longitudinal study to examine how different forms of social support, and perceived stress influence exclusive breastfeeding. Our study suggests that

perceived stress, perceived social support, and receipt of social support are important drivers of exclusive breastfeeding. Too often, structural issues including unpaid maternity leave, and racism are major sources of stress among childbearing people, and it may be necessary to address these issues among birthing people. Stress would be reduced if parents had extended paid leave, easy access to breastfeeding support in hospital, and access to racially concordant care from birth workers after discharge. In addition, maternal stress reduction interventions such as prevention of breastfeeding complications, prenatal advice about breastfeeding concerns, especially among new parents, and relaxation therapy during breastfeeding are effective interventions that can be explored.

Our findings call for more breastfeeding interventions that can improve social support and maximize the use of birthing people's existing social networks. One intervention that can be scaled up is the use of racially diverse Community Health Workers (CHWs) as breastfeeding peer counselors providing culturally and linguistically appropriate breastfeeding counseling and support services. The engagement of these community health workers in home visiting programs is a proven way to promote and support breastfeeding.²⁸⁹ In addition, the scope of work for Doulas can be expanded to provide breastfeeding support services. We also recommend that public health program implementers design more breastfeeding support programs involving partners, family, and friends as they play an important role in buffering stress especially among minority groups. We cannot overemphasize the need to deploy breastfeeding interventions among Black birthing people who need them the most.

CHWs are also uniquely positioned to address racial health disparities that disproportionately affect communities of color.^{290,291} Expanding their scope to provide

breastfeeding services can help reduce structural barriers to breastfeeding like access to information and services Black birthing people face.

Further studies are needed to determine the potential sources of stress among breastfeeding people and how different types of social support, such as emotional, informational, appraisal, and tangible support, including time-variant perceived social support, will affect exclusive breastfeeding in real-time.

4.3 Manuscript 3: Exclusive breastfeeding and discrimination: the role of stress

4.3.1 Background

Racial and ethnic disparities in the exclusive breastfeeding rates in the United States are persistent^{41,292,293} despite the established benefits of exclusive breastfeeding on maternal and child health outcomes.^{4,31} Black childbearing people exclusively breastfeed at a lower rate than other racial groups.²⁹³ The low breastfeeding rate among the Black population is a public health concern as Black childbearing people and their children, compared to other races, are disproportionately affected by poor birth outcomes for which breastfeeding may provide protection.^{109,294}

Historical, cultural, social, economic, and political forces have shaped long-standing racial and ethnic differences in breastfeeding duration and exclusivity.^{41,50} Historical factors have roots in the era of slavery when slave owners forced enslaved Africans to breastfeed and care for their children, using them as wet nurses while the children born by the Africans were left untended.⁶⁴ Taking away their right to breastfeed their children for the benefit of White infants entrenched the way Black childbearing people perceived breastfeeding, which in addition to other factors, has

affected breastfeeding rates among Black people. Some researchers argue that refusing to breastfeed for a Black person felt like a way to reject an act that signified re-enslavement and assert control over one's own body.⁷⁰ With the end of slavery and the great migration, Black childbearing people had to work outside their homes, often in menial jobs forcing long periods of maternal/child separation and making it challenging to breastfeed.^{70,71}

While slavery has been abolished and the Jim Crow era ended, racism still remains in the US.²⁹⁵ Racism results in racial discrimination and can be described as unfair, differential treatment based on race. Racial discrimination is pervasive in the United States, particularly as experienced by Black people.²⁹⁶ Often, racial discrimination occurs in the form of microaggressions, a form of racism that is characterized by subtle, daily, and unintentional racial slights committed against members of racialized groups.²⁹⁷

Racial discrimination, gender discrimination, and microaggressions are disproportionately reported by Black people compared to all other racial groups.²⁹⁸⁻³⁰⁰ Black women are a part of at least two groups subjected to racial and gender discrimination.³⁰¹ When both occur to an individual, the adverse effects of discrimination are compounded.³⁰¹ Racial and gender discrimination and microaggressions have been shown to have adverse effects on mental and physical health and are likely to contribute to the racial health inequities observed in the US.^{299,302-304} Constant exposure to these forms of discrimination causes “racial battle fatigue”, isolation, stress, and exhaustion.³⁰⁵

Discrimination impacts health directly or indirectly through multiple pathways.^{304,306} First, discrimination acts as a stressor and induces psychophysiological reactions linked to stress-related disorders, such as hypertension and other cardiovascular diseases.³⁰⁶⁻³⁰⁸ Second, discrimination can impact health behaviors by decreasing a person's ability or agency, including perceived control

and self-efficacy,³⁰⁹ leading to adopting unhealthy behaviors such as substance use.^{310,311} In a nationally representative survey, Bleich and colleagues reported that one-third of Black people in the US reported experiences of discrimination in a clinical setting, and 22% avoided seeking health care for themselves or family due to expected discrimination.²⁹⁸ Discrimination, therefore, affects health status by acting as a barrier to seeking health care services and other resources.³¹² Health providers often perpetuate discrimination in healthcare settings through their implicit bias, differential estimates of risks for diseases, and the quality of health information they provide.³⁰⁸

Researchers have demonstrated the relationship between racial discrimination and increased risk of preterm delivery, low birth weight, as well as the mediating role of stress in this relationship.^{121,133,137,138} Although various forms of discrimination have been linked to poor maternal and child health outcomes, its effect on breastfeeding has not been extensively researched.³¹³ A scoping review that examined literature published between 2010 and 2019 on racism, bias, or discrimination with breastfeeding as an outcome, only five studies were included, suggesting limited research.³¹⁴ Of those five studies, none examined the effect of racism, bias, and discrimination on exclusive breastfeeding as an outcome or measured microaggressions, gender discrimination as an exposure. Additionally, since the publication of Sue et al.'s seminal article on microaggressions,²⁹⁷ there has been an enormous interest in the impact of microaggressions on maternal and child health outcomes,³¹⁵⁻³¹⁷ however, there are limited studies on the effect of microaggressions, and gendered discrimination on breastfeeding outcomes including exclusive breastfeeding.

To reduce racial disparities in exclusive breastfeeding rates, it is first necessary to understand the risk factors that contribute to it. Highlighting specific mechanisms through which various forms of discrimination impact exclusive breastfeeding may open meaningful dialogue on

differences in racial realities and help to minimize race-related tension. Therefore, the purpose of the study was to examine the direct and indirect effects of various forms of discrimination- racial discrimination, gender discrimination, and microaggressions on exclusive breastfeeding using a longitudinal data from an Ecological Momentary Assessment. We hypothesized that Black childbearing people who experienced racial discrimination, gender discrimination, and microaggressions would less likely exclusively breastfeed. We also hypothesized that perceived stress would mediate the relationship between these forms of discrimination and exclusive breastfeeding.

By documenting the adverse effect of racial and gender discrimination and microaggressions on exclusive breastfeeding, the findings are expected to guide the design and development of programs and policies to address racial inequities in breastfeeding promotion.

4.3.2 Methods

4.3.2.1 Study Design

We used data from the Postpartum Mothers Mobile Study (PMOMS) study, a longitudinal study designed to understand the contextual, behavioral, psychosocial, and clinical factors related to racial disparities in postpartum weight and cardiometabolic health.^{179,180,182} PMOMS is an ancillary study to the Comparison of Two Screening Strategies for Gestational Diabetes (GDM-2)¹⁸¹, a randomized controlled trial conducted in a single birthing hospital in Southwestern Pennsylvania that records nearly 10,000 births each year and accounts for 45 percent of all births in Allegheny county. As of the 2020 census, the population of Allegheny County was 1,250,578, making it the second-most populous county in the state. The proportion of Black or African American people in the county is 13.4%.²⁵²

The GDM-2 study began recruitment in 2015 and required two study visits. Starting in December 2017, participants were approached at these visits, screened, and enrolled in PMOMS.^{179,180,182} PMOMS recruited 284 participants aged 18-44 years from the GDM-2 clinical trial and directly recruited an additional 29 participants. The study participants were recruited between 18-28 weeks of gestation and followed up to 1 year postpartum. Once participants consented to the study, they completed baseline surveys. Participants completed Ecological Momentary Assessment (EMA) surveys assessing physical activities, diet, breastfeeding behaviors, stress, and other psychosocial factors through 12 months postpartum. Data collection for the PMOMS ended in August 2021. A detailed description of the study methodology is published somewhere else.¹⁷⁹ The Human Research Protection Office at the University of Pittsburgh approved the PMOMS study.

4.3.2.2 Data collection

Participants used a smartphone to complete daily EMA surveys via a web-based app at the beginning of the day, end of the day, and random times throughout the day. Participants chose the timing of the beginning of day and end of day surveys, and there were at least nine hours between these two surveys. Random EMA surveys were delivered 0-3 times per day between the beginning of day and end of day survey times, targeting a mean of one random assessment per day over a 7-day period beginning at recruitment (18 weeks to 36 weeks) through 12 months postpartum.¹⁷⁹ Demographic data were collected at baseline in the GDM-2 study and at recruitment for the PMOMS-only participants.

Ecological Momentary Assessment via mobile device/smartphone was the primary data collection method for PMOMS.¹⁷⁹ Participants had the option of using their mobile device or obtaining a new smartphone from the study if their phone was not compatible with the study

infrastructure or limited in its ability to complete daily surveys.¹⁷⁹ Ecological momentary assessment (EMA) is a recognized method used in clinical and public health research.^{183,318} Unlike retrospective recall summary assessments, EMA integrates real-time, repeated measurements of respondents' momentary conditions, states, behaviors, and physiology in everyday life (ecologically relevant) context^{183,184}. Recall bias is a problem in studies that use retrospective self-reporting; EMA as a study method seeks to lessen recall bias, increase ecological validity, and study micro-processes that influence behavior in a real-world context.^{183,187,319}

4.3.2.3 Analytic sample

The overall PMOMS population included 313 participants. Of these, 284 answered EMA survey questions on breastfeeding. Since our primary aim was to compare psychosocial factors that influence exclusive breastfeeding between White and Black participants, we excluded participants that identified as Asian (n=12), Native Hawaiian (n=1) or multiracial and others (n=20); this resulted in 78 Blacks and 173 Whites and a total of 251 participants in the final analytic sample.

4.3.2.4 Measures

Outcome variable

Exclusive breastfeeding. Exclusive breastfeeding data were collected at the end of the day. For every 42-day block, breastfeeding questions were prompted eight weekend days and 20 weekdays. Participants received these breastfeeding questions from birth to 12 months postpartum. To determine if a participant exclusively breastfed, the following question was asked “Are you exclusively breastfeeding?” with answer options of “yes” or “no”. Participants selected “yes” if they breastfed exclusively that day or selected “no” if they did not breastfeed exclusively that

day. The WHO definition of exclusive breastfeeding (*exclusive BF includes only breastmilk (including expressed/pumped milk) with the exception of medicine, vitamins, or oral rehydration*) was included in the question to ensure that participants understood the question. Following the WHO recommendation for the duration of exclusive breastfeeding, we analyzed exclusive breastfeeding data collected in the first six months post-delivery.

Independent variables

Demographic characteristics. Self-reported demographic characteristics collected at baseline (during pregnancy) included maternal age at enrollment into the study (18-44 years), race categorized as (Black and White), educational attainment (less than a college degree and some college and above, where some college degree include those with an associate degree). Other demographic characteristics included current employment (employed and unemployed) and income (less than \$30,000 or \$31,000 and above).

Perceived stress. The random EMA measure of stress was adapted from the widely used and validated Perceived Stress Scale (PSS) 10 and 4.^{251,253} We used three items from the Cohen's PSS4 and one item from PSS10. Cronbach alpha for PSS 10 and 4 are 0.78 and 0.60, respectively.²⁵⁴ In this study, the adapted PSS has a Cronbach alpha of 0.82. The PSS has also been used among Black postpartum people in the United States.²⁵⁵ For our analysis, we used perceived stress as a continuous variable to determine the degree to which participants appraise situations in their lives as stressful, uncontrollable, unpredictable, and difficult. The items were scored on a 5-point Likert scale, with responses ranging from never (0) to a lot (4). The Perceived Stress Scores were obtained by reversing the responses of the positive item, e.g., 0=4, 1=3, 2=2, etc., and then summing across all four items with scores ranging from 0 to 16. A higher score indicates a higher perceived stress.

Racial discrimination. The racial discrimination variable was collected as a random EMA measure with a single item- “Today, how often were you treated unfairly than other people because of your race?” The response determined the number of times the respondent experienced racial discrimination in a day ranging from 0 to 4 or more times.

Gender discrimination. The gender discrimination variable was collected as a random EMA measure with a single item- “Today, how often were you treated unfairly than other people because of your gender?” The response determined the number of times the respondent experienced gender discrimination in a day ranging from 0 to 4 or more times.

Microaggressions. This was measured using an adapted Gendered Racial Microaggression (GRM) scale³²⁰ and collected as a random EMA measure. The GRM Scale is a 26-item measure that assesses Black women’s experiences of everyday and subtle gendered racism. It has a high internal consistency ($\alpha=0.92$) and evaluates Black women’s experience across four domains: a) Assumptions of Beauty and Sexual Objectification; (b) Silenced and Marginalized; (c) Strong Black Woman Stereotype, and (d) Angry Black Woman Stereotype.³²⁰ The adapted scale used in the study had 13 questions; questions from the domain that assessed the angry black woman stereotype were dropped to reduce respondents’ fatigue. The questions had a binary response of yes or no. If a participant responded yes to any of the first twelve questions, it would be recorded that the participant experienced microaggression (the 13th question was “none of the above”). We included this variable in the model as a dichotomous variable coded No (0) or Yes (1) to determine if the participant experienced gendered or racial microaggression.

Social Support. Perceived social support was measured using the Multidimensional Scale of Perceived Social Support (MSPSS).²⁵⁷ MSPSS has three subscales that measure an individual’s perception of support from 3 sources: family, friends, and significant other. The widely validated

MSPSS scale has 12 items a Cronbach's α of 0.88; however, we used 11 items to reduce survey burden on the respondents. On a 4-point Likert scale, the respondents indicated the extent to which each statement described their current relationships with their friends, family, and significant other. Responses ranged from 0 (strongly disagree) to 4 (strongly agree). We recoded MSPSS as a dichotomous variable, grouped as: no (0-2 points) and yes (3 and 4 points). To measure received social support, participants completed a single-item-"Is there a person/group/organization (e.g., family, professionals) that is helping you or providing any support (e.g., resources, emotional) to continue to breastfeed?" Responses were either "Yes" or "No".

4.3.2.5 Statistical Analyses

Descriptive statistics were computed to understand the sample characteristics and the differences across race categories. We used the generalized structural equation modeling (GSEM) to test the hypothesized pathway of influence through which racial discrimination, gender discrimination, and microaggression would affect exclusive breastfeeding directly or indirectly through perceived stress. Structural equation modeling enables visualization models and delineates associations into direct, indirect, and total effects of independent variables on the outcome variables.³²¹ Unlike the conventional Structural Equation Modeling (SEM), Generalized structural equation modeling (GSEM) allows for modeling continuous, binary, ordinal, count, and multinomial dependent variables, including interactions between independent variables.³²¹

First, a conceptual path diagram was developed to describe all the hypothesized relations between the three different forms of discrimination and exclusive breastfeeding (Figure 10). The GSEM enabled us to test a possible path model that links identified psychosocial factors to exclusive breastfeeding. Using a GSEM, we performed a mediation analysis to estimate the overall association (i.e., total effect) of racial discrimination, gender discrimination, and microaggressions

on exclusive breastfeeding for six months. We fitted a full model (Figure 11) that estimated the path coefficients (β) of the direct and indirect effects. The odds ratio for paths with binary outcomes were calculated for ease of interpretation. The direct effects estimated the associations between the different forms of discrimination and exclusive breastfeeding without the contribution of intermediate variables, and the indirect effects estimated the associations between the various forms of discrimination and exclusive breastfeeding through perceived stress. Based on previous exploratory analysis, we assumed that the relationship between race and discrimination also depends on some socio-demographic factors; as such, we included interaction terms between race and employment and race and education. In addition, this model included person-specific random intercepts, which account for unobserved, between-person heterogeneity, a key confounder in longitudinal data.

We fitted the re-specified parsimonious model (final models) (Figure 12) by retaining the complete paths with direct and indirect effects that have statistical significance $\alpha \leq 5\%$. The indirect effect was estimated as the product of the contributing coefficients in that pathway, and the total effects were calculated by summing the effects of direct and indirect effects. The “gsem” command in STATA was used to fit the generalized structural equation model. STATA/S.E 16.0 was used to conduct all statistical analyses.¹⁹⁴

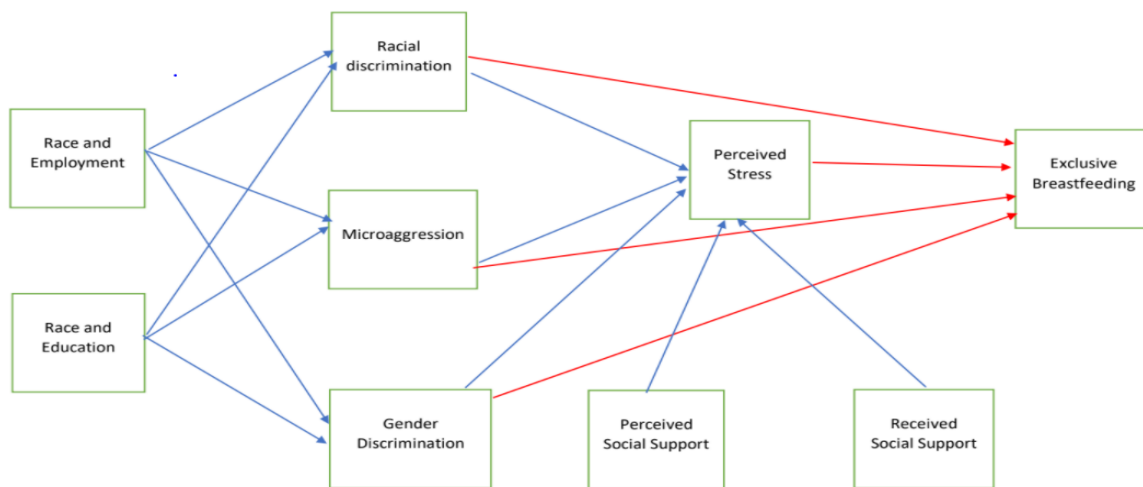


Figure 9: Conceptual path diagram of the relationship between psychosocial factors and exclusive breastfeeding

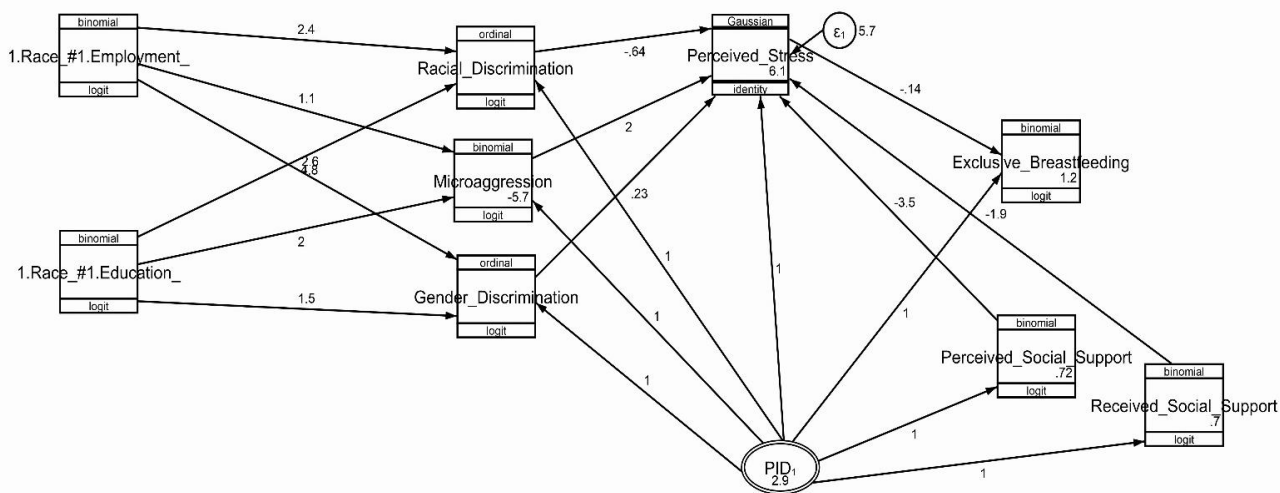


Figure 10: Full path diagram of the relationship between psychosocial factors and exclusive breastfeeding

Direct and indirect effects of racial discrimination, microaggressions, and gender discrimination on exclusive breastfeeding. Interaction terms between race and employment, race, and education were included in model. Numbers represent path coefficients. Panel Identification number (PID) (multilevel latent variables, with coefficients constrained to equal 1) is a random intercept for participants; arrows denote associations; ϵ in circles represent error terms for perceived stress (a continuous variable).

4.3.3 Results

Table 12 describes the characteristics of our analytic sample. Approximately 67% of the participants were White, and 32% were Black. Overall, more White participants had some college degree or higher, were employed, and had higher incomes than Black participants.

Table 12: Characteristics of the respondents stratified by race (White and Black)

| Sociodemographic variables | All (N=251) | % | White (n=173) | % | Black (n=78) | % |
|-----------------------------------|--------------------|----------|----------------------|----------|---------------------|----------|
| Maternal age in years | 251 | 29.9* | 173 | 31.0 | 78 | 27.5* |
| Employment status | | | | | | |
| Employed | 175 | 69.7 | 137 | 79.2 | 38 | 48.7 |
| Unemployed | 76 | 30.3 | 36 | 20.8 | 40 | 51.3 |
| Marital status | | | | | | |
| Unmarried | 128 | 42.5 | 45 | 26.0 | 14 | 18.0 |
| Married or partnered | 173 | 57.5 | 128 | 74.0 | 64 | 82.0 |
| Income level | | | | | | |
| Less than \$30,000 | 96 | 38.3 | 32 | 18.5 | 64 | 82.1 |
| \$31000 and above | 155 | 61.8 | 141 | 81.5 | 14 | 17.9 |
| Education level | | | | | | |
| Less than college degree | 55 | 21.9 | 17 | 9.8 | 38 | 48.7 |
| College degree or higher | 196 | 78.1 | 156 | 90.2 | 40 | 51.3 |

*Mean maternal age

Direct effects of stress and discrimination on exclusive breastfeeding

As shown in Tables **13** and **14**, perceived stress has a direct effect on exclusive breastfeeding (β : -0.14, 95%CI: -0.17 to -0.12, p-value<0.001). With one unit increase in perceived stress score, the likelihood of exclusive breastfeeding decreases by 13% (OR: 0.87, 95%CI: 0.84 to 0.89, p-value<0.001). In addition, table 2 shows that racial discrimination, microaggressions,

and gender discrimination do not have a significant direct relationship with exclusive breastfeeding.

Indirect effects of stress and discrimination on exclusive breastfeeding

Tables 13 and 14 show that perceived stress mediates the relationship between the following psychosocial factors: microaggressions, perceived social support, received social support, and exclusive breastfeeding. Compared to participants who did not report microaggressions, participants who reported microaggression experienced an increased stress level by two units (β : 2.02, 95%CI: 1.57 to 2.46, p-value<0.001). Participants who perceived they had social support reported lower stress than those who did not (β : -3.46, 95%CI: -3.61 to -3.32, p-value<0.001). Similarly, those who received breastfeeding support experienced a reduction in their stress by 1.87 units. There was no observed relationship between racial discrimination, gender discrimination, and perceived stress. Participants who self-identified as Black and had a college education were 7.4 times more likely to report microaggressions (OR:7.39, 95%CI: 3.78-14.44, p-value<0.001) than White participants with no college degree. Also, unemployed Black participants were more likely to report microaggressions (OR:3.06 95%CI:1.05-8.94, p value=0.041) than employed White participants.

Table 15 shows that the interaction term between race and education (β :-0.58) had the largest indirect effect on exclusive breastfeeding.

Table 13: Path coefficients of Full model

| Dependent variable | Independent variable | beta (95%CI) | P value |
|---------------------------|--|----------------------|----------------|
| Direct effect | | | |
| Exclusive breastfeeding | Perceived Stress | -0.14 (-0.17, -0.12) | <0.001 |
| | Racial discrimination | -1.69 (-4.74,-1.36) | 0.278 |
| | Microaggression | 0.20 (-0.27, 0.68) | 0.412 |
| | Gender discrimination | -0.19 (-0.88, 0.49) | 0.570 |
| Indirect effect | | | |
| Perceived Stress | Racial discrimination | -0.64 (-1.45, 0.17) | 0.121 |
| | Microaggression | 2.02 (1.57, 2.46) | <0.001 |
| | Gender discrimination | 0.23 (-0.50, 0.97) | 0.532 |
| | Perceived Social Support | -3.46 (-3.61, -3.32) | <0.001 |
| | Received social support | -1.87 (-2.01, -1.73) | <0.001 |
| Racial discrimination | Race*Employment(Ref:White;employed) Black unemployed | 2.39 (0.004, 4.78) | 0.049 |
| | Race*Education(Ref: White; uneducated) Black educated | 4.78 (2.40, 7.15) | <0.001 |
| Microaggression | Race*Employment(Ref:White;employed) Black unemployed | 1.12 (0.05, 2.19) | 0.041 |
| | Race*Education(Ref: White; uneducated) Black educated | 2.00 (1.33, 2.67) | <0.001 |
| Gender discrimination | Race*Employment(Ref:White;employed) Black unemployed | 2.64 (1.06, 4.21) | 0.001 |
| | Race*Education(Ref: White; uneducated) Black educated | 1.51 (-0.06, 3.09) | 0.059 |

^aDirect effect: Coefficients between the proximate and outcome variables without the contribution of intermediate variables

^bIndirect effect: Product of the coefficients between the distal variables and outcome through intermediate variables

^cPerceived Stress: Adapted cohen's perceived stress scale

^dRacial discrimination: Today, how often were you treated unfairly than other people because of your race?

^eMicroaggressions: Adapted gendered racial microaggressions scale

^dGender discrimination: Today, how often were you treated unfairly than other people because of your gender?

Complete pathways

The re-specified model (Figure 12) illustrates four complete pathways (both indirect and direct effects) through which stress mediates the relationship between psychosocial factors and exclusive breastfeeding. Path 1 has the highest impact on exclusive breastfeeding, followed by Path 2, Path 3, and Path 4, respectively.

Race*Education $\xrightarrow{\beta=2.00***}$ Microaggressions $\xrightarrow{\beta=2.02***}$ Perceived Stress $\xrightarrow{\beta=-0.14***}$ Exclusive breastfeeding (*Path 1*)

*Legend: \Rightarrow : Direct effect, \rightarrow : indirect effect; β : path coefficient; ***significant at p-value<0.001*

Perceived social support $\xrightarrow{\beta=-3.47***}$ Microaggressions $\xrightarrow{\beta=2.02***}$ Perceived Stress $\xrightarrow{\beta=-0.14***}$ Exclusive breastfeeding (*Path 2*)

*Legend: \Rightarrow : Direct effect, \rightarrow : indirect effect; β : path coefficient; ***significant at p-value<0.001*

Race*Employment $\xrightarrow{\beta=1.12*}$ Microaggressions $\xrightarrow{\beta=2.02***}$ Perceived Stress $\xrightarrow{\beta=-0.14***}$ Exclusive breastfeeding (*Path 3*)

*Legend: \Rightarrow : Direct effect, \rightarrow : indirect effect; β : path coefficient; *significant at p-value<0.05*

Received social support $\xrightarrow{\beta=-1.87***}$ Microaggressions $\xrightarrow{\beta=2.02***}$ Perceived Stress $\xrightarrow{\beta=-0.14***}$ Exclusive breastfeeding (*Path 4*)

*Legend: \Rightarrow : Direct effect, \rightarrow : indirect effect; β : path coefficient; ***significant at p-value<0.001*

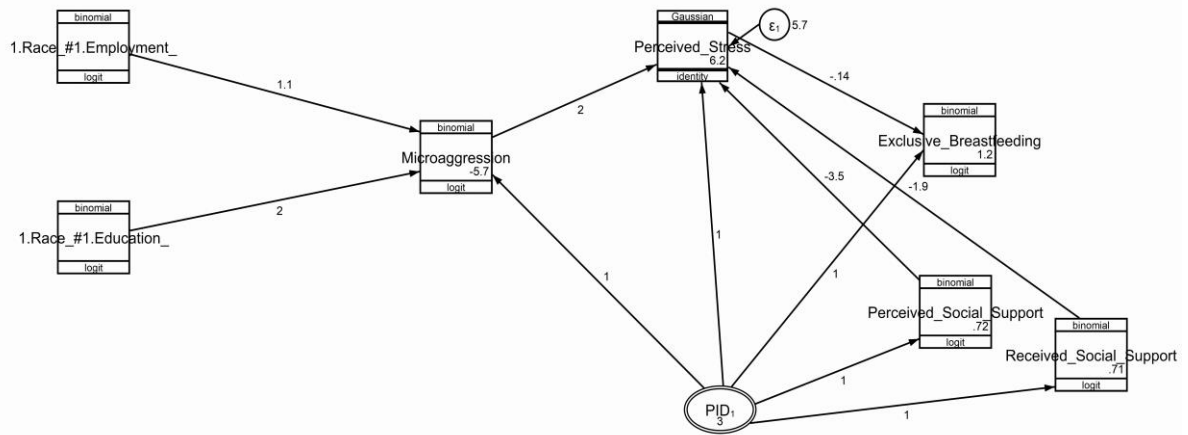


Figure 11: Respecified model showing only significant variables in the path diagram

Direct and indirect effects of microaggressions on exclusive breastfeeding. Interaction terms between race and employment, race, and education were included in model. Numbers represent path coefficients. Panel Identification numbers (PID) (multilevel latent variables, with coefficients constrained to equal 1) is a random intercept for participants; arrows denote associations; ϵ in circles represent error terms for perceived stress (a continuous variable).

Table 14: Odds ratio of the re-specified model (only significant paths included)

| Dependent variable | Independent variable | OR | P-value |
|------------------------------------|--------------------------------------|--------------------|---------|
| Direct effect^a | | | |
| Exclusive breastfeeding | Perceived Stress | 0.87 (0.84, 0.89) | <0.001 |
| Indirect effect^b | | | |
| Perceived Stress ^c | Microaggression | | |
| | Perceived Social Support | | |
| | Received social support | | |
| Microaggression ^d | Race*Employment(Ref:White;employed) | | |
| | Black unemployed | 3.06 (1.05, 8.94) | 0.041 |
| | Race*Education(Ref:White;uneducated) | | |
| | Black educated | 7.39 (3.78, 14.44) | <0.001 |

^aDirect effect: Coefficients between the proximate and outcome variables without the contribution of intermediate variables

^bIndirect effect: Product of the coefficients between the distal variables and outcome through intermediate variables

^cPerceived Stress: Adapted cohen's perceived stress scale

^dMicroaggressions: Adapted gendered racial microaggressions scale

Table 15: Path coefficients of significant direct, indirect, and total effects from psychosocial factors to exclusive breastfeeding

| Variables | Direct effect^a | Indirect effect^b | Total effect^c |
|--|----------------------------------|------------------------------------|---------------------------------|
| Race*Education (Ref:White;uneducated) Black educated | | -0.58(-0.34, -0.78) | 0.58 |
| Race*Employment (Ref:White;employed) Black unemployed | | -0.33(-0.20, -0.64) | 0.33 |
| Microaggression | | -0.29 (-0.26, -0.44) | 0.29 |
| Perceived Stress | -0.14 (-0.17, -0.12) | | 0.14 |
| Perceived Social Support | | 0.50 (0.39, 0.60) | 0.50 |
| Received social support | | 0.27 (0.20, 0.34) | 0.27 |

^aDirect effect: Coefficients between the proximate and outcome variables without the contribution of intermediate variables

^bIndirect effect: Product of the coefficients between the distal variables and outcome through intermediate variables

^cTotal effect: Sum of direct and indirect effects

4.3.4 Discussion

This study examines the direct and indirect effects of racial discrimination, microaggression, and gender discrimination on exclusive breastfeeding. Black educated and Black unemployed participants in our study compared to White uneducated and White unemployed participants were more likely to experience microaggressions. We found that perceived stress mediated the relationship between microaggression and exclusive breastfeeding such that microaggressions increased stress, which in turn reduced the likelihood of exclusive breastfeeding. Racial discrimination, microaggression, and gender discrimination had no significant direct effects on exclusive breastfeeding and among the three forms of discrimination examined, only microaggressions had an indirect effect on exclusive breastfeeding.

Our finding that Black educated participants were more likely to experience microaggressions is consistent with other research on microaggressions among Black educated graduate students, college professors, and professionals who identified as women.³²²⁻³²⁴ These

studies show that educated Black women across the academia, health care settings corporate world often reported higher levels of perceived microaggressions.³²⁴⁻³²⁸ From recent literature, some of the reported subtle microaggressions were as follows: people making you feel self-conscious when growing dreadlocks and “too Black”, White students roll their eyes, speak to one another during lectures, pass notes, or not participate in classroom discussions.^{325,328} It is possible that participants in our study with some college degree may have experienced institutional discrimination or received subtle derogatory messages, which can even serve as a barrier to educational or occupational achievement. We also observed that Black unemployed participants were more likely to report experiencing microaggressions. While most studies on microaggressions were situated in the workplace and institutions of higher education, research has shown that experiences of microaggressions in the workplace may result in unemployment, and job insecurity.³²⁹

As expected, participants in our study who reported microaggressions were more likely to report higher stress levels. Our results are comparable to many other studies that have demonstrated the relationship between microaggressions and stress among Black women.^{301,330,331} Microaggressions can lead to chronic stress, resulting in loss of appetite, anxiety, fatigue, hypertension, depression, and preterm birth.^{299,332-334} Our findings provide additional evidence that subtle forms of gendered racism, such as gendered racial microaggressions, are associated with increased perceived stress. While these single microaggressions events may appear harmless and mild, their accumulation over time may overstretch a person’s stress response systems and cause more harm to the body than major racial discrimination experiences.^{315,335} The path analysis further showed that increased perceived stress from microaggressions led to a reduced likelihood of exclusive breastfeeding. Other studies have also shown that stress reduces the likelihood of breastfeeding.^{143,249} This underscores the importance of exploring ways of reducing stress induced

by microaggressions, especially in childbearing people who are also burdened with stressors associated with postpartum periods.

The path analysis showed that perceived stress did not mediate the relationship between racial discrimination, gender discrimination, and exclusive breastfeeding in our study. The lack of statistically significant findings was unexpected, given the empirical support in the literature that racial and gender discrimination were associated with increased stress levels.³⁰¹ Participants in our study were more likely to experience subtle gendered racial microaggressions than overt racial and gender discrimination. Many scholars posit that the frequency and intensity of obvious forms of racial discrimination have decreased since the 1960s.³³⁶⁻³³⁹ However, subtle racial discrimination in the form of microaggressions persists.^{297,336}

No form of discrimination had a significant direct relationship on exclusive breastfeeding in our study. Our findings were inconsistent with the few studies that suggest a direct relationship between discrimination and breastfeeding. These studies reported that Black women's experiences of racism on the job, in housing, and structural racism, and implicit bias in healthcare services and lactation support adversely affected breastfeeding initiation and duration. The non-significant result that we observed could be attributed to our measure of racism assessing interpersonal racism, and perhaps fewer reported racial and gender discrimination cases than microaggressions in our study. Studies have shown that the direct effect of discrimination on breastfeeding is usually a result of institutional and structural racism,^{82,314,340,341} which may not be reported as interpersonal racism. Examples of institutional racism Black childbearing people often cite as directly impacting their breastfeeding outcomes were financial barriers to access lactation support, health care providers' skepticism about their ability to exclusively breastfeed, or the quality of breastfeeding information or support they receive from health care professionals.^{82,314,340} In addition, structural

racism in the form of workplace barriers prevents childbearing people from breastfeeding. Black childbearing people are more likely to engage in employments with no or shorter maternity leave, non-flexible work hours,^{41,342} more stressful, and less social support to breastfeed.^{105,343}

This study has several limitations. One of the limitations of this study is our inability to measure some forms of structural and institutional discrimination that prevent childbearing people from exclusively breastfeeding. Also, we used an adapted, and abridged version of the original validated Perceived Stress Scale (PSS), and Gendered Racial Microaggressions scale (GRMS). However, the reliability test of the adapted PSS showed high internal consistency of Cronbach's alpha 0.81. We also note that our sample was drawn from one county in Pennsylvania, and as such, our findings may not be generalizable to other settings.

While researchers refer to SEM as causal models, it is important to note that SEM does not demonstrate causality. Hence we interpreted our results as correlations; however, this approach enabled us to determine whether the hypothesized pathway is plausible or not.³⁴⁴ The generalized structural equation modeling is still evolving, and at the time of the analysis, the goodness-of-fit tests were not available on STATA software. As such, we were unable to assess model fit for our re-specified model.

Despite these limitations, our study found a relationship between microaggression, and exclusive breastfeeding mediated through perceived stress. In addition, our research utilized an ecological momentary assessment (EMA), a novel data collection method that samples subject experiences in real-time, minimizing recall bias. In our study, perceived stress was measured earlier in the day before exclusive breastfeeding which was measured at the end of the day. The longitudinal nature of the data enabled us to establish temporality, in which case we were certain that the mediator was not measured simultaneously as the outcome. This reduces the chances of

reverse causation. Another strength is using standardized scales to measure perceived stress and microaggressions. Scales are typically superior and capable of capturing a behavior, a feeling, or an action better than a single variable or item.³⁴⁵

4.3.5 Conclusion

To our knowledge, no other study has examined the direct and indirect effects of racial discrimination, gender discrimination, microaggressions, and exclusive breastfeeding using data from an ecological momentary assessment. We also hypothesized that perceived stress would mediate the relationship between these forms of discrimination and exclusive breastfeeding. Our findings suggest Black educated, and Black unemployed childbearing people were more likely to report microaggressions which was associated with higher perceived stress and reduce the likelihood of exclusive breastfeeding.

At the societal level, it is crucial to recognize the negative effect of microaggressions on Black childbearing people who also may be experiencing additional stress from pregnancy and postpartum periods. Recognition of this as a problem should translate into programs that address on the prevalence of microaggression, its negative effect and how and where individuals experiencing it can seek help. Healthcare workers would benefit from trainings on cultural competence, cultural humility, and relationship-centered care with a critical race perspective. This could help reduce preconceived prejudices and stereotypes about Black childbearing people and breastfeeding among them, as well as ensure that clinicians understand the effects of historical and present-day racism on health outcomes of Black people

Positive coping strategies have been demonstrated to have a protective effect among Black people who experienced higher levels of discrimination. Lu and colleagues, in their study

highlighted that “positive coping” behaviors, as discussing experiences of racism rather than keeping quiet, may help relieve the associated stress and provide a buffer against adverse biologic effects.³⁴⁶ It may be necessary to integrate positive coping strategies addressing gendered racial microaggressions in prenatal care among childbearing people. In addition, program implementers need to purposefully design interventions to increase social support among Black childbearing people, which buffers against the adverse effects of minority stress.

Further studies are needed to determine the direct and indirect effect of specific institutional and structural racism on exclusive breastfeeding. There is also a need to conduct qualitative research on the effect of discrimination on exclusive breastfeeding as this would provide the nuances lacking in quantitative studies.

5.0 Discussion

This dissertation aimed to examine the psychosocial factors that influence exclusive breastfeeding and potentially contribute to the racial disparity in exclusive breastfeeding. The psychosocial factors of interest were stress, various forms of social support and discrimination. To assess this, it was important to decide on the best measure of exclusive breastfeeding. The dissertation results are divided into three analyses, the first is an exploratory analysis of the two main methods of measuring exclusive breastfeeding. I compared the 24-hour recall/current status to the since-birth methods of measuring exclusive breastfeeding and assessed the magnitude of differences in exclusive breastfeeding rates between the two. World Health Organization recommends that exclusive breastfeeding rates be calculated based on the previous-day recall to avoid recall bias.²¹¹ Also, exclusive breastfeeding can be measured by obtaining life-long, or since birth exclusive breastfeeding indicator.¹⁹⁸ In this case, an infant is categorized as being exclusively breastfed if the infant has not received any food or drink other than breastmilk since birth.

The 24-hour recall method is commonly used in national demographic health surveys, which are mostly cross-sectional studies because it is easy to collect and requires little technology. It reduces the apparent risk of recall bias and is valuable in low-resource countries.¹⁹⁵ The since birth method requires a more extended recall period and strictly emphasizes the WHO recommendation of exclusive breastfeeding for the first six months of life.¹⁹⁸ The Center for Disease Control and Prevention estimates exclusive breastfeeding in the National Immunization Survey using the since birth method.

The results from the first analysis show that the 24-hour recall exclusive breastfeeding rates were higher across the first six months postpartum than the since birth exclusive breastfeeding

rates. This observed difference between the 24-hour recall and since birth EBF rates were seen across race, income, education, marital status, and employment status. Several other studies have demonstrated that using the 24-hour recall approach overestimates the prevalence of exclusive breastfeeding compared to the since birth approach.^{203,204,217,218,347} Irrespective of the method used to measure EBF rates, EBF rates among White participants were consistently higher than that of Black participants. This finding corroborates previous studies showing that Black people have the lowest breastfeeding initiation rates, exclusive breastfeeding, and breastfeeding duration than all other racial/ethnic groups.^{41,58,60,273-275}

Although the 24-hour recall method overestimates exclusive breastfeeding, it is useful and enables one to observe the complexities of infant feeding patterns and behavior in prospective studies or longitudinal studies like this. With an understanding of the two measures of exclusive breastfeeding, the different ways to measure and interpret, and their potential limitations, I chose to conduct subsequent analyses using the 24-hour recall exclusive breastfeeding rates. The fluctuation observed in the repeated measures of 24-hour recall exclusive breastfeeding suggests that the variable has a within-person variation (e.g., some days an individual exclusively breastfeeds and some days they do not), which is necessary to investigate further.

In the second analysis, I examined the relationship between the repeated measures of perceived stress and the repeated measures of 24-hour recall exclusive breastfeeding, including the racial differences and the moderating effects of perceived and received social support on this relationship. I found that participants who reported higher perceived stress were less likely to breastfeed exclusively for six months. Previous studies have shown that stress negatively affects exclusive breastfeeding.^{143,249} While these studies did not operationalize stress as perceived stress, they demonstrate a significant relationship between stressful life events and decreased likelihood

of exclusive breastfeeding.^{143,249} This result has possible physiological explanations. Elevated stress may induce hormonal responses that can reduce prolactin and oxytocin secretion, leading to inadequate milk supply or preventing the milk letdown reflex, thus causing exclusive breastfeeding cessation.^{228,233,241,259} Alternatively, stress can induce psychological burden and associated behavioral changes which can impair exclusive breastfeeding.²²²

My second analysis shows that perceived social support moderated the negative relationship between perceived stress and exclusive breastfeeding. Child-bearing people with social support had a less negative effect from stress. Perceived social support in this analysis measures an individual's perceived support from 3 sources: family, friends, and significant other. Perceived social support from family, friends, and significant others have been shown to moderate the effect of stress on health behavior.^{131,260,261} Previous studies have also shown that partners, friends, and family members provide psychological support, which may not necessarily be informational or tangible support needed for exclusive breastfeeding.²⁶²⁻²⁶⁶ Received social support did not moderate the relationship between perceived stress and exclusive breastfeeding but directly increased the likelihood of exclusive breastfeeding. Although I did not measure the specific source of breastfeeding support, research has shown that parents who received social support from health professionals, antenatal groups, or postpartum breastfeeding support groups tend to exclusively breastfeed longer.²⁶⁹⁻²⁷¹ Also, receiving informational support and emotional social support from health care professionals and lactation consultants can also increase exclusive breastfeeding.²⁶⁹⁻²⁷¹

Similar to the results of my first analysis, Black participants in my second analysis were less likely to breastfeed when compared to White participants. This result supports previous studies and national data demonstrating the racial gap and disparity in exclusive breastfeeding in the

United States.^{41,58,60,273-275} Following this, I hypothesized that Black participants who experienced higher stress would be less likely to exclusively breastfeed than White participants who experienced similar high stress levels. Interestingly, Black and White participants in this study had similar stress levels, and Black participants who experienced stress were more likely to breastfeed exclusively than White participants who experienced stress. This finding is inconsistent with other research studies that suggest that Black people are more likely to experience stress,^{278,301} and high stress which is associated with many disease conditions, contribute to the disparity observed in adverse birth outcomes, including breastfeeding.^{121,232,236,277} This unexpected result can be attributed to heightened stress experienced by the US public, especially during the early stages of the COVID-19 Pandemic, a non-normative event for everyone. In addition, coping and resilience models may explain the observed results. The coping and resilience model suggests that some Black people in the US have developed coping strategies and resilience that have enabled them to overcome difficulties and the negative consequences of their environments.^{279,348} Alternatively, the unexpected finding may also have resulted from the measure of stress. This study did not measure chronic stress, which is more prevalent among Black childbearing people and leads to adverse health outcomes.¹²³ An individual can have chronic stress yet does not perceive their life as stressful, having lived in that circumstance for an extended period.

In the third analysis, I examined the direct and indirect effects of three forms of discrimination- racial discrimination, microaggression, and gender discrimination on exclusive breastfeeding. Black educated and Black unemployed participants in the study compared to White uneducated and White unemployed participants were more likely to experience microaggressions. I found that perceived stress mediated the relationship between microaggression and exclusive breastfeeding such that microaggressions increased stress, which in turn reduced the likelihood of

exclusive breastfeeding. This finding highlights that the racial disparities observed in exclusive breastfeeding may be attributable at least in part to subtle gendered and racial microaggressions. Microaggressions, as shown in other studies, can lead to chronic stress, resulting in loss of appetite, anxiety, fatigue, hypertension, depression, and preterm birth.^{299,332-334} Sadly, racism persists in the United States and continues to negatively impact the health of affected people of color.

In addition, perceived stress in this analysis did not mediate the relationship between racial discrimination, gender discrimination, and exclusive breastfeeding. The lack of statistically significant findings was unexpected, given the empirical support in the literature that racial and gender discrimination were associated with increased stress.³⁰¹ Participants in this study were more likely to experience subtle gendered racial microaggressions than overt racial and gender discrimination. There are speculations that the frequency and intensity of obvious forms of racial discrimination have decreased since the 1960s.³³⁶⁻³³⁹ However, subtle racial discrimination in the form of microaggressions persists^{297,336} and is more likely to be noticed than how the law subtly excludes Blacks or people of color. These findings provide additional evidence that microaggressions are associated with increased perceived stress, and as earlier on discussed, perceived stress can hinder childbearing people from breastfeeding exclusively.

Together, these findings demonstrate the critical role of stress, social support, and discrimination in exclusive breastfeeding and their potential role in the observed racial disparities in exclusive breastfeeding rates and duration. Psychosocial factors like perceived stress, social support, and microaggressions may be easier to modify than sociodemographic factors and represent a potential focus for support and intervention. Previous research suggest that psychosocial factors are likely to play a significant role in exclusive breastfeeding.²²⁴⁻²²⁶ de Jager and colleagues in their study recommended that future research examining the influence of

psychosocial factors on exclusive breastfeeding should do so systematically and rigorously using longitudinal study designs.²²⁴ This is a rigorous longitudinal study and will contribute to the body of knowledge on the psychosocial factors that influence exclusive breastfeeding and contribute to the observed racial disparity in exclusive breastfeeding. The findings have important implications for public health interventions that can modify psychosocial factors that deter exclusive breastfeeding and exacerbate racial inequity across exclusive breastfeeding rates. They are valuable in designing and implementing interventions that can reduce stress and increase social support among childbearing people and address all manifestations of racism to ensure equitable breastfeeding outcomes.

This dissertation has several strengths. One of the strengths is the use of ecological momentary assessment (EMA), a novel data collection method that samples subject experiences in real-time, minimizing recall bias. The observed variation in stress and exclusive breastfeeding allowed us to examine the effect of daily reports of perceived stress and exclusive breastfeeding. Another strength is the use of a standardized scale to measure perceived stress, perceived social support, and microaggressions. In addition, the longitudinal nature of the data enabled me to establish temporality, in which case we were certain that the mediator was not measured simultaneously as the outcome. This reduces the chances of reverse causation.

Despite these strengths, this study has many limitations. First, the study sample has a higher income and education level than the general birth population of the study area. Second, the study had a limited sample size, especially for those who do not identify as either Black or White. Third, the sample was drawn from one maternity hospital serving the majority of births in one Pennsylvania county, and as such, our findings may not be generalizable to other settings. Fourth, while I used validated scales to measure perceived stress, perceived social support, and

microaggression, these scales were abridged to reduce respondent burden and fatigue. Nevertheless, the reliability test for the adapted Perceived Stress Scale (PSS) and Multidimensional Scale of Perceived Social Support (MSPSS) showed high internal consistency of Cronbach's alpha 0.81 and 0.95, respectively. Fifth, the measure of stress was self-reported perceived stress. Stress can be objectively measured by cortisol, an important biomarker for chronic stress. This measure is relevant since the effect of stress on health becomes prominent when it becomes chronic.³⁴⁹ Another limitation is the inability to delineate the sources of perceived social support and received social support. The Multidimensional Scale of Perceived Social Support (MSPSS) measures social support from family, friends, and significant others, but the analysis conducted did not disaggregate perceived social support by these sources. Similarly, I was not able to present the specific sources of the measure of received social support (breastfeeding support). This information can provide insights into the categories of health professionals that provide effective social support that can improve breastfeeding. Finally, I could not examine the role of institutional and structural racism on exclusive breastfeeding. While the measure of racism in the study is at the interpersonal level, it is essential to address racism at the societal level because interpersonal racism is learned and inherited from the biases in our society and upbringing.

6.0 Conclusion

This study contributes to the literature on the role of psychosocial factors in exclusive breastfeeding. My findings demonstrate the need for researchers to clarify the definition and how breastfeeding outcomes such as exclusive breastfeeding are measured in their studies. It highlights the need to explore how childbearing people articulate the term exclusive breastfeeding. It also provides evidence that critical psychosocial factors such as stress, various forms of social support, and gendered racial microaggression can influence exclusive breastfeeding and may contribute to the racial disparity observed in exclusive breastfeeding rates.

This study shows that perceived stress is detrimental to exclusive breastfeeding. Many modifiable problems such as lack of breastfeeding support both at work and outside the workplace and racial discrimination are stressors among childbearing people. It provides evidence that racism in the form of gendered racial microaggressions impacts exclusive breastfeeding negatively. Findings from my dissertation demonstrated that social support had both direct and indirect benefits for exclusive breastfeeding.

6.1 Implication for practice

Breastfeeding support programs involving partners, family, and friends can play an important role in buffering stress, especially among minority groups. Interventions that ensure easy access to breastfeeding support in birth facilities and, at home/in the community as well as, access to racially concordant care from birth workers is critical to increasing exclusive breastfeeding

among childbearing people, especially Black childbearing people. I recommend that health departments and public health program managers scale up the use of racially diverse community health workers (CHWs) as breastfeeding peer counselors as they can provide culturally appropriate breastfeeding counseling and support services.

6.2 Implication for research

This dissertation also has implications for research. Further research is needed to:

- Determine the potential sources of stress among breastfeeding people and how these specific sources of stress, like work stress, can influence exclusive breastfeeding.
- Examine how different types of social support such as emotional, informational, appraisal, and tangible support or different sources of social like family, health providers, lactation support staff can affect exclusive breastfeeding.
- Measure stress using cortisol or chronic stress in addition to perceived stress.
- Determine the effects of specific institutional and structural racism on exclusive breastfeeding.
- Conduct qualitative research on the effect of discrimination on exclusive breastfeeding as this would provide more insights into this relationship.
- Conduct qualitative studies to explore how parents view and define exclusive breastfeeding.

Appendix A : Measures for Analysis 2

| CONSTRUCT | Variable name | Question | Response | Delivery |
|---|-------------------|---|---|--------------------------------|
| Outcome variables | | | | |
| Exclusive breastfeeding | EXCLUSIVE | Are you exclusively breastfeeding? | 0-No 1-Yes | EMA: End of Day (EOD) |
| Independent variables | | | | |
| <p>PERCEIVED STRESS</p> <p>Perceived Stress was adapted from widely used and validated Cohen Perceived Stress Scale (CPSS) 10²⁵³ and CPSS.²⁵¹ Cronbach alpha for PSS 10 and PSS 4 are 0.78 and 0.60 respectively.²⁵⁴ The adapted PSS scale had Cronbach's alpha coefficient of 0.82.</p> | STRESS | Rate if you are feeling nervous or "stressed" right now? | 0-Never 1-Rarely 2-Sometimes 3-Often 4-Very Often | EMA: Random days (RAND) |
| | DIFFICULTY | Do you feel difficulties are piling up so high that you cannot overcome them? | 0-Never 1-Rarely 2-Sometimes 3-Often 4-Very Often | EMA: Random days (RAND) |
| | CONTROL | Rate if you feel like you are unable to control the important things in your life? | 0-Never 1-Rarely 2-Sometimes 3-Often 4-Very Often | EMA: Random days (RAND) |

| | | | | |
|---|----------------------|---|---|--------------------------------|
| | SELFEFFICACY | Rate if you feel confident in your ability to handle your personal problems? | 0-Never 1-Rarely 2-Sometimes 3-Often 4-Very Often | EMA: Random days (RAND) |
| BREAST FEEDING SUPPORT | BREASTSUPPORT | Is there a person/group/organization (e.g., family, professionals) that is helping you or providing any support (e.g., resources, emotional) to continue to breastfeed? | 0-No 1-Yes | EMA: End of Day (EOD) |
| <p>PERCEIVED SOCIAL SUPPORT</p> <p>Perceived social support was measured using the Multidimensional Scale of Perceived Social Support (MSPSS).²⁵⁷ MSPSS has three subscales that measure an individual's perception of support from 3 sources: family, friends, and significant other. The widely validated MSPSS scale has 12 items a Cronbach's α of 0.88; however, we used 11 items to reduce survey burden on the respondents. On a 4-point Likert scale, the respondents indicated the extent to which each statement described their current relationships with their friends, family, and significant other. Responses ranged from 0 (strongly disagree) to 4 (strongly agree). I recoded MSPSS as a dichotomous variable, grouped as: no (0-2 points) and yes (3 and 4 points).</p> | SPAROUND | There is a special person who is around when I am in need. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | SPSHARE | There is a special person with whom I can share my joys and sorrows. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FAMTRYHELP | My family really tries to help me. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |

| | | | | |
|--|-------------------|--|---|--|
| | FAMEMOHELP | I get the emotional help and support I need from my family. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | SPCOMFORT | I have a special person who is a real source of comfort to me. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FRDSHELP | My friends really try to help me. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FRDSCNTON | I can count on my friends when things go wrong. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FAMTALK | I can talk about my problems with my family. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |

| | | | | |
|--|-------------------|---|---|--|
| | FRDSSHARE | I have friends with whom I can share my joys and sorrows. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | SPFEELINGS | There is a special person in my life who cares about my feelings. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FRDSTALK | I can talk about my problems with my friends. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |

Appendix B : Measures for Analysis 3

| CONSTRUCT | Variable name | Question | Response | Delivery |
|---|-------------------|---|---|--------------------------------|
| Outcome variables | | | | |
| EXCLUSIVE BREASTFEEDING | EXCLUSIVE | Are you exclusively breastfeeding? | 0-No 1-Yes | EMA: End of Day (EOD) |
| Independent variables | | | | |
| <p>PERCEIVED STRESS</p> <p>Perceived Stress was adapted from widely used and validated Cohen Perceived Stress Scale (CPSS) 10²⁵³ and CPSS.²⁵¹ Cronbach alpha for PSS 10 and PSS 4 are 0.78 and 0.60 respectively.²⁵⁴ The adapted PSS scale had Cronbach's alpha coefficient of 0.82.</p> | STRESS | Rate if you are feeling nervous or "stressed" right now? | 0-Never 1-Rarely 2-Sometimes 3-Often 4-Very Often | EMA: Random days (RAND) |
| | DIFFICULTY | Do you feel difficulties are piling up so high that you cannot overcome them? | 0-Never 1-Rarely 2-Sometimes 3-Often 4-Very Often | EMA: Random days (RAND) |
| | CONTROL | Rate if you feel like you are unable to control the important things in your life? | 0-Never 1-Rarely 2-Sometimes 3-Often 4-Very Often | EMA: Random days (RAND) |

| | | | | |
|---|----------------------|---|---|--------------------------------|
| | SELFEFFICACY | Rate if you feel confident in your ability to handle your personal problems? | 0-Never 1-Rarely 2-Sometimes 3-Often 4-Very Often | EMA: Random days (RAND) |
| BREAST FEEDING SUPPORT | BREASTSUPPORT | Is there a person/group/organization (e.g., family, professionals) that is helping you or providing any support (e.g., resources, emotional) to continue to breastfeed? | 0-No 1-Yes | EMA: End of Day (EOD) |
| <p>PERCEIVED SOCIAL SUPPORT</p> <p>Perceived social support was measured using the Multidimensional Scale of Perceived Social Support (MSPSS).²⁵⁷ MSPSS has three subscales that measure an individual's perception of support from 3 sources: family, friends, and significant other. The widely validated MSPSS scale has 12 items a Cronbach's α of 0.88; however, we used 11 items to reduce survey burden on the respondents. On a 4-point Likert scale, the respondents indicated the extent to which each statement described their current relationships with their friends, family, and significant other. Responses ranged from 0 (strongly disagree) to 4 (strongly agree). I recoded MSPSS as a dichotomous variable, grouped as: no (0-2 points) and yes (3 and 4 points).</p> | SPAROUND | There is a special person who is around when I am in need. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | SPSHARE | There is a special person with whom I can share my joys and sorrows. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FAMTRYHELP | My family really tries to help me. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |

| | | | | |
|--|-------------------|--|---|--|
| | FAMEMOHELP | I get the emotional help and support I need from my family. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | SPCOMFORT | I have a special person who is a real source of comfort to me. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FRDSHELP | My friends really try to help me. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FRDSCNTON | I can count on my friends when things go wrong. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FAMTALK | I can talk about my problems with my family. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |

| | | | | |
|------------------------------|-------------------|--|---|-------------------------|
| | FRDSSHARE | I have friends with whom I can share my joys and sorrows. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | SPFEELINGS | There is a special person in my life who cares about my feelings. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| | FRDSTALK | I can talk about my problems with my friends. | 0-Strong disagree 1-Disagree 2-Neutral 3-Agree 4-Strongly agree | |
| RACIAL DISCRIMINATION | RACEDISC | Today, how often were you treated unfairly than other people because of your race? | 0=never 1= 1 time 2= 2 times 3= 3 times 4= 4 or more times | EMA: Random days |
| GENDER DISCRIMINATION | GENDERDISC | Today, how often were you treated unfairly than other people because of your gender? | 0=never 1= 1 time 2= 2 times 3= 3 times 4= 4 or more times | EMA: Random days |
| MICROAGGRESSION | FACIALFEAT | Receive negative comments about the size of my facial features | 0-No 1-Yes | EMA: Random |

| | | | | |
|---|-------------------|---|---------------|--------------------|
| <p>Adapted from the Gendered Racial Microaggression (GRM) scale.³²⁰ GRM Scale is a 26-item measure that assesses Black women’s experiences of everyday and subtle gendered racism. It has a reliability of (α 0.92) and evaluates Black women’s experience across four domains: a) Assumptions of Beauty and Sexual Objectification; (b) Silenced and Marginalized; (c) Strong Black Woman Stereotype, and (d) Angry Black Woman Stereotype.³²⁰ The adapted scale used in the study had 13 questions; questions from the domain that assessed the angry black woman stereotype were dropped to reduce respondents’ fatigue.</p> | SKINTONE | Receive negative comments about my skin tone | 0-No 1-Yes | EMA: Random |
| | PHYSFEAT | Objectified me based on physical features | 0-No 1-Yes | EMA: Random |
| | SEXUALINAP | Someone made a sexually inappropriate comment towards me | 0-No 1-Yes | EMA: Random |
| | HAIRCOM | Receive negative comments about my hair | 0-No 1-Yes | EMA: Random |
| | UNHEARD | I have felt unheard | 0-No 1-Yes | EMA: Random |
| | MYAUTH | Someone challenged my authority | 0-No 1-Yes | EMA: Random |
| | PUTINPLACE | Someone has tried to “put me in my place” | 0-No 1-Yes | EMA: Random |
| | ASSUMED | Assumed I did not have much to contribute to the conversation | 0-No 1-Yes | EMA: Random |
| | ASSERTIVE | I have been told that I am too assertive | 0-No 1-Yes | EMA: Random |
| | FEELEXOTIC | Someone made me feel exotic because of my race or gender | 0-No 1-Yes | EMA: Random |

Appendix C : Sample of panel plots for Exclusive Breastfeeding and Perceived Stress

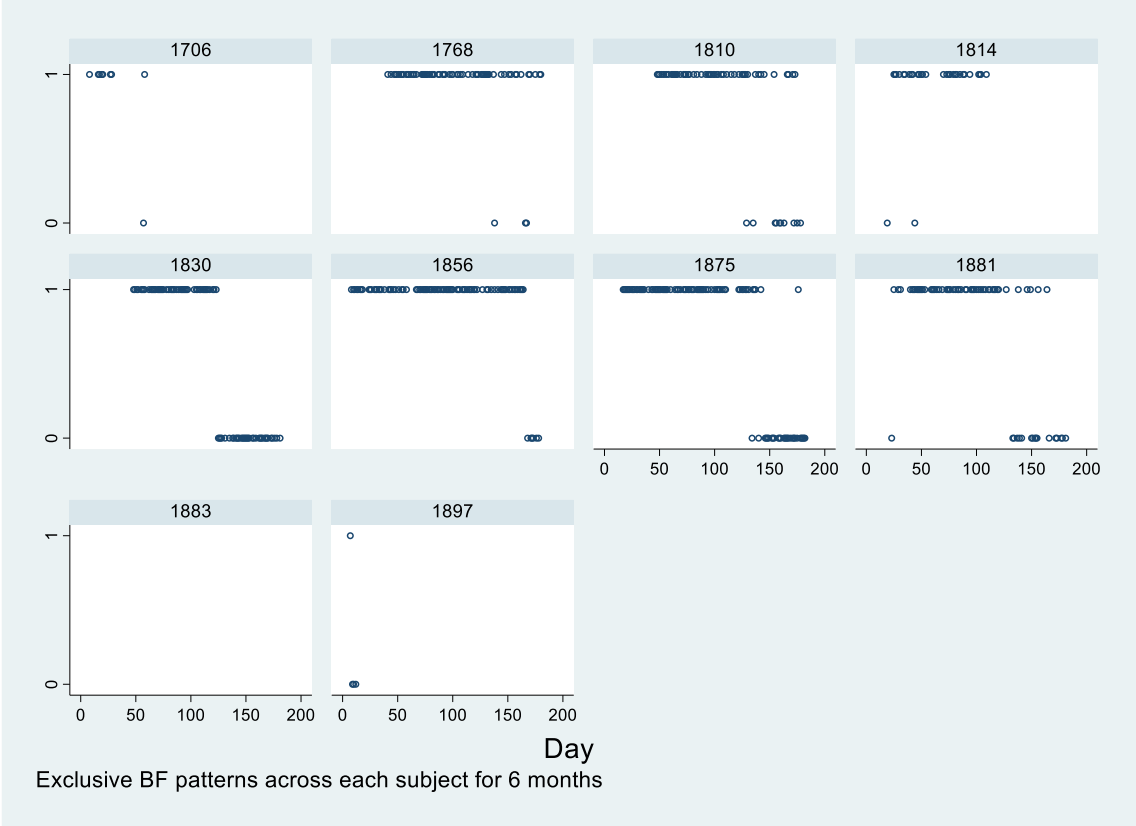
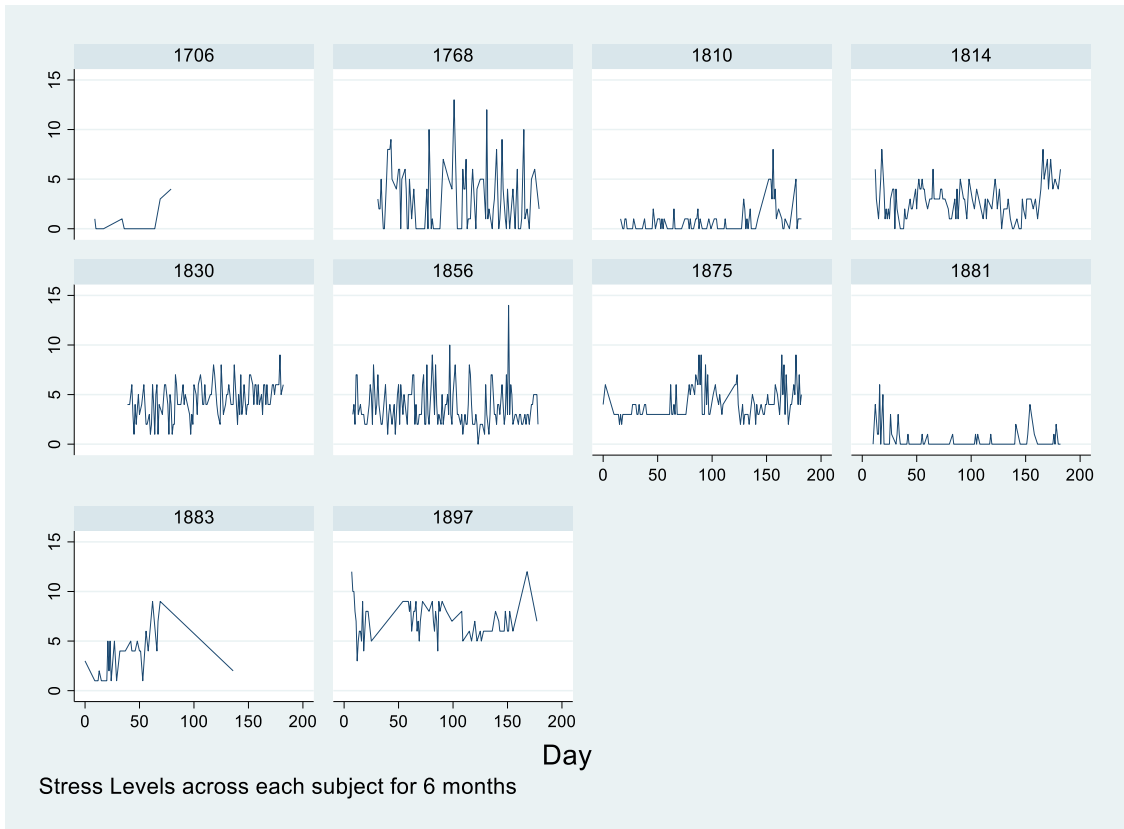


Figure 12: Panel plots for Exclusive breastfeeding showing variability within person and across selected subjects



Stress Levels across each subject for 6 months

Figure 13: Panel plots for stress showing variability within person and across selected subjects

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