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Telelactation and Breastfeeding Outcomes among Low-Income Mothers in Mississippi: A Retrospective Cohort Study

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TELELACTATION AND BREASTFEEDING OUTCOMES AMONG LOW-INCOME MOTHERS IN MISSISSIPPI: A RETROSPECTIVE COHORT STUDY

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Abstract

New mothers are recommended to exclusively breastfeed their infants for the first six months to provide optimal health for infant and mother. However, only 13.0% of mothers in Mississippi reached this milestone among infants born in 2015, which was far below the Healthy People 2020 objective of 25.5%. One factor that impacts breastfeeding success is access to certified lactation consultants, but low-income women may lack access due to an inadequate number of providers, unreliable transportation, rural location, or cost. The use of "telelactation" programs, which provide access to lactation consultants via video conferencing on internet connected devices, has been suggested as a potential solution to overcome these barriers. This prompted the Mississippi Women, Infants and Children Program (Mississippi WIC Program) to provide participants with free access to the Pacify "telelactation" application, which provides 24-hour access to video conferencing sessions with International Board Certified Lactation Consultants (IBCLC) via smartphones. Between June 2016 and May 2018, all pregnant and postpartum women enrolled in WIC were provided the opportunity to freely download the Pacify application. A retrospective cohort study was conducted to evaluate breastfeeding duration and exclusivity among women downloading the application compared to women not utilizing the application. Only women that initiated breastfeeding were included in the study due to the focus of the application in providing breastfeeding support. Rates of any breastfeeding (minimally, partially, and fully) and exclusive breastfeeding (fully) were compared between groups. Data were analyzed with logistic regression to compare rates of any or exclusive breastfeeding at three and six-months between groups. A total of 10,912 women were included in the study, of which 819 (7%) downloaded the Pacify application. Women downloading the Pacify application had significantly higher rates of any breastfeeding at three months (odds ratio [OR] 1.74, confidence interval [CI] 1.50-2.03) and six months (OR 2.01, CI 1.71-2.36) and exclusive breastfeeding at

three months (OR 2.47, CI 2.09-2.92) and six months (OR 2.06, CI 1.64-2.59) even after controlling for confounding demographic factors. The number of times the Pacify application was used was not significantly associated with any (p=0.14) or exclusive (p=.049) breastfeeding at six months. This study demonstrated a positive association between downloading the Pacify application and breastfeeding duration and exclusivity. However, uptake of the application was low and increased number of calls was not significantly associated with breastfeeding. The results of this study may also be overestimated due to selection bias. These findings may not be generalizable to higher-income populations, or even other WIC populations. This study was significant because it was to explore the impact of a "telelactation" program on breastfeeding rates among low-income women enrolled in a WIC program, and the first conducted in the state of Mississippi. The results can be used by WIC programs, public health professionals, and policy makers when designing programs to improve access to lactation consultants among low-income or rural populations. Future research should utilize randomized controlled trials among populations with low access to IBCLCs to determine the effectiveness of the application in improving breastfeeding rates, knowledge, attitudes, and behaviors.

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Chapter 1: Introduction

Several leading health organizations including the American Academy of Pediatrics (AAP), American Dietetic Association (ADA), and American College of Obstetricians and Gynecologists (ACOG) recommend that all infants be exclusively breastfed for the first six months of life, followed by the introduction of foods and continued breastfeeding for an additional 6-18 months (AAP, 2012; ACOG, 2007; James & Lessen, 2009). Exclusive breastfeeding has been defined as feeding only breast milk, with an optional vitamin D supplement, without any additional foods or fluids unless medically recommended (AAP, 2005). Exclusive breastfeeding is recommended because it provides optimal nutrition for the infant and is associated with several health, financial, and socioeconomic benefits for both the infant and the mother when compared to mix-feeding or formula feeding (Amin, Merle, Orlando, Dalzell, & Guillet, 2000; Martin et al., 2014; Rollins et al., 2016; Salone, Vann, & Dee, 2013; Services, 2011; Weimer, 2001).

Data collected from the 2016-2017 National Immunization Survey (NIS) indicated that over 80% of mothers in the United States initiated breastfeeding, but few of these women were able to meet the recommendation to exclusively breastfeed for six months (Centers for Disease Prevention and Control [CDC], 2018). By six months, the national rate for *any* breastfeeding, including exclusive and mixed, declined to 57.6%, and the rate for *exclusive* breastfeeding declined to 24.9% (CDC, 2018). Helping the remaining 75% of women that do not reach this milestone remains a public health priority.

The United States Department of Health and Human Services (USDHHS) has set several Healthy People 2020 (HP2020) objectives for breastfeeding, with the goal of improving maternal and child health (USDHHS, 2018). The HP 2020 objectives include increasing the proportion of infants who are breastfed: (1) ever to 81.9%, (2) at 6 months to 60.6%, (3) at one year to 34.1%,

(4) exclusively through 3 months to 46.2%, and (5) exclusively through 6 months to 25.5% (USDHHS, 2018). Currently, the national rates are exceeding all the targets except for any breastfeeding at 6 months (57.6% vs 60.6%) and exclusive breastfeeding at 6 months (24.9% vs 25.5%; CDC, 2018). This project focuses on the state of Mississippi, which had the lowest breastfeeding rates in the country among 2015 births, with only 63.2% of mothers initiating breastfeeding and 12.5% exclusively breastfeeding for six months, far below the HP 2020 objectives (CDC, 2018; USDHHS, 2018). Figure 1 shows the current breastfeeding rates for Mississippi compared to the national averages and the HP 2020 objectives.

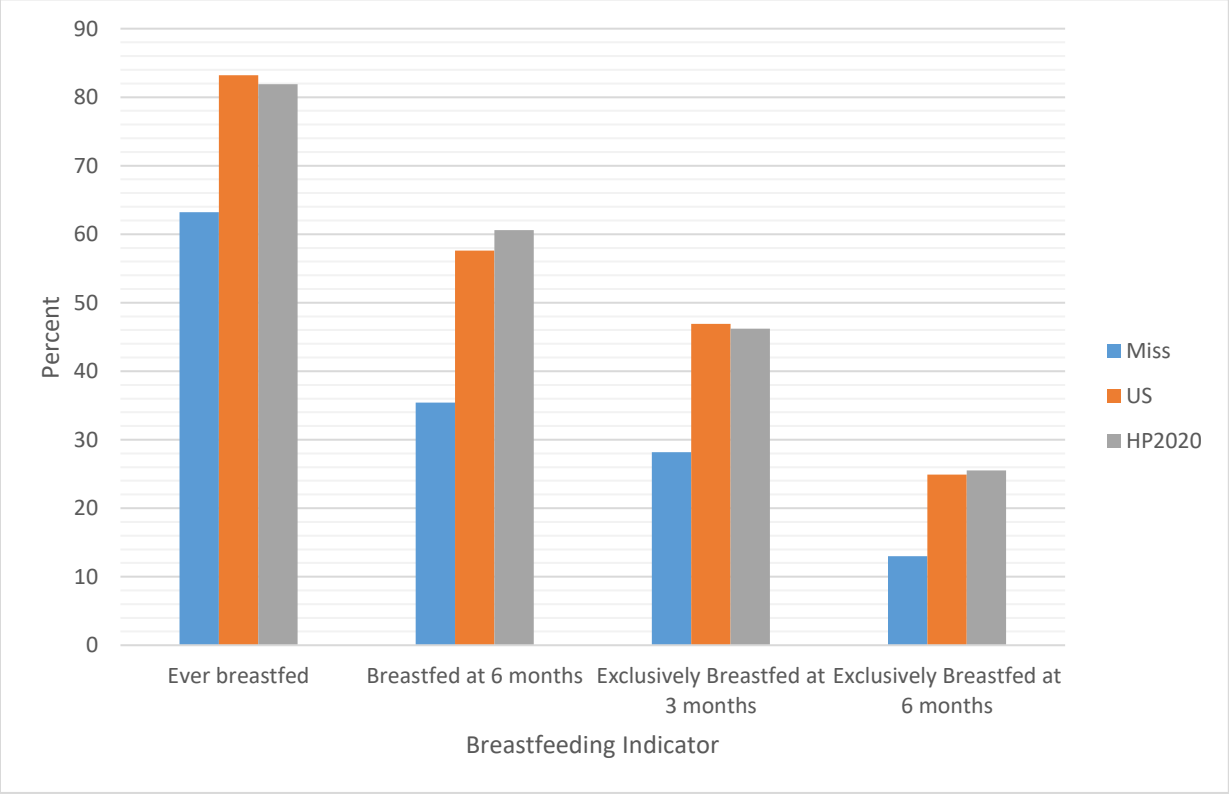

Figure 1. Comparison of breastfeeding rates in Mississippi to the national average and Healthy People 2020 goals, among 2015 births. Data were collected by the National Immunization Survey (CDC, 2018; USDHHS, 2018).

Certain subpopulations experience breastfeeding disparities and have rates much lower than the national averages and HP 2020 objectives (Table 1). According to data collected from the National Immunization Survey (NIS) from 2000-2008, overall breastfeeding rates have been increasing among all racial and ethnic backgrounds, but African American infants still have the lowest rates of breastfeeding for all indicators (CDC, 2013b, 2016b). In addition, low-income women were less likely to breastfeed than middle-or-high-income women (CDC, 2018; Ryan, Wenjun, & Acosta, 2002). Furthermore, low-income women participating in the United States Department of Agriculture's (USDA) Special Supplemental Nutrition Program for Women, Infants and Children (WIC) have had lower breastfeeding rates than low-income women not participating, putting them at a high risk for early breastfeeding cessation (CDC, 2018).

Several factors contribute to the low breastfeeding rates observed in Mississippi. This includes the state consistently being ranked as one of the unhealthiest states by surveys, such as America's Health Rankings 2016, due to high rates of obesity, smoking, and poverty, and poor access to healthcare services (United Health Foundation, 2017). Obesity may be a major problem in the state because over 39% of adult females are obese, which has been associated with lower rates of breastfeeding (CDC, 2015; Tenfelde, Finnegan, & Hill, 2011). In addition, Mississippi has a high proportion of groups with disparities associated with lower breastfeeding rates. This includes African Americans, which make up 37.7% of the state's population compared to 13.3% for the national average, and low-income women, with a state poverty rate of 22.0% compared to the national rate of 12.7% (CDC, 2010; Marshall et al., 2013; Ryan et al., 2002; United States Census Bureau, 2017).

Table 1. Percentage of infants breastfed by breastfeeding duration and select sociodemographic factors in the United States, 2015 births

Breastfeeding indicator	Ever Breastfed (%)	Breastfed at 6 Months (%)	Breastfed at 12 Months (%)	Exclusive Breastfed 3 Months (%)	Exclusive Breastfed 6 Months (%)
Healthy People 2020 Targets	81.1	60.6	34.1	46.2	25.5
US National	83.2	57.6	35.9	46.9	24.9
Mississippi	**63.2**	**35.4**	**18.3**	**28.2**	**13.0**
Race/Ethnicity					
Hispanic	84.6	54.1	32.6	42.2	20.9
Non-Hispanic White	85.9	62.0	39.8	53.0	29.5
Non-Hispanic Black	**69.4**	**44.7**	**24.0**	**36.0**	**17.2**
Non-Hispanic Asian	89.3	72.2	50.3	45.7	30.1
Non-Hispanic Hawaiian/Pacific Islander	83.0	57.8	24.4	45.3	29.0
Non-Hispanic American Indian/Alaska Native	76.4	55.0	31.3	44.6	19.6
2 or more races	82.5	55.5	35.9	46.5	21.9
Enrollment in WIC Program					
Yes	**76.7**	**44.5**	**25.4**	**38.0**	**17.8**
No, but eligible	83.3	65.8	47.2	51.2	29.7
Ineligible	91.7	72.6	47.4	57.8	33.1

Source: Data were collected for infants born in 2015 by the National Immunization Survey, Centers for Disease Control and Prevention, Department of Health and Human Services (CDC, 2018).

This study is focused on assessing the impact of an intervention among women enrolled in the WIC program, which is a government funded program for low-income families that provides breastfeeding support, health education, and nutritional supplementation by supplying formula or funds to purchase approved foods (USDA, 2017a). The WIC program serves over half of all infants born in the United States, showing the programs potential to improve breastfeeding rates (USDA, 2017a). However, several studies have found that women enrolled in WIC were less likely to breastfeed than middle-and upper-income mothers (Deming, Briefel, & Reidy, 2014; Houghtaling,

Byker Shanks, & Jenkins, 2017; Jacknowitz, Novillo, & Tiehen, 2007; Marshall et al., 2013; Ryan & Zhou, 2006). A recent review identified the key barriers to breastfeeding among WIC participants, which included: lack of support in prenatal, immediate postnatal, and postnatal periods; returning to work; practical issues, such as pain, discomfort, time, and breastfeeding misconceptions; WIC services and policies, such as providing free formula supplementation; and social/cultural barriers (Hedberg, 2013). Identifying ways to reduce these barriers and improve overall breastfeeding rates among the WIC population is a public health priority.

One approach to overcome barriers and increase breastfeeding rates in the WIC population is to increase access to breastfeeding support services provided by health professionals. Physicians and nurses have been found to be undertrained and unprepared to offer high quality breastfeeding support (Freed et al., 1995; Hellings & Howe, 2000, 2004). This gap has been filled by trained lactation professionals including Certified Lactation Counselors (CLCs), which are the entry level providers, and the expertly trained International Board Certified Lactation Consultants (IBCLC). A recent review found that women with access to lactation consultants had increased breastfeeding initiation, duration, and exclusivity rates compared to women without access (Patel & Patel, 2016). Furthermore, a large proportion of successful breastfeeding interventions have included one-on-one lactation support during the prenatal and postnatal periods (Bonuck et al., 2002). These results have been supported by the "2011 Surgeon General's Call to Action to Support Breastfeeding", which recommended that breastfeeding mothers have access to services provided by the highly trained IBCLCs (USDHHS, 2011).

Increasing access to lactation consultants in Mississippi may be difficult because the state has only 1.93 IBCLCs per 1,000 live births, which was far below the national average of 3.79 (CDC, 2016a). In addition, about half of the Mississippi population lives in rural areas, where

access to healthcare providers, such as IBCLCs may be limited (United States Census Bureau, 2012). The Mississippi WIC Program provides access to lactation consultations when available, but few locations employ IBCLCs. Women are far more likely to be enrolled in a peer counselor program, in which other mothers enrolled in the program provide support. This may be a problem due to a lack of expertise. In addition, low-income families wanting IBCLCs services have to wait for an appointment and travel to the WIC center with a newborn or other children to receive in-person lactation consultations, which have been identified as barriers among this population (Woelfel et al., 2004).

One approach to increase access to IBCLCs in the Mississippi WIC program is through the use of the Pacify mobile health application (Pacify, 2018). Mobile health (mHealth) applications utilize mobile technologies, such as smartphones, tablets, laptops, and computers to provide individual level services through phone calls, text messages, photos, videos, and software applications to improve health outcomes (Free et al., 2013). The potential impact of mHealth programs in the United States is massive due to the ubiquity of mobile devices in the United States, where over 90% of adults use the internet, 95% own a cell phone, and 77% own a smartphone (Pew Research Center, 2018a, 2018b). The use of mHealth programs also have the potential save money, time, and increase access to care (Doarn, Portilla, & Sayre, 2010). While work in this field is still developing, a recent review identified that mHealth interventions have had positive outcomes for smoking cessation, vaccine compliance, asthma control, physical activity, and psychological support (Free et al., 2013). The efficacy for breastfeeding has yet to be determined.

This study evaluated the use of the Pacify mHealth application, which is a direct-to-consumer application that provides clients with 24-hour access to video lactation consultations with trained IBCLCs via video calls. These services can be accessed on internet connected devices,

such as smartphones or tablets ("Pacify," 2018). Video lactation consultations offer WIC clients an opportunity to address any breastfeeding questions or concerns with a highly trained professional in the comfort of their own home as long as they have access to a video capable device and a connection to the internet. These types of applications have been categorized as "telelactation" and are hypothesized to increase access to IBCLCs, which will improve rates of breastfeeding initiation, duration, and exclusivity, but the impact is yet to be determined (Uscher-Pines, Mehrotra, & Bogen, 2017). This use of telelactation is in line with the action step to increase access to IBCLCs outlined in Surgeon General's Call to Action to Improve Breastfeeding Support for Mothers (USDHHS, 2011).

This dissertation used a retrospective cohort design to examine the association between free access to the Pacify application and breastfeeding duration and exclusivity among women enrolled the Mississippi WIC program. This was the first study to explore the impact of a "telelactation" program on breastfeeding rates among low-income women enrolled in a WIC program, and the first conducted in the state of Mississippi. The results of this study can be used by WIC programs, public health professionals, and policy makers when designing programs to improve access to lactation consultants among low-income or rural populations.

Conceptual Underpinnings for the Study

This study examined the association between providing free access to the Pacify "telelactation" application and breastfeeding duration and exclusivity among women enrolled in the Mississippi WIC program. As previously stated, women enrolled in WIC programs have lower rates of breastfeeding compared to higher income women or low-income women not enrolling in the WIC program (Deming et al., 2014; Houghtaling et al., 2017; Jacknowitz et al., 2007; Marshall et al., 2013; Ryan & Zhou, 2006). In addition, low-income women in Mississippi lack access to

IBCLCs due to the low number of providers or other barriers. Increasing access to IBCLCs through free access to the Pacify application was hypothesized to increase breastfeeding self-efficacy by providing support to overcome common barriers during the prenatal, immediate postnatal, and postnatal periods, which have been shown to impact breastfeeding success (Hedberg, 2013; Labbok, 2013; Meedya, Fahy, & Kable, 2010).

The prenatal period is the first point in which a lactation consultant could influence breastfeeding outcomes. WIC participants who receive prenatal care during the first trimester have been found to have higher rates of exclusive breastfeeding compared to those receiving prenatal care in later trimesters (Tenfelde et al., 2011). This may result from increased exposure to breastfeeding education resulting in stronger intention to breastfeed, which has been identified as one of the strongest predictors of breastfeeding initiation and duration (Meedya et al., 2010; Ryser, 2004; Swanson & Power, 2005). Providing access to a lactation consultant during the prenatal period at obstetrician/gynecologist offices was found to increase exclusive breastfeeding rates by 27% (Bass et al., 2014). However, a survey of women enrolled in a Maryland WIC program found that only 10% received one-on-one breastfeeding education during their prenatal care (Cross-Barnet, Augustyn, Gross, Resnik, & Paige, 2012). Providing access to lactation consultants through the Pacify application is a potential solution to increase breastfeeding education during this period.

The period immediately following the birth of the infant has been identified as critical time point for breastfeeding success (Hedberg, 2013). Women who exclusively breastfeed in the hospital were found to be up to eight times more likely to continue breastfeeding for 12 months than mix-feeding mothers (Langellier, Chaparro, Wang, Koleilat, & Whaley, 2014). In addition, an analysis of mothers enrolled in WIC in Louisiana found that receiving breastfeeding support in

the hospital was significantly associated with breastfeeding initiation (Ma & Magnus, 2012). The WIC program does not have any influence over hospital policies, but programs have tried to offer hospital visits and telephone support during this time from lactation counselors or peer counselors with positive outcomes (Ahluwalia, Tessaro, Grummer-Strawn, MacGowan, & Benton-Davis, 2000; Pugh et al., 2010). This approach requires investing a large amount of resources into few patients, and the Pacify application could be a more effective approach.

Hospital services and support vary depending on the facility as there are no current national regulations. This has led to the development of the Baby-friendly Hospital Initiative (BFHI) by the World Health Organization (WHO) and the United Nations International Children's Emergency Fund (UNICEF). The BFHI requires hospitals to adhere to the "Ten Steps to Successful Breastfeeding" to qualify as Baby-Friendly facility (WHO, 1989). The ten steps ensure that hospitals are equipped to provide mothers with high quality breastfeeding support. A recent systematic review found that Hospitals in the United States that follow the BFHI ten steps were associated with better breastfeeding short-term outcomes, but results were mixed for longer term breastfeeding success (Perez-Escamilla, Martinez, & Segura-Perez, 2016). It is important to note there are only two hospitals in Mississippi that adhere to the BFHI standards, reducing the probability that WIC clients receive this high standard of care (Baby Friendly USA, 2017). If women deliver in hospitals without adequate support services, the Pacify application could be utilized to fill this gap.

The post-discharge period has also been identified as a critical period for breastfeeding support, and access to support during this time period is a major barrier among WIC participants (Hedberg, 2013). Sources of postnatal support include family, friends, community, workplace, or the healthcare system (Rollins et al., 2016). Several studies have found low breastfeeding rates

among WIC participants are associated with lack of support during the postpartum period from different sources including pediatricians, male partners, family, and friends (Cross-Barnet et al., 2012; Tenfelde et al., 2011; Wojcicki et al., 2010). The use of lay peer counselors has been the main approach WIC has implemented to improve support during this period, which has been associated with positive outcomes (Chapman, Morel, Anderson, Damio, & Perez-Escamilla, 2010). However, many mothers may not enroll in WIC until after the birth of their child, eliminating this option in the post-discharge period. Adding the option of the Pacify program during this period would provide an alternative option which may improve outcomes.

The Breastfeeding Self-Efficacy Theory (BSET), developed by Dr. Dennis, was the guiding framework for the use of an mHealth application in breastfeeding improvement (Dennis, 1999). This theory utilizes Bandura's Social Cognitive Theory, which indicated that behaviors are strongly impacted by self-efficacy, which is a person's confidence in their perceived ability to perform a behavior (Bandura, 1977, 2004). With regard to the BSET, breastfeeding self-efficacy is characterized by a mother's perception of her capability to breastfeed her infant and not her actual ability (Dennis, 1999). Breastfeeding self-efficacy has been found to be one of the strongest predictors of breastfeeding success (Blyth et al., 2002; Meedya et al., 2010).

This theory has shown that breastfeeding self-efficacy is influenced by four sources of information: (1) personal accomplishments, such as successful breastfeeding; (2) vicarious experience through observing others breastfeeding; (3) verbal persuasion from respected people such as lactation consultants; and (4) physiological and affective states in response to breastfeeding, such as stress, anxiety, and fatigue (Dennis & Faux, 1999). Lactation consultants have an excellent opportunity to improve self-efficacy by impacting these sources of information among new mothers. Ideally, the lactation consultant will help the mother obtain the skills to

successfully breastfeed and provide encouragement which will reduce stress and improve outcomes.

Statement of the Problem

New mothers are recommended to exclusively breastfeed their infants for the first six months to provide optimal health for infant and mother (AAP, 2012). Despite improvements around the country, only 13.0% of mothers in Mississippi reached this milestone in 2017, which was the lowest rate in the United States (CDC, 2018). Breastfeeding disparities exists among women enrolled in the WIC program even when compared to other low-income women not enrolled in the program (CDC, 2018; Deming et al., 2014; Houghtaling et al., 2017; Jacknowitz et al., 2007; Marshall et al., 2013; Ryan & Zhou, 2006). One factor that impacts breastfeeding success is access to breastfeeding support services provided by International Board Certified Lactation Consultants (IBCLC), which is poor among low-income women due to an inadequate number of providers, unreliable transportation, or cost (Hedberg, 2013; Patel & Patel, 2016; Woelfel et al., 2004). Using a telelactation program, such as Pacify, that provides access to lactation consultants via video calls may reduce these barriers and improve breastfeeding rates.

The main strategy that WIC programs have implemented to improve breastfeeding rates has been the use of peer counselors, which were either a trained professional, such as lactation consultants, or a mother who had successfully breastfed in the past (Bronner, Barber, & Miele, 2001; Stremler & Lovera, 2004; Wambach et al., 2011). A recent review found that peer counselor programs and interventions have been associated with improved breastfeeding outcomes in the WIC population (Chapman et al., 2010). The main limitations of peer counseling programs are that programs utilized untrained volunteer counselors, were usually restricted to working hours (8-5 Monday-Friday), utilize phone calls more than face-to-face meetings, and may not enroll mothers

until the postpartum period (Ahluwalia et al., 2000; Bolton, Chow, Benton, & Olson, 2009; Bronner et al., 2001; Grummer-Strawn, Rice, Dugas, Clark, & Benton-Davis, 1997; Stremler & Lovera, 2004). An evaluation of peer counseling in Mississippi WIC programs found positive outcomes, but the presence of a lactation consultant was found to be more important to breastfeeding success than the peer counselors (Grummer-Strawn et al., 1997).

To date, no other study has evaluated a mHealth program that provides access to lactation consultants through video calls success in improving breastfeeding duration and exclusivity among WIC participants. A study conducted among low-income patients at an Indiana community health clinic indicated that onsite videoconferencing sessions with lactation consultants improved breastfeeding outcomes (Friesen, Hormuth, Petersen, & Babbitt, 2015). Another small study showed that home-based videoconferencing could improve breastfeeding skills, but it did not assess breastfeeding outcomes (Rojjanasrirat, Nelson, & Wambach, 2012). Several commercial telelactation services that provide videoconferencing with lactation consultants have been developed and can be purchased by consumers, but none have been evaluated for effectiveness (Uscher-Pines et al., 2017). There is an ongoing randomized clinical trial being conducted to test the effectiveness of a commercial direct-to-consumer telelactation video service, but the focus was on women living in rural Pennsylvania and results are pending (Uscher-Pines, 2017).

Purpose of the Study

The purpose of this study was to evaluate the impact of the Pacify application, which provides virtual lactation consultations with IBCLCs via video calls, on breastfeeding duration and exclusivity among women enrolled in the Mississippi WIC program. Additional data were collected from women downloading the application to better understand its usefulness. The results from this study can be used by policy makers and public health professionals when designing

breastfeeding improvement programs.

Research Objectives

Aim 1: Determine if women who downloaded the Pacify application had higher rates of *any* breastfeeding at three and six-months postpartum compared to the unexposed group.

Aim 2: Determine if women who downloaded the Pacify application had higher rates of *exclusive* breastfeeding at three and six-months postpartum compared to the unexposed group.

Aim 3: Determine if the number of times that the Pacify application was used, for video lactation consultations, was associated with higher rates of any or exclusive breastfeeding at six months.

Aim 4: Assess user comments associated with using the Pacify application among Mississippi WIC participants to identify the common positive and negative perceptions.

Research Hypotheses

I hypothesized that women who downloaded and utilized the Pacify application would have higher rates of any breastfeeding and exclusive breastfeeding at three and six-months postpartum compared to women who did not download the Pacify application. This was anticipated because increasing access to lactation consultants could help mothers overcome common breastfeeding problems (e.g. incorrect latching, pain, and low milks supply). This would improve breastfeeding self-efficacy, which has been linked to positive breastfeeding outcomes (Blyth et al., 2002; Meedya et al., 2010). Access to the lactation consultant services through the Pacify application was also available 24 hours a day as long as internet was accessible, which may reduce barriers, such as transportation, cost, or embarrassment.

Limitations, Assumptions, and Design Controls

This study utilized a retrospective cohort design, which is an observational study, and the conclusions drawn from this study are not as strong as a randomized control trial (Euser, Zoccali, Jager, & Dekker, 2009). However, a randomized trial was not feasible because the program had already been implemented and additional funding was not available. In addition, this study had and increased risk for selection bias because the exposed and unexposed were based whether or not the participant downloaded the mobile application (Euser et al., 2009). This could result in mothers with high intentions of breastfeeding self-selecting into the exposed group, and mothers with low intentions being in the unexposed group. The use of a multivariate regression to calculate an adjusted odds ratio was used to improve the significance of the findings (Pourhoseingholi, Baghestani, & Vahedi, 2012). However, the datasets were limited and the only variables that were available were age, race, ethnicity, and number of people in the household. No other variables could be accounted for including the ability to remove mothers that have previously breastfed.

Definition of Key Terms

Breastfeeding: The practice of feeding an infant breastmilk from the breast of expressed by a pump with milk through the act of suckling at the mother's breast (Labbok & Starling, 2012).

Breastfeeding continuation: The process of breastfeeding with or without supplements (CDC, 2013a).

Breastfeeding duration: The amount of time the infant is breastfed, can be exclusive or mixed (CDC, 2013a).

Breastfeeding initiation: The initial time a mother puts the baby to the breast for feed (CDC,

2013a).

Breast-feeding intent: The amount of time a mother plans on breastfeeding her baby (DiGirolamo, Thompson, Martorell, Fein, & Grummer-Strawn, 2005).

Breastfeeding self-efficacy: A mother's belief in her ability to successfully breastfeed her baby (Dennis, 1999).

Certified Lactation Counselor (CLC)- a lower level professional in lactation counseling with skills, knowledge, and attitudes to provide breastfeeding counseling and management support (Academy of Lactation Policy and Practice, 2017).

Exclusive breast-feeding: An infant only consumes human milk with no supplementation of any type except for vitamins, minerals, and medications (AAP, 2005)

Fully-breastfeeding: Mothers that report exclusively breastfeeding, and only give their infants breastmilk (USDA, 2016)

Fully-formula feeding: Mothers that report only feeding their infant formula (USDA, 2016).

International Board Certified Lactation Consultant: An internationally certified healthcare professional in the clinical management of breastfeeding and human lactation (Wambach et al., 2005)

Mobile Health (mHealth): Programs or applications that utilize mobile technologies such as smartphones, tablets, laptops, and computers to provide individual level services through phone calls, text messages, photos, videos, internet access, and software applications to improve health outcomes (Free et al., 2013).

Partially Breastfeeding: Mothers that provide their infants breastmilk in combination with formula, food, or water (USDA, 2016).

Prenatal period: The period from becoming pregnant until the period before giving birth (CDC,

2013a).

Postpartum period: The period following giving birth to a child (CDC, 2013a).

Telelactation: Providing access to lactation services through phones, text messages, and video conferencing through smartphones, tablets, and computers. (Uscher-Pines et al., 2017).

United States Department of Agriculture's (USDA) Special Supplemental Nutrition Program for Women, Infants and Children (WIC): A government funded program for low-income families that provides breastfeeding support, health education, and nutritional support by supplying formula or funds to purchase approved foods (USDA, 2017a).

Summary

New mothers are recommended to exclusively breastfeed their infants for the first six months to provide optimal health for infant and mother (AAP, 2012). Despite improvements around the country, only 13.0% of mothers in Mississippi reached this milestone in 2016, which was the lowest rate in the United States and far below the HP 2020 Objective of 25.5% (CDC, 2018; USDHHS, 2018). Providing breastfeeding support services by IBCLCs, via video calls, was hypothesized to improve access to lactation consultants, which may reduce barriers and improve breastfeeding rates. This study evaluated the association between the use of a mHealth application and breastfeeding outcomes among women enrolled in the Mississippi WIC program. The results from this study can be used by policy makers and public health professionals when designing breastfeeding improvement programs.

In this chapter, the problem statement, purpose, research questions, conceptual framework and limitations of this study were presented. The following chapter will cover the literature review and include historical perspectives of breastfeeding and an evaluation of interventions targeting the WIC population with a focus on improving access to lactation consultants.

Chapter 2: Literature Review

Historically, breastfeeding initiation rates have fluctuated in the United States from a low of 22% observed in 1972, to the most recent rate of 83.2% for babies born in 2015 (CDC, 2018; Wright, 2001). This reflects the evolution of the scientific understanding of breastfeeding and the benefits to the infant and mother over the past fifty years as well as changes in our society, especially regarding women in the workforce (Wright, 2001). Despite improvements in breastfeeding initiation rates, most mothers quickly turn to formula with only 24.9% exclusively breastfeeding for six months and only 35.9% breastfeeding for 12 months (CDC, 2018). However, the outcomes are worse among low-income women, especially those enrolled in WIC programs compared to both higher-income women not eligible for WIC, or those who are eligible but refuse to enroll as seen in Table 1 (CDC, 2018). Currently, WIC programs provide services to half of the infants born in the United States, showing the massive potential impact that improvements could have on breastfeeding rates (USDA, 2017a). Identifying effective interventions and programs to improve breastfeeding outcomes among WIC participants remains a priority of the Surgeon General and the United States Breastfeeding Committee (Labbok M & Taylor, 2008; USDHHS, 2011).

Understanding the determinants of breastfeeding is essential to design effective interventions and programs. Breastfeeding is a complex behavior that is impacted by social, economic, cultural, and individual factors (Rollins et al., 2016). This study was focused on improving access to lactation consultants, which may improve breastfeeding knowledge, attitudes, intention, and self-efficacy, which are key determinants of breastfeeding (Brown, Dodds, Legge, Bryanton, & Semenic, 2014; Dennis, 1999; DiGirolamo et al., 2005). This literature review will delve into these concepts and other determinants among the WIC population.

Several different interventions and programs have been utilized over the past 30 years to increase breastfeeding rates in the United States, with varying success. This study targeted the WIC population, among which fewer interventions have been thoroughly tested. This chapter includes a systematic review of interventions that have targeted WIC and other low-income populations. In addition, breastfeeding interventions utilizing lactation consultants or telelactation services were reviewed to compare to the current study.

Benefits of Breastfeeding

As mammals, human mothers produce breastmilk which is specifically designed to meet all of the nutritional and health needs of an infant (Ballard & Morrow, 2013). To date, there is no formula or supplement that can provide as many benefits as breastmilk. The Academy of Pediatrics (AAP) has reported that breastfeeding provides medical, nutritional, immunological, developmental, psychological, social, economic, and environmental advantages over alternative methods of infant feeding, such as formula (AAP, 1997). Several leading health organizations including the AAP, American Dietetic Association (ADA), and American College of Obstetricians and Gynecologists (ACOG) recommend that all infants be exclusively breastfed for the first six months of life, followed by the introduction of foods and continued breastfeeding for an additional 6 months (AAP, 2012; ACOG, 2007; James & Lessen, 2009). Exclusive breastfeeding has been defined as feeding the infant only breast milk, with an optional vitamin D supplement, without any additional foods or fluids, unless medically recommended (AAP, 2005). This recommendation was backed by a systematic review, which found that six months is the optimal duration for exclusive breastfeeding in both developing and developed countries (Kramer & Kakuma, 2012).

Numerous health benefits have been identified among infants who are mixed or exclusively breastfed compared to non-breastfed infants (Gartner et al., 2005; Victora, Bahl, Barros, Franca,

et al., 2016). Exclusive breastfeeding has been associated with lower rates of infections (Bowatte et al., 2015; Sankar et al., 2015), reduced rates of childhood obesity or diabetes (Horta, Loret de Mola, & Victora, 2015b), and fewer educational or behavioral problems (Heikkila, Sacker, Kelly, Renfrew, & Quigley, 2011; Horta, Loret de Mola, & Victora, 2015a; Quigley et al., 2012) when compared to non-breastfed infants. Improving breastfeeding worldwide could prevent an estimated 823,000 child deaths annually (Victora, Bahl, Barros, França, et al., 2016). In addition, a lack of breastfeeding has been associated with lower intelligence (Victora, Bahl, Barros, Franca, et al., 2016). Due to the vast impact on health and development, exclusive breastfeeding has been identified as a key tool in reducing poverty and obesity (McGuire, 2012; Rollins et al., 2016). It is important to note women who exclusively breastfeed are often more educated, have higher incomes, and receive more support, which also impacts these health outcomes and is important to take into consideration (Rollins et al., 2016).

Breastfeeding has also been shown to be beneficial to the mother. Research suggest that mothers who breastfeed have a reduced risk of diabetes, breast cancer, ovarian cancer, and postpartum depression (Chowdhury et al., 2015; Ip et al., 2007; Services, 2011; Victora, Bahl, Barros, França, et al., 2016). If a majority of mothers breastfed, an estimated 20,000 breast cancer deaths could be prevented annually (Victora, Bahl, Barros, França, et al., 2016). In addition, breastfeeding assists mothers to return to their pre-pregnancy weight more quickly, increases child spacing, and improves the physical and physiological bond between mother and baby (Gartner et al., 2005; Services, 2011). The strengthened psychological bond between mother and infant has been identified as one of the key factors in choosing to breastfeed (Bai, Middlestadt, Joanne Peng, & Fly, 2009).

The economic impact of breastfeeding is also substantial. Worldwide, there is an estimated

economic loss of $302 billion dollars due to lost productivity and healthcare costs associated with mothers not breastfeeding (Rollins et al., 2016). Specifically, in the United States it has been estimated that $13 billion dollars would be saved per year in healthcare cost due to reduced number of infections and obesity rates if 90% of women exclusively breastfed for the recommended six months (Bartick & Reinhold, 2010). Families that breastfeed can save an estimated $1,200 in formula costs and up to $475 in healthcare costs (Ball & Wright, 1999; Bartick & Reinhold, 2010; Weimer, 2001). Costs to WIC programs could also be reduced by an estimated 18% if all mothers exclusively breastfed for six months, followed by 6 months of exclusive formula use, or 38% if all mothers partially breastfed (Drago, 2011).

Breastfeeding Prevalence and Goals

Historically, breastfeeding initiation rates have fluctuated in the United States from a low of 22% observed in 1972, to the most recent rate of 83.2% for babies born in 2015 (CDC, 2018; Wright, 2001). This dramatic shift has been driven by advances in science and public health as well as by the development of the Healthy People (HP) framework by the United States Department of Health and Human Services (USDHHS). The Healthy People (HP) program develops measurable objectives and goals every ten years for issues that impact the health and well-being of Americans (USDHHS, 2018). This health promotion program assesses data for all 50 states, Washington DC and Puerto Rico. National and state policies are designed to meet the objectives set by this initiative.

The most recent version is HP 2020, and it contains several breastfeeding related goals. The goals include increasing breastfeeding initiation to 81.9%, increasing any breastfeeding at 6 months to 60.6% and 12 months to 34.1%, and increasing exclusive breastfeeding at 3 months to 46.2% and 6 months to 25.5% (USDHHS, 2018). In addition, HP 2020 strives to increase worksite

lactation support programs to 38%, reduce formula supplementation within the first 2 days of life to 14.2%, and increase the proportion of live births at lactation friendly hospitals to 8.1% (USDHHS, 2018).

The HP 2020 program breastfeeding objectives align with the four critical time points for breastfeeding in the United States, which occur at birth, three months, six months, and one year (USDHHS, 2018). Measuring breastfeeding at birth will identify if the mother was able to successfully initiate breastfeeding. The three-month time point correlates with the twelve-week point, which is what most employers in the US offer as a maternity leave or the Family Medical Leave Act (FMLA) and corresponds to the time point when over 80% of employed mothers return to work (Shepherd-Banigan & Bell, 2014). Shorter maternity leave and returning to work, both part and full-time, have been negatively associated with continued breastfeeding (Mandal, Roe, & Fein, 2010; Mirkovic, Perrine, Scanlon, & Grummer-Strawn, 2014). The six-month time point correlates the recommendation for exclusive breastfeeding, and the twelve-month time point correlates to the continued breastfeeding recommendation (AAP, 2012).

Another important breastfeeding data source is the Breastfeeding Report Card (BRC) produced annually by the Centers for Disease Control and Prevention (CDC). The BRC evaluates breastfeeding statistics for each state and territory and compares them to the HP objectives (Table 2). The most recent BRC included an assessment of the five breastfeeding outcome indicators and seven process indicators including breastfeeding-friendly healthcare facilities, number of lactation support professionals, public infrastructure, and breastfeeding supportive child care (CDC, 2018; USDHHS, 2018).

National Immunization Survey

Breastfeeding surveillance data are collected from the National Immunization Survey

(NIS) each year in the United States. Data from the most recent survey were collected in 2017 and represent babies born during 2015 (CDC, 2018). Table 2 contains a summary of the NIS data for the breastfeeding indicators for the United States and Mississippi compared to the Healthy People 2020 objectives (CDC, 2018; USDHHS, 2018). Overall, three of HP 2020 objectives were met nationally including breastfeeding initiation, breastfeeding at 12 months, and exclusive breastfeeding at three months. The remaining objectives for duration or exclusivity have not been met nationally or in Mississippi. However, many of the 50 individual states and 5 territories have met or exceeded the HP 2020 Objectives, but overall Mississippi remains the worst performing state.

Ideally, all mothers should exclusively breastfeed for six months followed by continued breastfeeding for at least 12 months according to the AAP recommendations (AAP, 2012). Currently, only 24.9% of mothers exclusively breastfed their infants for six months and only 35.9% of mothers were breastfeeding at 12 months in the United States (CDC, 2018; USDHHS, 2018). The rates for Mississippi were the lowest in the country with only 13.0% exclusively breastfeeding at 6 months and 18.3% breastfeeding at 12 months which were far below the Healthy People 2020 goals (CDC, 2018; USDHHS, 2018).

Table 2. Breastfeeding rates compared to the Healthy People 2020 objectives for the US and Mississippi*

	HP 2020 Targets (%)	US National (%)	Mississippi (%)	Number of states/territories meeting Objective
Ever breastfed	81.9	83.2	63.2	36
Breastfeeding at 6 months	60.6	57.6	35.4	17
Breastfeeding at 12 months	34.1	35.9	18.3	27
Exclusive breastfeeding at 3 months	46.2	46.9	28.2	33
Exclusive breastfeeding at 6 months	25.5	24.9	13.0	30

* Source: Data were collected for infants born in 2015 by the National Immunization Survey, Centers for Disease Control and Prevention, Department of Health and Human Services (CDC, 2018; USDHHS, 2018)

The National Survey of Maternity Practices in Infant Nutrition and Care (mPINC) is a survey collected from maternity hospitals and birth centers every two years (CDC, 2016c). The results are used to calculate an mPINC score based on polices, practices, and protocols. The scores include data about birth facility support, the percent of live births at facilities meeting the baby friendly facility requirements, and the percent of breastfed infants receiving formula before 2 days of age, among other factors. Access to appropriate healthcare personnel was measured by the number of Certified Lactation Consultants (CLC) or International Board Certified Lactation Consultants (IBCLC) available per 1000 live births. Community support was measured by the number of La Leche League (LLL) Leaders available per 1,000 live births. The LLL is the leading national organization that provides breastfeeding support services to mothers (LLL, 2017). Lastly, a review of childcare regulations was completed to determine which states have laws in place to protect breastfeeding at childcare centers. Data are being collected on worksite lactation programs,

but data are not yet available.

Table 3. Summary of the HP 2020 breastfeeding support indicators for the US and Mississippi, among 2013 births*

Breastfeeding Support Indicators	National Average	MISS	HP 2020 Goal
Average mPINC Score	79	60	NA
Percent of live births occurring at baby friendly facilities	18.3	6.1	14.2
Percent of breastfed infants receiving formula before 2 days of age	17.1	26.9	8.1
Number of La Leche League Leaders per 1,000 live births	0.85	0.96	NA
Number of certified lactation consultants per 1,000 live births	4.57	2.21	NA
Number of IBCLC per 1,000 live births	3.79	1.93	NA
Child care regulation supports onsite breastfeeding	8 states	Yes	NA
Increase the proportion of employers that have worksite lactation support programs	38.0	NA	NA

*Data were obtained from the Breastfeeding Report Card among 2013 births (CDC, 2016a).

The breastfeeding process indicators reported by the 2016 Breastfeeding Report Card for the National average and Mississippi can be seen in Table 3 (CDC, 2016a) . Neither the National average nor Mississippi average were able to meet the HP 2020 goals. Overall, Mississippi had an mPINC score of 60, which was the lowest in the country and far below the national average of 79. Mississippi was below the national average of certified lactation consultants with 2.21 per 1,000 live births and IBCLCs with 1.93 per 1,000 live births. States should strive to increase both CLCs and IBCLCs to ensure mothers have access to lactation support services. The only areas that Mississippi is exceeding national averages was having 0.96 Leche League Leaders per 1,000 live births and having regulations that support breastfeeding at child care facilities (CDC, 2016a).

Breastfeeding Disparities

According to data collected from the National Immunization Survey (NIS) among infants born between 2000 and 2014, breastfeeding initiation and duration increased overall and among all racial and ethnic backgrounds at the national level (Table 4; CDC, 2016b). The largest gains during this period were observed among non-Hispanic Blacks, among whom breastfeeding initiation increased 20.6%, breastfeeding at six months increased 24.6%, and breastfeeding at 12 months increased 15.2%. Despite these gains, non-Hispanic Black infants still have the lowest rates of breastfeeding initiation, duration, and exclusivity at all time points with only 68% initiating breastfeeding, 41.5% breastfeeding at 6 months and 21.5% breastfeeding at 12 months. These are much lower than the rates among non-Hispanic Whites (85.7% initiating breastfeeding, 60.0% breastfeeding at 6 months, and 37.8% breastfeeding at 12 months) and Hispanics (84.8% initiating breastfeeding, 52.5% breastfeeding at 6 months, and 31.7% breastfeeding at 12 months). The rates for exclusive breastfeeding among non-Hispanic Blacks are even lower, with only 15.0% achieving the recommended six months compared to 27.9% among non-Hispanic Whites and 24.5% among Hispanics.

Improvements in breastfeeding rates have not been equally distributed around the country, with weaker gains in breastfeeding duration observed in Mississippi compared to the national averages. Breastfeeding rates in Mississippi increased 10.6% at six months and 11.6% at 12 months compared to the national gains of 20.8% at six months and 17.7% at 12 months (Table 4) (CDC, 2016b). Mississippi did improve breastfeeding initiation rates by 12.8% among births from 2000 to 2014, which was slightly higher than the national increase of 12.2%. Nevertheless, all of the breastfeeding rates in Mississippi remain far below national averages and the Health People 2020 objectives.

Table 4. Percentage of infants breastfed, by breastfeeding duration and race/ethnicity in the United States, 2000 and 2014 births*

Duration and Race/Ethnicity	2000	2014	
Ever breastfed	**%**	**%**	**Percent increase**
Mississippi	44.7	57.5	12.8
National Average	70.3	82.5	12.2
non-Hispanic White	71.8	85.7	13.9
non-Hispanic Black	47.4	68	20.6
Hispanic	77.6	84.8	7.2
Breastfed at 6 months			
Mississippi	18.6	29.2	10.6
National Average	34.5	55.3	20.8
non-Hispanic White	38.2	60	21.8
non-Hispanic Black	16.9	41.5	24.6
Hispanic	34.6	52.5	17.9
Breastfed at 12 months			
Mississippi	3.7	15.3	11.6
National Average	16	33.7	17.7
non-Hispanic White	17.1	37.8	20.7
non-Hispanic Black	6.3	21.5	15.2
Hispanic	18.2	31.7	13.5

*Data obtained from the CDC National Immunization Survey (NIS), among 2000 and 2014 births, and include data from all 50 states and 5 additional territories (CDC, 2016b).

Furthermore, several studies have indicated that low-income women were less likely to breastfeed than middle or high-income women (CDC, 2018; Ryan et al., 2002). According to data collected by the NIS for infants born in 2015, mothers with incomes at or below the 100% of federal poverty level had the lowest breastfeeding duration and exclusivity rates at all time points (CDC, 2018). For example, only 17.8% of women below the poverty level exclusively breastfeed for 6 months compared to 32.1% among women with incomes at or above 600% of the poverty level (CDC, 2018).

Many of these low-income women qualify for WIC but not all utilize this service. The NIS compared women who qualify for WIC but do not enroll to those who do enroll and found lower

breastfeeding rates among those that enroll (Table 1). Among WIC participants, 76.7% initiated breastfeeding, 25.4% breastfed at 12 months, and 17.8% exclusively breastfed for six months. These were lower than the rates among eligible non-participants of which 83.3% initiated breastfeeding, 47.2% breastfed at 12 months, and 29.7% exclusively breastfed for six months. This confirms findings from studies that indicate participation in WIC results in lower breastfeeding rates (CDC, 2018).

A recent paper assessed data from the 2004-2008 Pregnancy Risk Assessment Monitoring System to compare breastfeeding rates by race and WIC among women in Mississippi (Marshall et al., 2013). This study confirmed the low breastfeeding initiation rates among WIC and non-WIC women in the state with initiation rates of 39.7% among black women (45.9% non-WIC, 38.4% WIC) and 60.4% among white women (70.8% non-WIC, 50.8%WIC). In addition, WIC participation rates were higher among black women (82%) compared to only white women (52%). Among white women, WIC enrollment was associated with a decrease in breastfeeding initiation and breastfeeding at 10 weeks. However, WIC enrollment did not have an impact on rates of breastfeeding initiation or breastfeeding at 10 weeks among black women. These results indicated that effective interventions aimed at the WIC population should target the low breastfeeding rates among blacks as well as identifying the factors associated with the gap between White WIC and non-WIC participants.

Determinants of Breastfeeding among WIC participants

While the majority of women understand that breastfeeding is the best choice for infants, many WIC participants have been shown to lack the specific knowledge about the benefits of breastfeeding for the mother and infant compared to formula use (USDHHS, 2011). This has been confirmed from the WIC Infant Feeding Practices Study, which surveyed a national representative

sample of WIC participants and found that 77% agreed that breastmilk gives a baby all they need to eat, and 66% that breastfed babies are healthier than bottle-fed babies. Only 36% agreed that breastfeeding could protect infants from diarrhea, 46% agreed that breastfeeding protected against ear infections, and 53% agreed that breastfeeding helped women lose weight (McCann, Baydar, & Williams, 2007).

A recent review identified the key barriers to breastfeeding among WIC participants, which included: lack of support in prenatal, immediate postnatal, and postnatal periods; returning to work; practical issues such as pain, discomfort, time, and misconceptions; WIC services and policies such as providing free formula supplementation; and social/cultural barriers (Hedberg, 2013). Identifying ways to reduce these barriers and improve overall breastfeeding rates among the WIC population is a public health priority.

A systematic review by Houghtaling et al. (2017) assessed 32 articles to identify predictors of breastfeeding among WIC participants. The main predictors identified were higher education, older age, higher income, and being married, all of which impacted the likelihood of breastfeeding among WIC participants. These factors have also been observed in the general population (Table 5). The studies reviewed by Houghtaling et al (2017), were conducted in several states across the country, but none were conducted specifically in Mississippi, which may limit the generalizability to this study. Several sociodemographic factors were associated with higher rates of breastfeeding. Race and ethnicity were found to impact breastfeeding rates in several studies with Whites and Hispanic women having higher rates of initiation and longer duration compared to African Americans and other groups. This was further confirmed by findings that women who were not born in the US, spent less time in the US, or spoke Spanish had higher breastfeeding rates. With regards to education level, women with more than a high school education were more likely to

breastfeed. Being married, having children at later age, and having a higher income also improved breastfeeding rates. Women who were not employed full time or did not return to work before 7 months postpartum had higher breastfeeding rates.

Table 5. Percentage of infants breastfed by sociodemographic factor in the United States*

	Ever Breastfed	Breastfed at 6 months	Breastfed at 12 months	Exclusively breastfed 3 months	Exclusively breastfed 6 months
Sociodemographic Factors	**%**	**%**	**%**	**%**	**%**
Maternal Education					
Less than high school	74.4	47.9	30.3	35.3	19.0
High school graduate	72.8	43.0	23.9	36.9	17.8
Some college or technical school	85.2	53.6	31.4	47.3	23.7
College graduate	92.2	73.2	48.6	57.9	32.8
Maternal Age[#]					
20 - 29	79	44.6	25.3	41.3	21
30 or older	84.8	62.4	39.2	50.1	27.5
Poverty Income Ratio					
Less than 100	74.4	43.6	26.5	34.8	16.4
100 – 199	82.5	53.6	32.7	46.9	24.3
200 – 399	87.3	64.1	41.1	54.1	30.4
400 – 599	91.0	71.0	45.4	56.5	30.1
600 or greater	90.4	72.4	45.0	54.4	32.1
Marital Status					
Married	88.6	67.5	44.4	53.2	30.0
Unmarried	74.0	40.8	21.4	36.4	16.5

*Data obtained from the CDC National Immunization Survey (NIS), among 2015 births, and include data from all 50 states and 5 additional territories (CDC, 2018).
[#]Maternal age data were reported among 2014 births (CDC, 2017).

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)

The United States Department of Agriculture's (USDA) Special Supplemental Nutrition Program for Women, Infants and Children (WIC) is a government funded program that provides federal grants to States for supplemental foods, health care referrals, and nutrition education for

low-income families. Services are provided to women who are pregnant, breastfeeding, or non-breastfeeding in the postpartum period. Infants and children may qualify for services up to age five if they are at nutritional risk. Eligibility is limited to families with incomes up to 185% of the federal poverty guidelines, which translated to an annual salary of $45,510 for a family of four in 2017-2018. The WIC program serves over a quarter of all pregnant women and half of all infants born in the United States, which costs over six billion dollars a year (National Academies of Sciences, Engineering, and Medicine, 2016; USDA, 2017a) .

The WIC program emphasizes the importance of breastfeeding as the optimal food for infants. All mothers are encouraged to breastfeed unless they have a limiting medical condition, such as HIV/AIDS. All WIC staff are trained to promote and support breastfeeding, and the program offers several services to help breastfeeding mothers succeed. These services include education, counseling, breast pump lending, and referrals to health care services. In addition, the WIC program provides breastfeeding Mothers with a few economic incentives to breastfeed. These include a greater quantity and variety of foods provided in their food package, which helps mothers acquire the additional 500 calories/day they are recommended to consume while breastfeeding. Fully breastfed infants also receive higher quantities of foods because they are not receiving formula. Breastfeeding mothers can qualify for the WIC program up to six months longer than non-breastfeeding mothers (National Academies of Sciences, Engineering, and Medicine, 2016; USDA, 2017a).

Since 1997, WIC has benefited from the Loving Support campaign, which has worked to identify approaches to improve breastfeeding promotion and support in WIC populations. The Loving Support program now offers a number of services to WIC programs including social marketing research, media campaigns, community organizer kits, education, training,

breastfeeding resource guide, and technical assistance (Institute of Medicine, 2011). In 2004, the campaign launched the Loving Support Peer Counseling Program, which links new mothers with peer counselors in their community who have successfully breastfed and provides education, support, and role modeling. This program has grown and was available to 87% of pregnant women enrolled in WIC in 2014. Over 93% of local WIC agencies in Mississippi offed this program (Best Start Social Marketing (BSSM), 2004).

Although WIC programs have been promoting breastfeeding through new policies, such as the expanded food packages and services such as peer counseling, several studies have found that women enrolled in WIC were less likely to breastfeed than middle-and upper-income mothers or other low-income women not enrolled in the WIC program (Deming et al., 2014; Houghtaling et al., 2017; Jacknowitz et al., 2007; Marshall et al., 2013; Ryan & Zhou, 2006). Addressing this problem is important because the Mississippi WIC program provides services to about 8,000 pregnant women per month, indicating that effective breastfeeding promotion programs could have a large impact (USDA, 2017b). The average monthly WIC participation rates by breastfeeding status or infant feeding status observed in Mississippi, for the last three fiscal years can be seen in Table 6. Overall, WIC programs did make small gains in the percentage of women fully breastfeeding (8.7% to 9.5%) and partially breastfeeding (16.6%-21.8%) during this period (USDA, 2017b). However, the vast majority of WIC infants were fully formula fed and the rates are far below the HP 2020 objectives.

Table 6. Average participation of women and infants enrolled in the Mississippi WIC program by breastfeeding status for fiscal years 2015-2017

	FY 2015		FY 2016*		FY 2017*	
Feeding Status	**Monthly Average**	**(%)**	**Monthly Average**	**(%)**	**Monthly Average**	**(%)**
Postpartum Women						
Women Fully Breastfeeding	860	8.7%	874	9.4%	854	9.5%
Women Partially Breastfeeding	1645	16.6%	1848	20.0%	1959	21.8%
Women formula feeding	7422	74.8%	6529	70.6%	6170	68.7%
Postpartum Women Participating	9927		9251		8983	
Infants						
Infants fully breastfed	734	2.9%	761	3.1%	752	3.1%
Infants Partially Breastfed	1741	6.8%	1977	8.0%	2123	8.8%
Infants fully formula fed	23279	90.4%	22003	88.9%	21267	88.1%
Total Infants participating	25754		24741		24142	

*Preliminary data reported by the USDA
Source: State level data collected by the USDA for WIC participation by category and program cost (USDA, 2017b)

Breastfeeding Friendly Hospital Initiative (BFHI)

The Baby-friendly Hospital Initiative (BFHI) was developed by the WHO/UNICEF to ensure mothers were provided with the support to successfully breastfeed by healthcare facilities. The BFHI requires hospitals to adhere to the Ten Steps to Successful Breastfeeding to become a BFHI facility (WHO, 1989). The ten steps ensure that hospitals are equipped to provide mothers with high quality breastfeeding support. The Ten Steps to Successful Breastfeeding are:

1. Have a written breastfeeding policy that is routinely communicated to all health care staff.
2. Train all health care staff in the skills necessary to implement this policy.
3. Inform all pregnant women about the benefits and management of breastfeeding.
4. Help mothers initiate breastfeeding within one hour of birth.

5. Show mothers how to breastfeed and how to maintain lactation, even if they are separated from their infants.
6. Give infants no food or drink other than breast-milk, unless medically indicated.
7. Practice rooming in - allow mothers and infants to remain together 24 hours a day.
8. Encourage breastfeeding on demand.
9. Give no pacifiers or artificial nipples to breastfeeding infants.
10. Foster the establishment of breastfeeding support groups and refer mothers to them on discharge from the hospital or birth center.

A recent systematic review found that Hospitals in the United States that follow the BFHI ten steps were associated with better breastfeeding short-term outcomes, but results were mixed for longer term breastfeeding success (Perez-Escamilla et al., 2016). The review also found that the breastfeeding outcomes improved with the number of ten steps that were implemented, indicating that hospitals should attempt to implement some of the steps even if they cannot gain full BFHI status. It is important to note there are only two hospitals in Mississippi that adhere to all of the BFHI standards, reducing the probability that WIC clients receive this high standard of care (Baby Friendly USA, 2017). If women deliver in Hospitals without adequate support services, the proposed telelactation application could be utilized to fill this gap.

Affordable Care Act (ACA)

The passage of the Patient Protection and Affordable Care Act (ACA) in 2010 expanded benefits for breastfeeding mothers (Hawkins, Dow-Fleisner, & Noble, 2015). The law requires insurance plans to cover breastfeeding support services and breast pumps for new mothers. The support services include prenatal and postnatal lactation support and counseling provided by

trained professionals. There is no requirement that the support must be provided by an IBCLC or other certified lactation specialist, which may limit their access. In addition, the law requires most employers to provide time and private space, other than a bathroom, for mothers to express breast milk for up to one-year after delivery. While these are important first steps, states are allowed to provide more detailed legislation that could improve breastfeeding outcomes.

WIC Breastfeeding Interventions Systematic Review

To understand breastfeeding interventions previously used to increase breastfeeding among WIC recipients, a systematic review was conducted. The objective of this review was to identify interventions to increase breastfeeding among women enrolled in the WIC programs in the United States. Databases included in this review were PubMed, CINAHL, PyscInfo, Scopus and the time frame included manuscripts published in the past 20 years. The search terms used for this review can be found in Table 7. Inclusion and exclusion criteria for manuscripts were:

Inclusion Criteria:

- An intervention to improve breastfeeding among women enrolled in the WIC Program.
- Written in English.
- Published in a peer-reviewed scientific journals
- Included breastfeeding outcomes (initiation, duration or exclusivity)

Exclusion criteria:

- Non-WIC populations
- No intervention

Table 7. Search Terms used in compound Boolean search

WIC terms	*"WIC" OR "women, infants, and children" OR "*Special Supplemental Nutrition Program for Women, Infants and Children"
Breastfeeding Terms	"Breastfeeding" OR "breast feeding" OR "infant feeding" OR "mixed feeding" OR "combined feeding" OR "exclusive breastfeeding"
Intervention	Intervention

A total of 180 references were identified from the original search, from which 73 duplicates were removed. The titles and abstracts of the remaining 107 references were screened and an additional 85 references were removed due to not meeting inclusion criteria. The remaining 22 full articles were reviewed. Three more articles were removed due to not measuring breastfeeding outcomes (2) and no full article available (1). The full table containing an overview of the final 19 included studies can be found in Appendix A.

Results and Discussion of the Systematic Review

Peer Counseling Interventions.

One of the most common interventions identified from this systematic review were peer counseling programs, which utilize either a trained professional, such as lactation consultants, or more commonly, a volunteer mother who had successfully breastfed in the past, to provide breastfeeding counseling, education, referrals, and support (Bronner et al., 2001; Stremler & Lovera, 2004; Wambach et al., 2011). The Mississippi WIC program began offering peer counseling provided by mothers who had successfully breastfed, lactation specialists, and lactation consultants to participants in 1990. An analysis of data from the Pediatric Nutrition Surveillance System from 1989-1993, among Mississippi WIC programs with or without a peer counseling program, found a significant increase in the percent of infants ever breastfed, increasing from 12.3% to 19.9% among peer counselor program clinics compared to an increase from 9.2% to

10.7% among clinics without a program (Grummer-Strawn et al., 1997). The analysis also found that WIC clinics that employed a lactation consultant increased breastfeeding initiation by 4.4% more than clinics without a lactation consultant. These results indicate the importance of a lactation consultant among this population (Grummer-Strawn et al., 1997). Breastfeeding rates have continued to increase since 1990, when peer counselor programs were initiated, but the impact has been limited and the current breastfeeding initiation rate of 63.2% remains far below the national average of 83.2% and the Health People 2020 objective of 81.9% (CDC, 2018; USDHHS, 2018).

Currently, the standard peer counseling program implemented at WIC centers is the Loving Support Peer Counseling Program (LSPCP), which is an evidenced based program designed to train current or previous WIC clients who have successfully breastfed, to become lay peer counselors (Best Start Social Marketing, 2004). These peer counselors provide education and support to mothers enrolled in WIC programs and refer the mother to a specialist for any major problems. A recent evaluation of LSPCP in Washington found increases in breastfeeding initiation and duration in WIC clinics pre-and post LSPCP implementation (Lee et al., 2017). These result were similar to previous studies that assessed peer counseling programs among low-income women (Campbell, Wan, Speck, & Hartig, 2014; Chapman et al., 2010; Gross et al., 2009). However, this study, like others, was not a randomized study and the authors also found a significant increase in breastfeeding rates among WIC clinics that did not implement LSPCP, indicating that other factors were impacting rates.

Interventions have tested other variations of peer counseling programs, such as the frequency (how many contacts), duration of the program (prenatal, postnatal), and communication style (face-to-face, phone, text message, video conferencing). An intervention targeting African American WIC participants showed significant increases in breastfeeding initiation using

enhanced peer counseling (62%), which included three prenatal contacts and weekly postnatal visits for 16 weeks, compared to a control group (26%), but breastfeeding rates dropped to 30% in the intervention group at 7-10 days post-delivery (Caulfield et al., 1998). A similar study testing the same enhanced peer counseling intervention found positive results for on breastfeeding initiation but, unlike the original study, the intervention was successful at increasing breastfeeding rates at 8 and 16 weeks (Gross et al., 1998). These conflicting results indicate that other factors may be more influential in breastfeeding success. A volunteer-based peer counselor program was also found to be effective in increasing breastfeeding initiation and duration among WIC participants living in rural areas (Schafer et al., 1998).

Telephone based peer counselor programs have also emerged as a potential tool. A recent study evaluated a telephone only peer-counseling program with no home or hospital visits, on breastfeeding rates among WIC participants in Oregon (Reeder et al., 2014). This study compared a control group, with no peer counseling, to a low frequency group, which had 4 telephone contacts (2 prenatal, 2 postnatal), and a high frequency group, which had 8 telephone contacts (2 prenatal, 6 postnatal). Overall, there were no differences in the number of contacts by the peer counselors in the low-frequency and high frequency groups with most participants receiving only one prenatal and one postnatal call. The telephone peer counseling intervention increased breastfeeding rates at three months in the treatment groups compared to the control. Significant increases in exclusive breastfeeding at six months were only found among Spanish speakers. The results from this study were comparable to other resource intensive peer counselor programs that utilize home visits, hospital visits, and telephone calls, which may indicate the usefulness of telephone peer counseling when resources are limited (Anderson, Damio, Young, Chapman, & Perez-Escamilla, 2005; Chapman et al., 2010; Reeder et al., 2014).

Text messaging has also been added to peer counseling programs to improve communication and to capitalize on the high percentage of cell phone ownership in the United States. A recent pilot study tested the feasibility of adding text messaging to a WIC peer counselor program (Harari et al., 2017). The intervention group was sent educational text messages during both the prenatal and postnatal periods, and the mothers could send text messages to the peer counselor when needed, but responses were limited to business hours (Monday-Friday, 8:00am-5:00pm). Overall, this pilot study found that adding text messaging to a peer-counseling program is feasible and may improve breastfeeding rates, but the sample size used did not have adequate power. While it did not significantly increase exclusive breastfeeding rates at 2 weeks postpartum, it did significantly increase contact with a peer counselor within 48 hours after delivery, which is a crucial time for breastfeeding mothers (Harari et al., 2017; Patel & Patel, 2016). Future studies with a larger sample size could fully evaluate the effectiveness of text messaging.

Other studies have evaluated the impact of more resource intensive peer counselor programs on breastfeeding rates. A randomized clinical trial evaluated a 24-week intervention that provided hospital visits, home visits, telephone support, and 24-hour pager access to a community nurse and peer counselor (Pugh et al., 2010). The intervention was found to be effective at improving breastfeeding rates at 6 weeks postpartum, but not at 12 or 24 weeks. The authors pointed out that the amount of support was most intensive during the first 6 weeks of the intervention, which may have contributed to the positive results. It seems unlikely that WIC programs will have the funding or resources to implement such an intensive intervention. However, the use of the Pacify application in this study provided WIC clients 24-hour access to a lactation consultant via video calls, which may replicate some of the observed benefits.

Several of the more recent studies have used the Breastfeeding Attrition Prediction Tool

(BAPT), which is a 26-item questionnaire designed to identify the positive and negative attitudes toward breastfeeding, family and professional expectations, and perceived ability to successfully breastfeed among pregnant women (Bortree, 2013; Dick et al., 2002; Edmunds et al., 2017; Janke, 1994). The results from the BAPT are used to develop a custom counseling plan to address areas of concern such as negative attitudes, low self-efficacy, or others (Dick et al., 2002; Janke, 1994). A quasi-experimental study in New York administered the BAPT in combination with peer counseling during both the prenatal and postnatal period, which improved exclusive breastfeeding rates at 7, 30, and 60 days postpartum compared with a baseline group (Edmunds et al., 2017). Similar results were found among the Vermont WIC program, where the BAPT was used in combination with the new WIC food packages (Bortree, 2013). Overall, higher exclusive breastfeeding rates were observed compared to historical controls at 4 weeks (55% vs 39%), 3 months (43% vs 22%), and six months (34% vs 16%). However, the multicomponent program made it difficult to determine if the gains were from the BAPT, peer counseling, or new food packages.

While several studies found that peer counselor programs could increase breastfeeding initiation and duration, few showed improvements in exclusive breastfeeding. In addition, the peer counselor programs have been in place since the 1990s and, while improvements have been made, breastfeeding rates among WIC participants remain below national averages (CDC, 2016b). The main limitations of peer counseling programs were that the programs utilized untrained volunteer counselors, were usually restricted to working hours, utilize phone calls more than face-to-face meetings, and may not enroll mothers until the postpartum period (Ahluwalia et al., 2000; Bolton et al., 2009; Bronner et al., 2001; Grummer-Strawn et al., 1997; Stremler & Lovera, 2004). Increasing access to highly trained IBCLCs may have stronger outcomes among this population.

Access to Lactation Consultants.

WIC programs have also been attempting to improve access to trained breastfeeding specialists, such as lactation consultants. A few studies have utilized lactation educators or counselors to provide breastfeeding support, but results have been mixed. A study by Chezem et al (2004) found an intervention that provided postpartum women with 2 home visits and three phone calls by a lactation educator was insignificant for increasing breastfeeding rates at 16 weeks. Limitations of the study included the small sample size (N=100) and the lactation educators were not licensed IBCLCs. However, the results indicate that providing education and support by phone may not be effective. Another intervention provided prenatal and postnatal one-on-one support from a lactation consultant with a focus on education during the sessions (Petrova et al., 2009). While the intervention did increase exclusive breastfeeding rates at one week, the gains were diminished by three months and overall the intervention did not have a significant impact.

The majority of women enrolled in WIC quickly introduce formula, despite recommendations for exclusive breastfeeding. Identifying ways to help mothers who begin mixed feeding return to exclusive breastfeeding could improve outcomes among WIC participants. A recent randomized trial demonstrated that assigning mixed feeding Hispanic mothers to a breastfeeding clinic with access to an IBCLC significantly increased exclusive breastfeeding rates at four weeks postpartum (16.4% vs 10.0%) (Hopkinson & Konefal Gallagher, 2009). While these gains were small, the results indicate that WIC programs should encouraging mixed feeding mothers to return to exclusive breastfeeding and provide access to an IBCLC if possible. The proposed intervention may increase access to IBCLCs, which may have similar outcomes among mixed feeders in Mississippi.

Other Interventions.

WIC programs have also begun providing peer counseling to fathers, with the hope of increasing male involvement which may improve breastfeeding support among mothers and breastfeeding rates. A pilot study examined a peer dad counseling program among Hispanic couples, but overall participation in the program did not significantly increase breastfeeding rates (Lovera et al., 2010). However, this was a small study focused on Hispanics and larger, more diverse studies are needed to clarify the effectiveness of this approach.

Interventions have also tested the effectiveness of incentives, such as gift cards, diapers, cash, or other items in increasing breastfeeding rates. A recent study demonstrated that providing incentives (gift cards, diapers, etc.) to couples that attended breastfeeding or child birthing classes had positive outcomes on exclusive breastfeeding at hospital discharge, 2 weeks, 6 weeks, and 3 months postpartum, compared to a control group (Sciacca, Phipps, Dube, & Ratliff, 1995). A similar study found that providing cash incentives to mothers that demonstrating breastfeeding to WIC staff during appointments resulted in increased breastfeeding rates at one, three and six months among Puerto Rican mothers (Washio et al., 2017). While these studies have observed positive results, it may be difficult for WIC programs to obtain funding or donations to provide incentives on a large scale.

Changes in the physical and social environment of WIC centers to be more breastfeeding friendly resulted in breastfeeding initiation rates that were 1.5 times higher than control group (Hildebrand et al., 2014). The social environmental changes included training staff to be friendlier, actively listen, remove judgement, and provide positive feedback among other techniques. The physical changes included posting positive pictures of breastfeeding women along with personal testimonies, having staff wear colorful health care scrubs, and having mothers sign a colorful breastfeeding pledge card. While the impact of this study is limited, it demonstrated that small

changes could have a positive impact among participants.

Intervention focused on breastfeeding education have had mixed results. A recent randomized clinical trial found that showing a 25-minute video, covering breastfeeding topics, during the third trimester did not improve breastfeeding initiation, duration, or exclusivity during the hospital stay after delivery among women enrolled in WIC (Kellams et al., 2016). This video only intervention may have failed because the education may have been provided too late in the pregnancy to change breastfeeding intentions or perhaps participants need face-to-face interaction. Other studies have found significant increases using educational videos and pamphlets, but the gains were not as large as using peer counselors in alone or in combination with the videos (Caulfield et al., 1998; Gross et al., 1998). An educational video-based intervention was conducted in Mississippi, which was found to improve breastfeeding perceptions, but it did not measure breastfeeding outcomes (Khoury, Mitra, Hinton, Carothers, & Sheil, 2002).

The use of a daily breastfeeding log that was designed to help mothers monitor breastfeeding activity, urine output, stool output, pumping activity, and feelings was also found to be ineffective (Pollard, 2011). Participants were encouraged to use the log for at least 6 weeks, but overall there was not a significant increase in breastfeeding duration. However, the study indicated that among women that did breastfeed for six months, women who used the breastfeeding log were more likely to exclusively breastfeed (85.7% vs 23.1%, $p < .001$).

Conclusions.

Overall, the most common intervention utilized by WIC programs has been peer counselor programs. The majority used lay volunteer peer counselors, who were mothers who successfully

breastfed. While this approach is cost effective and has had some success, breastfeeding rates remain too low among the WIC population, especially in Mississippi. In addition, most of the studies included in this review did not account for the number of referrals to a trained lactation consultant to address questions or concerns that the peer counselor could not solve. The current study attempted to clarify the impact of increasing access to highly trained IBCLCs among this population.

Impact of Lactation Consultants

This project focuses on increasing access to lactation consultants, which is one of the action steps recommended by the Surgeon General to support breastfeeding (USDHHS, 2011). The review of interventions among WIC population only included a few that were focused on increasing access to lactation consultants. Therefore, an additional review of the literature was conducted to identify high quality studies that have evaluated the effectiveness of lactation consultants in improving breastfeeding initiation, duration, and exclusivity. A high quality systematic review by Patel and Patel (2016) was identified that summarized all the randomized trials evaluating the impact of lactation consultants (including lactation educators, lactation counselors, CLCs, and IBCLCs) conducted between 1985 and 2014. Overall, the review identified 16 studies conducted in seven countries, of which eight were conducted in the United States. The authors indicated that all the countries were highly developed, and the meta-analysis would be applicable to the United States. In addition, seven of the eight studies conducted in the United States focused on low-income women.

Overall, the review by Patel and Patel (2016) found that access to lactation consultants was associated with positive breastfeeding outcomes. With regard to breastfeeding initiation, the meta-analysis found that interventions that used lactation consultants increased breastfeeding initiation

rates (OR 1.35, 95% CI 1.10-1.67). Rates of any breastfeeding duration were also improved at 1 month (OR 1.49, 95% CI 1.09-2.04), 1 to 3 months (OR 1.76, 95% CI 1.20-2.57), and 3 to 6 months (OR 1.29, 95% CI 1.05-1.58). Improvements were also noted for exclusive breastfeeding at 1 month (OR 1.71, 95% CI 1.20-2.44), and 1 to 3 months (OR 1.80, 95% CI 1.14-2.83). The impact on exclusive breastfeeding between 3 to 6 months was not significant (OR 1.17, 95% CI 0.82-1.67). The methods used in the studies varied by timing (prenatal or postnatal), amount of education provided, and contact method (face-to-face, phone), which may limit the applicability of the overall results. In addition, this review did not identify any interventions that utilized video conferencing.

An additional search was conducted to identify any other relevant interventions utilizing lactation consultants published since 2014 that may have been missed, with an emphasis on mHealth or telelactation. This search identified an additional three studies relevant to this project. A pilot study conducted in Indiana evaluated the impact of videoconferencing sessions with IBCLCs on breastfeeding rates among low-income (WIC eligible) patients attending a community health clinic (Friesen et al., 2015). The study enrolled 35 patients to test the acceptability and feasibility of the program but did not measure breastfeeding outcomes. Patients enrolled in the intervention group received at least one prenatal and one postnatal videoconference call with an IBCLC, using equipment set up in a patient room at the community health clinic. The patients also received an in person visit from the IBCLC at the hospital following delivery. The authors indicated that video conferencing with IBCLC was accepted by low-income women and a feasible option to use to increase access by integrating videoconferencing into routine care.

Another small pilot study evaluated the effectiveness of a home-based videoconferencing program on breastfeeding skills, but it did not assess breastfeeding outcomes (Rojjanasrirat et al.,

2012). This project enrolled 10 patients who were provided 4 weekly videoconferencing calls with an IBCLC following delivery. The videoconferencing sessions were accessed through a computer or laptop in the patient's home. Overall, the results indicated that the mothers were comfortable using the service and that their overall breastfeeding skills improved, but a larger scale study needs to be conducted to evaluate the full impact.

There is an ongoing randomized clinical trial being conducted to test the effectiveness of a commercial direct-to-consumer telelactation video application that provides 24-hour access to IBCLCs via video calls, which can be accessed through internet capable devices (Uscher-Pines, 2017). This trial is evaluating the same mHealth (Pacify) application that is being evaluated in this project. However, the ongoing trial is evaluating the impact of the mHealth application on low-income women living in rural Pennsylvania.

Conclusion

Previous work has demonstrated that increasing access to lactation consultants improves breastfeeding initiation, duration, and exclusivity (Patel & Patel, 2016). However, access to highly trained IBCLCs is limited in the United States with only 3.79 per 1000 live births and further limited in Mississippi, with only 1.93 per 1000 live births (CDC, 2016b). While improvements have been made by using peer counselor programs, breastfeeding rates remain low both nationally and in Mississippi. New interventions are needed to address the gap in access to IBCLCs, especially among women enrolled in WIC programs. The most promising approach is through the use of video conferencing sessions with IBCLCs, but the best method has yet to be determined. To date only one randomized clinical trial is being conducted and the results are pending. The proposed project expands on the work of these initial studies by evaluating the impact of increasing access to IBCLCs via video calls among women enrolled in WIC programs in the state of

Mississippi. The results could help WIC programs decide if they should invest funding into the implementation of mHealth or telelactation programs.

Chapter 3: Research Design and Methodology

New mothers are recommended by the American Academy of Pediatrics (AAP) to exclusively breastfeed their infants for the first six months to provide optimal health for infant and mother (AAP, 2012). However, only 13.0% of mothers in Mississippi reached this milestone in 2016, which was the lowest rate in the United States and far below the Healthy People 2020 objective of 25.5% (CDC, 2018; USDHHS, 2018). New interventions and programs are needed to help states, such as Mississippi, reach this goal.

One factor that impacts breastfeeding success is access to breastfeeding support services provided by certified lactation consultants, with mothers who have access being more likely to initiate and exclusively breastfeed (Patel & Patel, 2016). In 2016, Mississippi had 1.93 International Board Certified Lactation Consultants (IBCLC) per 1,000 live births, which was far below the national average of 3.79 (CDC, 2016a). In addition, few insurance plans cover services provided by lactation consultants outside of the hospital, reducing access to low-income families that may have to pay out of pocket. This is compounded by the stress and needs of the newborn on new parents. Identifying new approaches to increase access to lactation consultation services may improve outcomes in this population.

The Mississippi WIC Program provides nutrition services, including breastfeeding education and support, to low-income women (USDA, 2017c). However, these low-income families still must travel to the WIC center, with a newborn, to receive in- person lactation consultations, which may be a barrier among this population. One promising approach to increase access to breastfeeding support services provided by IBCLC, is through the use of mHealth applications that provide lactation consultations via video calls that can be accessed by smartphones, tablets, and computers in any location with internet access (Uscher-Pines et al., 2017;

World Health Organization, 2011). This field has been called "telelactation" and has been proposed as a potential approach to reduce barriers to access, but the impact on breastfeeding duration and exclusivity has yet to be determined (Uscher-Pines et al., 2017).

Between June 2016 and May 2018, all pregnant women enrolled in the Mississippi WIC Program were provided with the option to freely download the Pacify "telelactation" application, which provides access to breastfeeding support services provided by IBCLCs via video conferencing through a cell phone, tablet, or computer application. This allows the women to have access to lactation services 24 hours a day, as long as they have access to the smartphone and an internet connection. However, the effectiveness of the telelactation applications, such as Pacify, in improving breastfeeding duration and exclusivity among low-income mothers has yet to be established.

Purpose

This research project used a retrospective cohort design to determine if providing free access to the Pacify mHealth application, which provides lactation consultations via video calls to new mothers enrolled in the Mississippi WIC Program, significantly increased any breastfeeding and breastfeeding exclusivity at three and six-months postpartum. Additional analyses were conducted among the cohort that downloaded the Pacify application to determine if the number of times the Pacify application was used was associated with breastfeeding duration or exclusivity. Pacify application user reviews were assessed to identify positive and negative perceptions about the application.

Research Objectives

Aim 1: Determine if women who downloaded the Pacify application had higher rates of *any*

breastfeeding at three and six-months postpartum compared to the unexposed group.

H^o: There is no difference in any breastfeeding rates between the intervention and unexposed groups at three or six months

H^a: There is a difference in any breastfeeding rates between the intervention and unexposed groups at three or six months

Aim 2: Determine if women who downloaded the Pacify application had higher rates of *exclusive* breastfeeding at three and six-months postpartum compared to the unexposed group.

H^o: There is no difference in exclusive breastfeeding rates between the intervention and unexposed groups at three or six months

H^a: There is a difference in exclusive breastfeeding rates between the intervention and unexposed groups three or six months

Aim 3: Determine if the number of times that the Pacify application was used, for video lactation consultations, was associated with higher rates of any or exclusive breastfeeding at six months.

H^o: There is no difference in any or exclusive breastfeeding at six months associated with the number of times the application was used.

H^a: There is a difference in any or exclusive breastfeeding at six months associated with the number of times the application was used.

Aim 4: Assess user comments associated with using the Pacify application among Mississippi WIC participants to identify the common positive and negative perceptions.

Research Hypotheses

I hypothesized that women who downloaded and utilized the Pacify application would have higher rates of any breastfeeding and exclusive breastfeeding at three and six-months postpartum compared to women that did not use the application. This was anticipated because increasing access to lactation consultants may help mothers overcome common breastfeeding misconceptions or problems, such as incorrect latching, perceptions of insufficient milk supply, or other problems. This service was also available 24 hours a day as long as internet is accessible, which may reduce barriers such as transportation, cost, or embarrassment.

Study Period

This retrospective cohort study assessed de-identified data collected by the Mississippi WIC Program and Pacify application between June 2016 and May 2018. All pregnant and postpartum women enrolled in the Mississippi WIC program were provided the opportunity to freely download the Pacify application during this period. This program was promoted by the WIC staff and peer counselors. Data were only collected from mothers whose infants were born between June 2016 and February 2018, to allow for at least a three-month follow-up period needed to measure exclusive breastfeeding rates at three-months postpartum. Data analyses for the six-month postpartum period were limited to infants born between June 2016 and November 2017.

Study Design

This study utilized a retrospective cohort design to evaluate the association between downloading the Pacify application and breastfeeding duration and exclusivity among women enrolled in the Mississippi WIC Program. De-identified data were collected from the Mississippi WIC program and the Pacify application among women meeting the eligibility requirements listed

below.

Inclusion Criteria

- Women 18 years and older
- Enrolled in the Mississippi WIC Program
- Delivered an infant between June 2016 and February 2018
- Initiated breastfeeding (as indicated by reporting any breastfeeding during the month 0 or month 1 postpartum Mississippi WIC visit)

Exclusion Criteria

- Women who never initiated breastfeeding due to personal choice or medical condition

Women were assigned to the Pacify group or WIC only group (unexposed) based on whether or not they downloaded the Pacify application, regardless of use. This was decided because women who downloaded the application receive educational and reminder push notifications that may have impacted breastfeeding behavior. The proportions of women reporting any and exclusive breastfeeding at three and six-months postpartum were compared between groups to identify any differences. Additional analyses were completed among women that downloaded the Pacify application to determine if the number of times the application was used impacted breastfeeding duration or exclusivity. A full review of the data included in the Pacify database was also completed to identify the main breastfeeding problems that were addressed as well as the positive and negative comments provided during post-call reviews.

Number of Subjects

National rates for exclusive breastfeeding among WIC participants range from 38.0% at

three months to 17.8% at six months (CDC, 2018). The rates for all women in Mississippi were lower ranging from 28.2% at three months to 13.0% at six months (CDC, 2018). Based on these rates, it was estimated that rates of exclusive breastfeeding would be smallest at six months ranging from 10% to 20% in the study population. It was estimated that 20 percent of the study population would download the Pacify application. It was determined that a sample size of 637 participants (128 Pacify and 509 unexposed) with reported breastfeeding status at six months were required to have an 80% chance of detecting differences with significance at the 5% level, in exclusive breastfeeding at six months, from the current estimate of 10% in the unexposed group to 20% in the Pacify group (OpenEip, 2018). This would allow the detection of an odds ratio of 2.3. The actual sample size exceeded this expectation.

Recruitment of Subjects

De-identified data were provided from the Mississippi WIC program and the Pacify program for all women, 18 years and older, that delivered an infant during the study period. These data were screened for additional inclusion criteria and any women not meeting the requirements were removed.

Study Methodology

In June 2016, the Mississippi WIC Program began providing pregnant and postpartum mothers the opportunity to download the Pacify application free of charge. The Pacify application provided access to lactation consultations provided by trained IBCLC via video conferencing on smartphones or tablets. This service was available 24-hours a day and the IBCLCs would answer any breastfeeding questions and assist with any problems. If problems could not be addressed by video, then patients were encouraged to visit providers at WIC centers or other healthcare facilities

in their area. The goal of offering this application was to increase access to lactation consultations, which was hypothesized to improve breastfeeding duration and exclusivity rates among this low-income population.

The purpose of this retrospective cohort study was to compare the rates of exclusive breastfeeding and any breastfeeding at three and six-months postpartum among women that downloaded the Pacify application compared to those that did not download the application. The three-month period is important because this is when most women return to work at the end of the 12 weeks protection provided by Family and Medical Leave Act (FMLA) (Shepherd-Banigan & Bell, 2014). The six-month period is important because that is the length of time that the AAP recommends mothers to exclusively breastfeed (AAP, 2012). I hypothesized that the women who downloaded the Pacify application will have 15% higher rates of exclusive breastfeeding at three months and 10% six-months. In addition, the rates of any breastfeeding will increase by 15% at three months and 10% at six months. These assumptions are based on the results of a meta-analysis of interventions providing lactation support, which found positive odds ratios for any breastfeeding at 3 and 6 months and exclusive breastfeeding at 3 months (Patel & Patel, 2016).

This retrospective cohort study collected 24 months of data, from June 2016 to May 2018, from both the Mississippi WIC program and the Pacify program. Each organization provided a de-identified database that included the Mississippi WIC State ID to use as an identifier to merge the data. A description of each database and the important variables follows.

Mississippi WIC Database.

The Mississippi WIC Program stores client information into a database as part of their health record as well as for research and reporting. This database includes the mothers name, date

of birth, race, ethnicity, zip code, number of people in household, WIC center, infant date of birth, infant feeding category (formula, minimal breastfeeding, partial breastfeeding, fully breastfeeding), and whether or not the participant received information about the Pacify application. A report was generated at the end of each month that merges all the data from all WIC participants statewide. These monthly reports were collected and de-identified by WIC staff from June 2016 through May 2018 and sent to the researcher for data cleaning and analysis. A list of the key variables used for analyses is included below.

Key Variables:

- Mother date of birth- used to calculate the mothers age at infant's date of birth. All mothers had to be at least 18 years old at infant birth to be included in the study.
- Mother age at infant birth- this was calculated using Microsoft Excel. Dates of birth for the mother and infant were converted to numeric values. The values were subtracted which resulted in the number of days old the mother was on the infant date of birth. This number was divided by 365 to report the age of the mother, which was reported out two places past the decimal point.
- Infant date of birth- used as the reference point to determine the month for each reported infant feeding status. The month of birth was considered month 0, the next month was month 1 and so forth. This was done, due to the limitations of the data. The reporting date was not included in the database.
- Household size- this was reported to WIC as the total number of people in the household. It was not differentiated by child or adults and only reported as a total number.
- Race- this was reported as Black or African American, American Indian or Alaskan Native,

White, Asian, Native Hawaiian or Other Pacific Islander, or Unknown. Due to the small sample size, the final database was limited to African American or Black, White, Asian, Other, or Unknown. People reporting multiple races were included in the other category.

- Ethnicity- this was reported as Hispanic or Latino, Not Hispanic or Latino, or unknown.
- Infant Feeding Status- this was classified as unreported, formula feeding, minimally breastfeeding (> 1/2 is formula), partially breastfeeding (<= 1/2 is formula), or fully breastfeeding (exclusively breastmilk).
- Any breastfeeding- this included all women that reported minimal, partial, or fully breastfeeding.
- Exclusive breastfeeding- this only included women that reported fully breastfeeding.

Pacify Database.

The Pacify application has an agreement to share all the data they collect from the Mississippi WIC users with the Mississippi WIC Program. In addition, they agreed to allow data to be used for this study. Pacify collects information in their database on their clients that includes Pacify ID, enrollment date, call ID for each call, time to answer, length of each video call, brief consultation notes, user rating, patient feedback, and use of push notifications. This information was collected in a database for the study period. The data were de-identified and sent to the researchers. A list of the key variables used for data analyses are listed below.

Key Variables

- Call ID- used to calculate the total number of calls made to a lactation consultant.
- Call length- used to calculate the average time of all calls made during the study period
- Patient rating- users could provide a rating from 1-5, with 1 being the worst and 5 being the best, at the end of each call. The average rating was calculated for all the calls made

during the study period.

- Patient complaint- the lactation consultants would provide a note indicating the chief complaints discussed during the call. These notes were reviewed to identify the main theme for each call and used to provide a summary of the most common problems addressed during calls among this population.
- Provider recommendation- the lactation consultants also documented a brief note indicating the main recommendations to address the reported problems.
- Patient feedback- users could leave a comment at the end of each call. These comments were reviewed to identify the positive and negative perceptions of the application.
- Push notifications- this indicated if the participant allowed push notifications.

Merging and De-identifying the Databases.

Both of the de-identified databases were sent to the PhD student, Aaron Hunt, through encrypted email. The databases were merged using the Mississippi WIC State ID assigned to the mother, which was included in both databases. Participants that were confirmed to have downloaded the Pacify application were assigned to the Pacify group and all other women were assigned to the unexposed or WIC only group.

Outcome Measures.

The primary study outcomes were the rates of any breastfeeding and exclusive breastfeeding at three and six-months postpartum. These proportions were compared between the groups to determine if there was a significant difference associated with downloading the Pacify application. Additional analyses were conducted among the cohort that downloaded the Pacify application to determine if the number of times the Pacify application was used was associated

with breastfeeding duration or exclusivity. Pacify application user reviews were assessed to identify positive and negative perceptions about the application.

Data Analysis.

Women that downloaded the Pacify application were assigned to the "Pacify Group" regardless of whether or not they used the application. The remaining were assigned to the unexposed or "WIC Only Group". Once the women were assigned to a group, data were reviewed to ensure they meet the inclusion criteria. The data were analyzed for the total population, study population (only women meeting inclusion criteria), and the Pacify sub population (only women downloading the application).

Sociodemographic characteristics were obtained from the Mississippi WIC database and included the following information about the mother: age at infant birth; race (African American or Black; White; Asian; or other); ethnicity (Hispanic/Latino or not Hispanic/Latino); and number of people in household (does not differentiate by adult/child). The means and standard deviations were calculated for the continuous variables (age and household size) and compared between groups using *t*-tests. Proportions were calculated for all categorical variables (race and ethnicity) and compared between groups using chi square testing. Any characteristics that were significantly different between groups were considered potential confounders.

Infant feeding status was obtained during each postpartum visit and recorded in the Mississippi WIC database. WIC participants were classified by staff as fully breastfeeding (exclusive), partially breastfeeding ($\geq$ ½ is breastfeeding), minimally breastfeeding ($<$ ½ is breastfeeding) or fully formula feeding (no breastmilk) during monthly visits starting at month 0. Mothers that reported any breastfeeding (minimal, partial or fully) at least once during either the month 0 or month 1 postpartum visit were considered to have initiated breastfeeding, which was

required to meet the inclusion criteria. The first two postpartum visits were included in determining breastfeeding initiation because many mothers may miss the month 0 visit, due to medical reasons or not knowing that they were eligible for WIC services.

Infant feeding status was converted to dichotomous variables for any breastfeeding and exclusive breastfeeding. The rates of any breastfeeding were calculated for each group for months two through six by dividing the number of mothers reported any breastfeeding (minimal, partial or fully) by the number that reported formula only. All unreported data were excluded from the calculation of the proportions for any breastfeeding. The rates of exclusive breastfeeding were also calculated by dividing the number of women that reported fully breastfeeding by the number that reported minimal, partial or formula feeding. Again, the unreported data were excluded in the calculation of the proportions for each month.

Descriptive statistics were also obtained from the Pacify database to further the understanding of the population that downloaded the application. Means and standard deviations were calculated for the continuous variables (patient rating, length of call, and number of calls). The number of calls was also converted to a dichotomous variable (0 calls, 1 or more calls) and a categorical variable (0, 1, 2, or 3 or more calls). These were compared with rates of any and exclusive breastfeeding to identify any associations.

Statistical Methodology.

Baseline sociodemographic characteristics and rates of any breastfeeding and exclusive breastfeeding of the mothers who downloaded the Pacify application were compared to mothers who did not download the application. Pearson's $\chi 2$ tests were used to identify significant differences in proportions and *t*-tests were used to identify significant differences in means between groups. Any characteristics that were found to be significantly different were considered

potential confounders. Models were created for any breastfeeding and exclusive breastfeeding. The unadjusted odds ratios were calculated with logistic regression. A full model was calculated by multivariate logistic regression to adjust for all variables, to estimate the adjusted odds ratio (aOR) of breastfeeding (exclusively or any) at three and six months postpartum, based on downloading the pacify application.

A further analysis among the entire group of women who downloaded the Pacify mHealth application was conducted to determine if the number of times the application was used impacted rates of any and exclusive breastfeeding. Participants who used the Pacify application were grouped by the number of times they used the application (0, 1, 2, 3 or more times). Pearson's $\chi 2$ tests were used to identify significant differences in proportions between the different categories.

Data were analyzed using SPSS version 25. A 2-sided significance level of .05 was used for all study outcomes. Frequencies and percentages were calculated for all dichotomous data, and the differences between groups was identified by using Pearson $\chi 2$ tests and supplemented by Fisher exact test when needed. The odds ratio and 95% confidence intervals were estimated using logistic regression. The means and standard deviation were calculated for all continuous data, and the differences between groups were examined by using an independent 2-sample t test. Logistic regression was also conducted to assess group differences. Multiple logistic regression analyses were used to calculate the adjusted odds ratios and 95% confidence intervals.

Ethical Issues.

Approval for this study was obtained from the Institutional Review Boards of the Mississippi Department of Health and the University of Nevada Las Vegas (Appendix B). All identifiable information was removed before analyses were completed to ensure no participants could be personally identified.

Chapter 4: Results

This retrospective cohort study was conducted to evaluate the impact of providing a free "telelactation" mobile application on breastfeeding rates among low-income women enrolled in the Mississippi WIC program. Specifically, this chapter includes the data analysis related to the specific aims and hypotheses of this study:

Aim 1: Determine if women who downloaded the Pacify application had higher rates of *any* breastfeeding at three and six-months postpartum compared to the unexposed group.

> **Hypothesis:** Mothers that downloaded the Pacify application will demonstrate an increase in rates of any breastfeeding rates at three and six-months compared to the unexposed group.

Aim 2: Determine if women who downloaded the Pacify application had higher rates of *exclusive* breastfeeding at three and six-months postpartum compared to the unexposed group.

> **Hypothesis:** Mothers that downloaded the Pacify application will demonstrate an increase in rates of exclusive breastfeeding rates at three and six-months compared to the unexposed group.

Aim 3: Determine if the number of times that the Pacify application was used, for video lactation consultations, was associated with higher rates of any or exclusive breastfeeding at six months.

> **Hypothesis:** Mothers who called the lactation consultant 1 or more times will demonstrate an increase in rates of any and exclusive breastfeeding at six months compared to mothers making no calls.

Aim 4: Assess user comments associated with using the Pacify application among Mississippi WIC participants to identify the common positive and negative perceptions.

Hypothesis: The positive perceptions associated with the Pacify application will include increased accessibility to highly trained lactation consultants to address common breastfeeding problems, improved self-efficacy, and ease of use. The negative perceptions will include the lack of access to reliable internet access.

Description of the Data

This retrospective cohort study analyzed de-identified data collected from the Mississippi WIC program and the Pacify application between June 2016 and May 2018. The Mississippi WIC program provided data about mothers and their infants that included demographics and infant feeding status in monthly reports. This information was matched with usage data from the Pacify application including number of calls, length of calls, user reviews, and medical notes. Women that downloaded the Pacify application were assigned to the "Pacify Group", regardless of the number of times the application was used. The remaining women that did not download the application were assigned to the "WIC Only Group". The following analyses are organized by the population or outcome.

Demographics & Descriptive Characteristic of the Mississippi WIC Total Population

A total of 41,949 women, 18 years and older, were enrolled in the Mississippi WIC program and delivered an infant between June 2016 and February 2018. The data collected from these women by the Mississippi WIC program and Pacify were used for study eligibility screening. The total population characteristics can be seen in Table 8. Overall, uptake of the Pacify application was low, with only 3.1% (1317) of women downloading the application. The majority

of participants reported a race of African American (56.6%) or White (41.0%), and an Ethnicity of non-Hispanic (94.6%).

Table 8. Total Mississippi WIC population characteristics

Characteristics	**Mean (SD)**
Mother age at birth (SD)	26.35 (5.28)
Household size (SD)	4.08 (1.446)
Race	**Number (%)**
African American or Black	23,702 (56.6%)
White	17,154 (41.0%)
Asian	349 (0.8%)
Other	685 (1.6%)
Ethnicity	**Number (%)**
Hispanic	2260 (5.4%)
Non-Hispanic	39,630 (94.6%)
Group	**Number (%)**
WIC Only	40,632 (96.9%)
Pacify	1317 (3.1%)

The infant feeding status reported to the Mississippi WIC program during the first six months postpartum can be seen in Table 9. Infant feeding status was classified as unreported, formula feeding, minimally breastfeeding (> 1/2 is formula), partially breastfeeding (<= 1/2 is formula), or fully breastfeeding (exclusively breastmilk). It is important to note the breastfeeding status was commonly unreported due to missed appointments or women dropping out of the program. In addition, the majority of women (>74%) reported formula feeding at each time point. Among women with reported infant feeding statuses, the rates of any breastfeeding (minimal,

partial, or fully) were 20.1% at three months and 10.5% at six months. The rates for exclusive breastfeeding (fully) were 5.0% at three months and 3.3% at six months.

Table 9. **Breastfeeding status by month among total Mississippi WIC population**

Infant Age (months)	0	1	2	3	4	5	6
Fully Breastfeeding (BF)	1608 (4.5%)	2619 (6.6%)	2411 (6.0%)	2008 (5.0%)	1488 (3.9%)	1285 (3.5%)	1104 (3.3%)
Partially BF <= 1/2 is formula	1560 (4.4%)	2729 (6.9%)	2686 (6.7%)	2080 (5.2%)	1367 (3.5%)	1098 (3.0%)	883 (2.6%)
Minimally BF > 1/2 is formula	2592 (7.3%)	4784 (12.1%)	5138 (12.8%)	3993 (9.9%)	2750 (7.1%)	2235 (6.1%)	1559 (4.6%)
Formula	29802 (83.8%)	29509 (74.4%)	29945 (74.5%)	32133 (79.9%)	32967 (85.5%)	31766 (87.03	30091 (89.5%)
Total Reported	35562	39641	40180	40214	38572	36384	33637
Unreported*	6387	2308	1769	1735	3377	5565	8312

*Unreported data were not included in the calculation of proportions.

The infant feeding status reported at month 0 and 1 postpartum were combined to estimate the rate of breastfeeding initiation. Among women with a reported status, 10,912 (38.0%) women reported breastfeeding (minimal, partial, or fully) at least once during month 0 or 1 and were considered to have initiated breastfeeding. Women meeting this requirement were included in the study analyses. The remaining 28,731 (62.0%) reported formula feeding, and 2,306 had an unreported status.

Demographics & Descriptive Characteristic of the Study Population

The study population was limited to women that initiated breastfeeding, due to the function of the Pacify application to provide breastfeeding support from lactation consultants. Women were considered to have initiated breastfeeding if they reported any breastfeeding (minimal, partial, or fully) at least once during the first two months postpartum (month 0 and month 1). A total of

31,037 women reported formula only or had unreported status during these months and were excluded. A total of 10,912 women were included in the final study population, of which 819 (7%) downloaded the Pacify application (Figure 2).

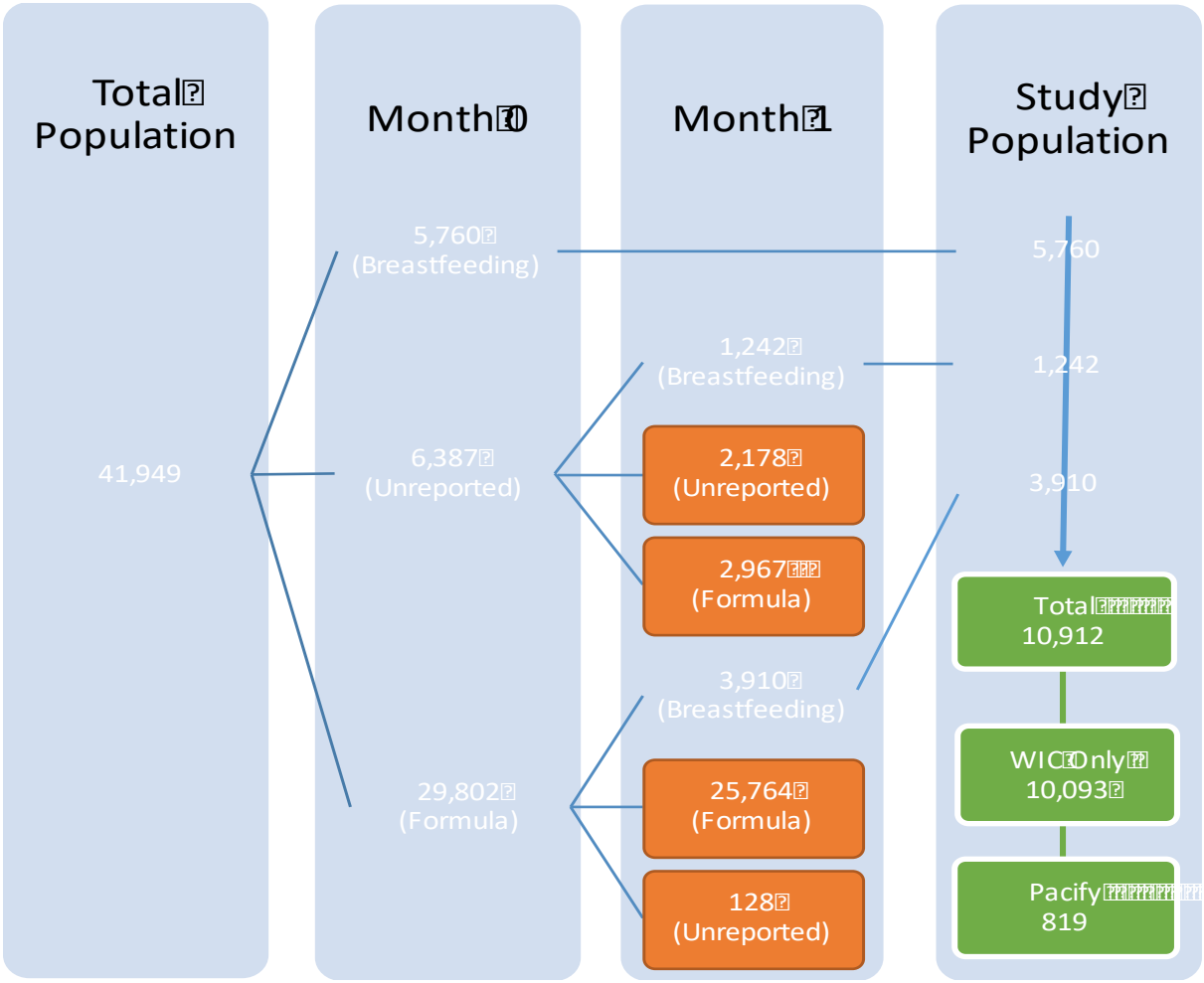

Figure 2. Study inclusion flow chart. Women were included in the study if they reported any breastfeeding (minimal, partial, or fully) during the month 0 or 1 WIC visit. All women with an unreported status or formula only were removed and colored orange. The final study population is shown in green and broken down by group.

The group characteristics are shown in Table 10. Women in the Pacify group had a smaller household size (p<001) and were less likely to be Hispanic (p<001) compared to the WIC Only group. There were no significant differences in the mother's age at infant birth with both groups averaging 26 years. In addition, no differences were observed in race with both groups having a majority of participants reporting as African American or White (Table 10). No other demographics were available from the analyzed datasets.

Table 10. Study population characteristics

Characteristics	**Overall Sample (10912)**	**Pacify (819)**	**WIC only (10093)**	***P* value**
Mother age at birth (SD)	26.68 (5.42)	26.39 (5.09)	26.70 (5.45)	.095
Household size	4.03 (1.47)	3.74 (1.32)	4.06 (1.47)	**<.001**
Race				.111
African American	5706 (52.3%)	417 (50.9%)	5289 (52.4%)	
White	4853 (44.5%)	385 (47.0%)	4468 (44.3%)	
Asian	139 (1.3%)	9 (1.1%)	130 (1.3%)	
Other	211 (1.9%)	8 (1.0%)	203 (2.0%)	
Ethnicity				**<.001**
Hispanic	875 (8.0%)	20 (2.4%)	855 (8.5%)	
Non-Hispanic	10034 (92.0%)	799 (97.6%)	9235 (91.5%)	

Bold values indicate statistically significant difference ($P \leq .05$). *P* values are based on independent t-test or Pearson's χ^2 test.

Sample Size used for Breastfeeding Outcomes

The proportions of any and exclusive breastfeeding among the Pacify and WIC Only group were calculated after removing the unreported data for each month. This was done because the actual infant feeding status could not be determined. This caused the sample size to change for each of the monthly analyses. The final sample sizes used to calculate the proportions can be seen in Table 11.

Table 11. Group sample sizes used for analyses

Infant Age (months)	Pacify (N=819)				WIC Only (N= 10093)			
	Valid		Unreported		Valid		Unreported	
	n	Percent	n	Percent	n	Percent	n	Percent
0	753	91.94%	66	8.06%	8917	88.35%	1176	11.65%
1	819	100.00%	0	0.00%	10091	99.98%	2	0.02%
2	817	99.76%	2	0.24%	10077	99.84%	16	0.16%
3	814	99.39%	5	0.61%	10041	99.48%	52	0.52%
4	779	95.12%	40	4.88%	9451	93.64%	642	6.36%
5	732	89.38%	87	10.62%	8733	86.53%	1360	13.47%
6	690	84.25%	129	15.75%	7968	78.95%	2125	21.05%
7	283	34.55%	536	65.45%	2157	21.37%	7936	78.63%
8	239	29.18%	580	70.82%	1727	17.11%	8366	82.89%
9	210	25.64%	609	74.36%	1483	14.69%	8610	85.31%

Rates of Any Breastfeeding by Group: Aim 1

The primary outcome of this study was to determine if women who downloaded the Pacify application had higher rates of any breastfeeding at three and six-months postpartum compared to unexposed group. The rates of any breastfeeding (minimal, partial or exclusive) for the Pacify group and the WIC only group for months two through nine can be seen in Figure 3. The rates were higher among the Pacify group during all months. The increases in breastfeeding rates observed following month six were due to high proportions of unreported infant feeding statuses, which were not included in the calculations (Table 11). Logistic regression analyses were not conducted past six months due to this occurrence.

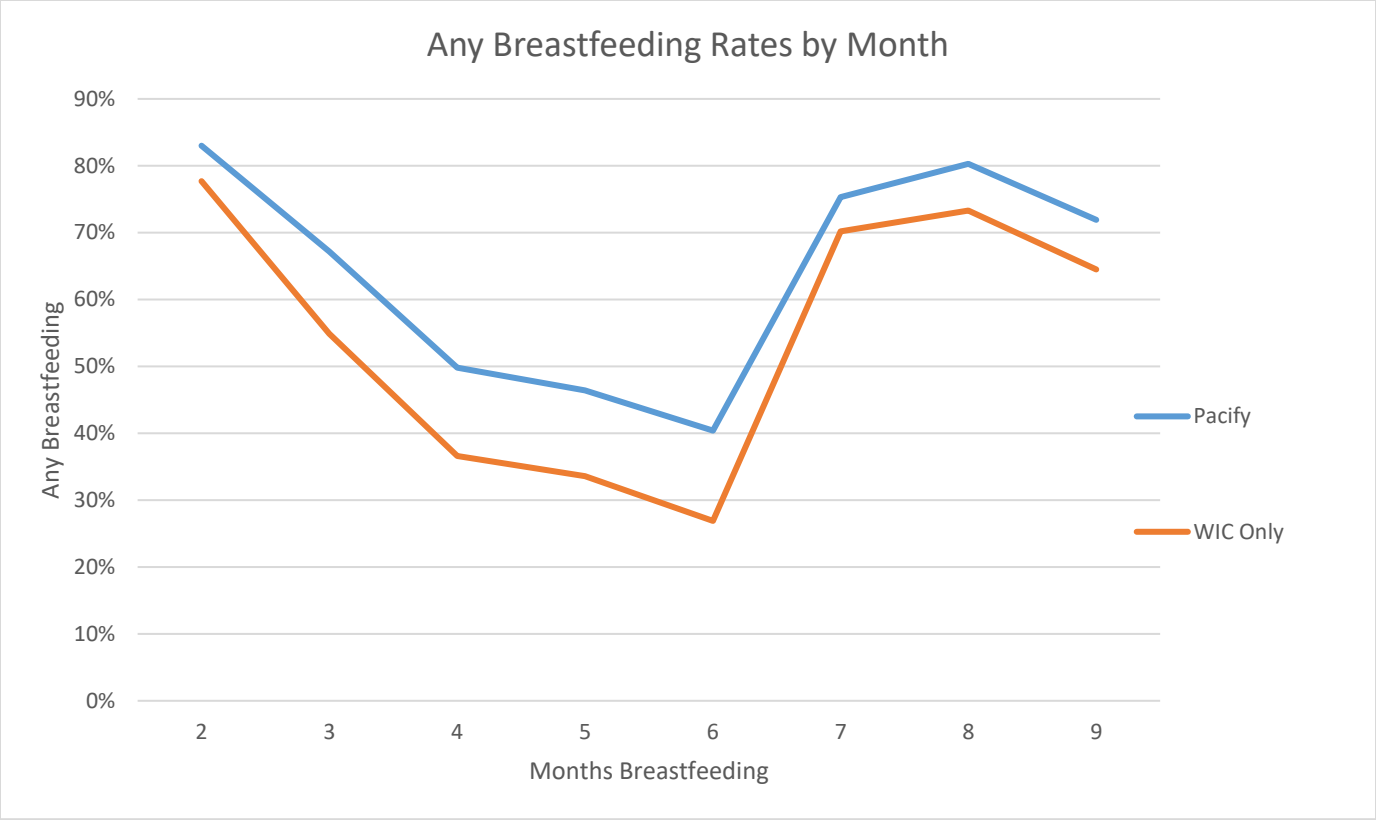

Figure 3. Rates of any breastfeeding by month and group. See Table 11 for valid sample size by group and month.

The specific breastfeeding rates by groups can be seen in Table 12. Rates begin at month two because mothers reporting formula feeding only were excluded during month 0 and 1 to ensure breastfeeding initiation. Overall, the Pacify group had significantly higher rates of any breastfeeding during all months compared to the WIC only group ($p<.001$). The differences between groups was smallest at 2 months (5.3%) and largest at six months (13.5%). After controlling for household size and ethnicity, women downloading the Pacify application were approximately one and a half times more likely to breastfeed at 3 months (AOR 1.744) and twice as likely to breastfeed at six months (AOR 2.011) than women in the WIC only group (Table 12).

Table 12. Rates and odds of any breastfeeding by group and month

Month	Pacify	WIC Only	% difference	p value	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
2	678 (83.0%)	7834 (77.7%)	5.3%	<.01	1.40 (1.16-1.69)	1.41 (1.17-1.70)
3	547 (67.2%)	5517 (54.9%)	12.3%	<.01	1.68 (1.44-1.96)	1.74 (1.50-2.03)
4	388 (49.8%)	3455 (36.6%)	13.2%	<.01	1.72 (1.49-1.99)	1.85 (1.60-2.15)
5	340 (46.4%)	2934 (33.6%)	12.8%	<.01	1.71 (1.47-2.00)	1.851 (1.59-2.16)
6	279 (40.4%)	2146 (26.9%)	13.5%	<.01	1.84 (1.57-2.16)	2.01 (1.71-2.36)

*Adjusted for household size and ethnicity
See Table 11 for valid sample size by group and month.
CI, confidence interval; OR, odd ratio; AOR, Adjusted odd ratio.

Rates of Exclusive Breastfeeding by Group: Aim 2

The secondary outcome of this study was to determine if women who downloaded the Pacify application had higher rates of exclusive breastfeeding at three and six-months postpartum compared to unexposed group. The rates of exclusive breastfeeding for the Pacify group and the WIC only group for months two through nine can be seen in Figure 4. The rates were higher among the Pacify group during all months. As previously stated, the increases in breastfeeding rates observed following month six were due to high proportions of unreported infant feeding statuses (Table 11).

The Pacify group had significantly higher rates of exclusive breastfeeding during months 2 through 6 ($p<.001$, Table 13). The largest difference between groups was observed at month two (15.3%) and the smallest at month six (7.1%). After controlling for household size and ethnicity, women downloading the Pacify application were approximately 2.5 times more likely to exclusively breastfeed at three months (AOR 2.47) and six months (AOR 2.50) than women in the

WIC only group (Table 13).

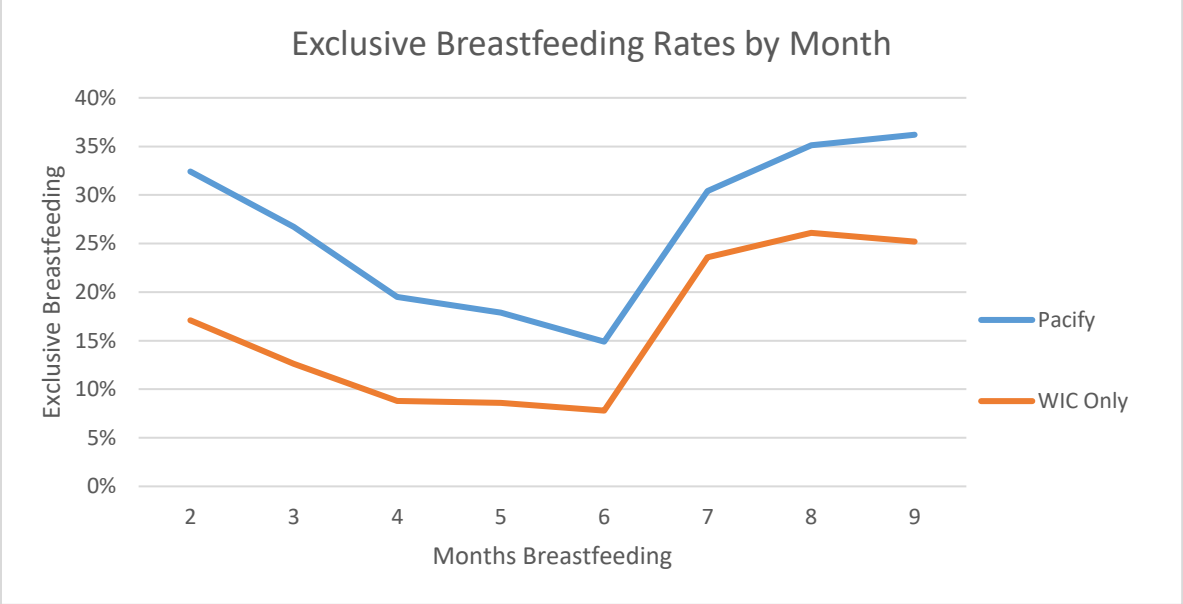

Figure 4. Rates of exclusive breastfeeding by month and group. See Table 11 for valid sample size by group and month.

Table 13. Rates and odds of exclusive breastfeeding by group and month

Exclusive Breastfeeding	Pacify (732)	WIC Only (8733)	% difference	p value	Unadjusted OR	Adjusted OR*
2	265 (32.4%)	1727 (17.1%)	15.3%	<.001	2.321 (1.987-2.711)	2.262 (1.935-2.645)
3	217 (26.7%)	1267 (12.6%)	14.1%	<.001	2.517 (2.132-2.972)	2.470 (2.090-2.920)
4	152 (19.5%)	834 (8.8%)	10.7%	<.001	2.505 (2.069-3.032)	2.501 (2.063-3.032)
5	131 (17.9%)	749 (8.6%)	9.3%	<.001	2.323 (1.896-2.847)	2.309 (1.881-2.834)
6	103 (14.9%)	624 (7.8%)	7.1%	<.001	2.065 (1.649-2.586)	2.063 (1.644-2.588)

*Adjusted for household size and ethnicity
See Table 11 for valid sample size by group and month.
CI, confidence interval; OR, odd ratio

Comparison of Key Breastfeeding Indicators

The reported breastfeeding rates at three and six months were also compared to the rates for Mississippi, the United States, and the Healthy People 2020 objectives (Table 14). Overall, both the Pacify and WIC only group were far below the National averages and HP 2020 objectives. However, the Pacify group was above the Mississippi rates for any and exclusive breastfeeding at six months. The WIC only group had the lowest rates for all indicators.

Table 14. Key breastfeeding indicators among study population compared to state and national averages and HP 2020 objectives

Breastfeeding	Pacify	WIC Only	Mississippi[a]	US WIC Average	National Average[a]	HP 2020 Objective[b]
Any at 6 months	40.4%	26.9%	35.4%	44.5%	57.6%	60.6%
Exclusive at 3 months	26.7%	12.6%	28.2%	38.0%	46.9%	46.2%
Exclusive at 6 months	14.9%	7.8%	13.0%	17.8%	24.9%	25.5%

[a] 2018 Breastfeeding Report Card (CDC, 2018)
[b] HP 2020 objectives (USDHHS, 2018)

Breastfeeding Status by Race

To explore the impact of race on group and breastfeeding status a two by three chi-square analysis was conducted. Women identifying as African American or Black in the Pacify group were found to have significantly higher rates of any and exclusive breastfeeding at three and six months postpartum compared to the WIC only group (Table 15). Significant increases were also observed among White women in the Pacify group for any and exclusive breastfeeding at three and six months postpartum compared to the WIC only group (Table 15). The differences in breastfeeding rates between the Pacify group and the WIC only group was higher among African

Americans compared to Whites for any breastfeeding at three months (19.1% vs. 5.2%), exclusive breastfeeding at three months (16.7% vs. 10.9%), and exclusive at six months (7.0% vs 6.5%) but lower for any breastfeeding at six months (8.7% vs. 18.8%). Asian and other were removed from the output due to insufficient sample sizes.

Table 15. Rates of any and exclusive breastfeeding by race and group

	African American or Black				White			
Breastfeeding Indicator	**Pacify**	**WIC Only**	**Difference**	**p value**	**Pacify**	**WIC Only**	**Difference**	**p value**
Any at 3 months	70.5%	51.4%	19.1%	<.001	63.2%	58.0%	5.2%	<.048
Any at 6 months	39.4%	30.7%	8.7%	<.001	41.2%	22.4%	18.8%	<.001
Exclusive at 3 months	24.9%	8.2%	16.7%	<.001	28.5%	17.6%	10.9%	<.001
Exclusive at 6 months	11.4%	4.4%	7.0%	<.001	18.1%	11.6%	6.5%	<.001

Association between Use of the Pacify Application and Breastfeeding: Aim 3

Further analyses were conducted among the Pacify group to determine if the number of times the application was used was associated with breastfeeding duration or exclusivity. A total of 851 video calls to lactation consultants were made among the 819 women in this group. The average time of the calls was 5 minutes and 34 seconds. Utilization of video conference calls with lactation consultants ranged from 0 to 17 calls with 295 (36.0%) making no calls, 376 (45.9%) calling once, 80 (9.8%) calling twice, and 68 (8.3%) calling 3 or more times. The number of times women called a lactation consultant did not significantly impact rates of any breastfeeding and

exclusive breastfeeding at three and six months (Table 16).

Table 16. Breastfeeding rates by the number of calls to a lactation consultant among women downloading the Pacify application

	Any BF at 3 months		**Exclusive BF at 3 months**		**Any BF at 6 months**		**Exclusive BF at 6 months**	
Number of Calls	Yes	Percent	Yes	Percent	Yes	Percent	Yes	Percent
0	201	68.8%	71	24.3%	93	38.8%	30	12.5%
1	237	63.0%	96	25.5%	124	38.3%	49	15.1%
2	57	72.2%	29	36.7%	33	46.5%	14	19.7%
3 or more	34	73.9%	12	26.1%	20	55.6%	5	13.9%
p value	0.171		0.162		0.144		0.489	

Overall, all the women that downloaded the Pacify application allowed push notifications, which allowed Pacify to send educational information to all the women enrolled. To assess the inferred impact of the push notifications, rates of any and exclusive breastfeeding at three and six months were compared among women that never called a lactation consultant to those called one or more times. Overall, the breastfeeding rates were similar, and no significant differences were observed (Table 17).

Table 17. Breastfeeding rates by the number of calls to a lactation consultant among women downloading the Pacify application

	Any BF at 3 months		Exclusive BF at 3 months		Any BF at 6 months		Exclusive BF at 6 months	
Number of Calls	Yes	Percent	Yes	Percent	Yes	Percent	Yes	Percent
0	201	68.8%	71	24.3%	93	38.8%	30	12.5%
1 or more	346	66.3%	146	28.0%	186	41.3%	73	16.2%
p value	0.457		0.258		0.510		0.191	

Breastfeeding Complaints and User Review: Aim 4

A brief clinical note is collected during each call that identifies the patient complaint. Several main issues were identified reading each note and identifying the main theme. Overall, the most common issues discussed were milk supply, latching problems, pumping, and drug interactions. Mothers were often concerned about maintaining milk supply when transitioning to pumping or returning to work. Many other mothers called for assistance with latching problems, which may have been resulting in pain or other problems. Using a breast pump and best practices for milk storage was another common topic. Multiple mothers asked about using over the counter or prescription drugs while breastfeeding, mostly due to colds, flu, or diarrhea. Other key topics that emerged were feeding amounts for infants at different ages, normalcy of infant spit up, common problems when transitioning to formula, and introducing solid foods, juice, or cow's milk.

The Pacify application offers clients the option to provide a review of the call after completion. Overall, 465 women provided a review. Ratings ranged from 1 (lowest) to 5 (highest). The average rating was 4.67. African American or Black women were the most likely to leave a review with 290, followed by White (156), other (13), and Asian (5). In addition, women could leave written comments about the call. Many women left comments indicating that the service was helpful and that the lactation consultants were knowledgeable among other key statements seen in the word cloud (Figure 5). The main negative comments were related to the application not functioning because of sound quality, video quality, disconnections, and no answer. A few example quotes from the user comments are below.

- "[She] was great. She took the time to tell me how to calm my baby down since she was fussy about being hungry. Great information was provided on how to get her to latch."

- “[She] was great!!! Really made me feel comfortable and I felt like I learned what I need to know to do what's best for me and baby. Thank you soooooo much!”
- “[She] was super! She was very detailed in her explanation of what could be going on with my baby. She gave me several suggestions and tips and agreed to email them to me. She was encouraging and excited to talk to me. I wish I could speak to her each time I called!”
- “[She] was amazing! Answered all my questions and gave some good tips to try. She has made me feel more confident about breastfeeding. Hopefully things will start to get better.”
- “[She] was very helpful. I was on the verge of giving up because I thought my body wasn't making enough milk but she explained everything!”

Figure 5. Word cloud from Pacify user review. The word cloud shows the most common words left in user review comments, with larger and darker words indicating higher frequency.

Chapter 5: Discussion

This chapter provides a summary of the retrospective cohort study and an in-depth review of the findings, followed by the overall conclusions about the association of the Pacify application with breastfeeding rates. The practical implications for improving breastfeeding among low-income women, as well as future research needs, are also discussed.

Synthesis of the Study

New mothers are recommended to exclusively breastfeed their infants for the first six months to provide optimal health for infant and mother (AAP, 2012). However, only 13.0% of mothers in Mississippi reached this milestone among infants born in 2015, which was the lowest rate in the United States (CDC, 2018). This study focused on low-income women enrolled in the Mississippi WIC program because this population has been associated with lower breastfeeding rates compared to both low-income women not enrolled in WIC and higher income populations (CDC, 2018). One factor that impacts breastfeeding success is access to breastfeeding support services provided by certified lactation consultants (Patel & Patel, 2016). However, many low-income women may not have access due to an inadequate number of providers, unreliable transportation, rural location, or cost (Hedberg, 2013; Patel & Patel, 2016; Woelfel et al., 2004).

In June of 2016, the Mississippi WIC program began offering pregnant and breastfeeding participants free access to the Pacify "telelactation" application, which provides access to International Board Certified Lactation Consultants (IBCLC) via video conferencing through a cell phone or tablet. The staff and peer breastfeeding counselors at all Mississippi WIC centers provided information about the Pacify application to all pregnant or breastfeeding women. Downloading the application was voluntary and participants had to use their own smartphone and

internet access. Women who downloaded the application had 24-hour access to video lactation consultations with trained IBCLCs. In addition, women who downloaded the application and allowed push notifications received weekly notifications related to breastfeeding based on their infants age.

Women that chose not to download the application received the standard services available at their WIC center. This includes breastfeeding education and support from WIC staff as well as referral to a peer breastfeeding counselor, if available. It is important to note that during this study period, none of the WIC staff in the state were trained IBCLCs. In addition, WIC services were only available during scheduled appointments at the WIC clinic during normal business hours (Monday-Friday 8:00am-5:00pm).

This research project used a retrospective cohort design to determine if providing free access to the Pacify application to new mothers enrolled in the Mississippi WIC Program was associated with increased breastfeeding duration and exclusivity. The research objectives of this study were to (1) determine if women who downloaded the Pacify Application had higher rates of *any* breastfeeding at 3 and 6-months postpartum compared to women who did not download the application, (2) determine if women who downloaded the Pacify Application had higher rates of *exclusive* breastfeeding at 3 and 6-months postpartum compared to women who did not download the application, (3) examine if increased use of the Pacify application was associated with increased rates of any or exclusive breastfeeding, and (4) review Pacify user feedback to identify positive and negative perceptions of user experiences. It was hypothesized that women downloading the Pacify application would have higher rates of any and exclusive breastfeeding at 3-and 6-months compared to women not downloading the application. It was also hypothesized that increased use of the Pacify application would be associated with higher rates of any and

exclusive breastfeeding.

Findings

Breastfeeding Initiation.

A total of 41,949 women enrolled in the WIC program during the study period. However, only 10,912 (38%) reported breastfeeding at least once during their first two WIC visits (month 0-1), which was used as an indicator of breastfeeding initiation (Table 9). This finding is consistent with a previous analysis of the Mississippi data from the 2004-2008 Pregnancy Risk Assessment Monitoring System, which observed initiation rates among WIC participants of 38.4% among black women and 50.8% among white women (Marshall et al., 2013). However, these rates are lower than the most recent breastfeeding initiation rate of 63.2% (+/-6.3) reported to the National Immunization Survey of for all women in Mississippi (CDC, 2018). These differences in rates may be due to the study population of lower income women in the WIC program versus women from varying socioeconomic conditions in the National Immunization Survey.

Regardless of the true breastfeeding initiation value, the results indicate that over 60% of women enrolled in the Mississippi WIC program either never started breastfeeding or had stopped breastfeeding by their first WIC visit. This finding is supported by research indicating that breastfeeding cessation rates are highest during the first four-weeks postpartum (Tenfelde, Finnegan, Miller, & Hill, 2012). Furthermore, the period immediately following the birth of the infant had been identified as a critical time point for breastfeeding support and success (Hedberg, 2013). Most mothers receive breastfeeding support in the hospital following delivery, but once they are discharged they must utilize other sources of support if they are having difficulties. Low-income women may lack the resources to obtain support during the critical period between hospital

discharge and the first WIC visit. Identifying ways to address this gap in care should be a priority.

Two approaches that have been used to address this gap in care are the use of home visits and telephone calls from WIC staff, nurses, or lactation consultants. A randomized clinical trial that provided hospital visits, home visits, telephone support, and 24-hour pager access to a community nurse and peer counselor had improved breastfeeding rates at 6 weeks postpartum, but not at 12 or 24 weeks (Pugh et al., 2010). Another study, which provided access to bilingual lactation consultants via home visits and telephone calls, found improved breastfeeding initiation and any breastfeeding at 6 weeks among Hispanic WIC participants (Gill et al., 2007). Both approaches are resource intensive and may not be feasible in rural or underserved areas.

The Pacify application may be able to fill the support gap while also utilizing fewer resources. However, it appears that most women utilizing the application did not download the application until after delivery. Identifying strategies to get women to download and test the application during the 2nd or 3rd trimester may increase use during the critical period. This approach may help WIC participants receive the support needed to improve breastfeeding knowledge and problem solving skills which have been identified as key tools to reduce early cessation of breastfeeding (Brand, Kothari, & Stark, 2011; Persad & Mensinger, 2008).

Any Breastfeeding at 3 Months Postpartum.

The three-month time point is important because it aligns with the twelve-week point, which is the minimal maternity leave required by the Family Medical Leave Act (FMLA), and corresponds to the time point when over 80% of employed mothers return to work (Shepherd-Banigan & Bell, 2014). If a mother wants to continue breastfeeding while working, she must obtain and learn to use a breast pump as well as have support from her family, childcare provider, employer, and healthcare provider to succeed. These are some of the reasons why returning to

work has been negatively associated with breastfeeding rates (Hedberg, 2013; Houghtaling et al., 2017).

Women who downloaded the Pacify application had rates of any breastfeeding (minimal, partial or exclusive) at three months that were 12.3% higher than the WIC only group. After controlling for household size and ethnicity, women downloading the Pacify application were about 1.7 times more likely to breastfeed at three months (AOR 1.74) compared to the WIC only group (Table 12). An additional analysis was done at 4 months to account for women that may have reported their breastfeeding status at three months before returning to work. Overall, downloading the Pacify application was also associated with a significantly higher rate of any breastfeeding at 4 months (AOR 1.85) with women in the Pacify group having rates that were 13.2% higher than the WIC Only Group (Table 12). However, a large decrease in breastfeeding rates was observed in both groups from month 3 to 4 with a decreased of 17.4% among the Pacify group, and 18.3% among the WIC Only group. This decrease may have been due to women returning to work, but these data were unavailable to confirm.

These findings were consistent with the results from a systematic review that assessed the breastfeeding outcomes from 14 interventions utilizing lactation consultants, which found significant increases in any breastfeeding from 1 to 3 months (OR 1.76, 95% CI 1.20-2.57) (Patel and Patel, 2016). Findings from this study were slightly more impactful than a more resource intensive intervention utilizing hospital visits, home visits, telephone support, and 24-hour pager access to a community nurse and peer counselor that reported an odds ratio of 1.58 (1.00-2.49) for any breastfeeding at 12 weeks (Pugh et al., 2010). In addition, the observed odds ratios were similar to the results from an intervention utilizing 4 scheduled telephone calls from peer counselors that

found an adjusted relative risk of 1.22 (1.10–1.34) at three months (Reeder et al., 2014).

Exclusive Breastfeeding at 3 Months Postpartum.

Overall, 26.7% of women downloading the Pacify application were exclusively breastfeeding at three months. This rate was comparable to the rate reported for the state of Mississippi (28.2%), but much lower than the national average of 38% reported among WIC participants (CDC, 2018). In addition, it was almost 20% below the Healthy People 2020 Objective of 46.2% for exclusively breastfeeding at three months (USDHHS, 2018). When comparing groups, it was found that after controlling for household size and ethnicity, women downloading the Pacify application were more likely to exclusively breastfeed at three months (AOR 2.47) compared to the WIC only group (Table 13). This association was stronger than the grouped data reported from 14 randomized trials utilizing lactation consultants, which found an odds ratio of 1.80 (1.14-2.83) for exclusive breastfeeding between 1 and 3 months (Patel & Patel, 2016).

Similar results were observed when expanding the analysis to four months, to fully account for mothers returning to work. Women who downloaded the Pacify application had significantly higher odds of exclusive breastfeeding (AOR 2.50; Table 13). However, a decrease in rates was observed in both groups from month 3 to 4, with rates decreasing 7.2% among the Pacify group and 3.8% among the WIC Only group. This was much higher than the decrease observed between months 4 and 5, when the rates only decreased by 1.6% among the Pacify group and 0.2% among the WIC Only group.

While the rates of any and exclusive breastfeeding in the Pacify group were significantly higher at both 3 and 4 months, both groups had large decreases in breastfeeding during this critical time period. This decrease may be associated with mothers returning to work in both groups, but

this information was not available in our datasets. However, previous work had found that shorter maternity leave and returning to work, either part or full-time, are negatively associated with continued breastfeeding (Mandal et al., 2010; Mirkovic et al., 2014). The HP 2020 objectives have targeted this issue by setting a goal to increase the number of employers with worksite lactation support programs to 38%. The current national rate of 49.0% has exceeded this goal (USDHHS, 2018).

The three-month time point appears to be the second critical time for breastfeeding success. This is the time when most working mother return to work and many stop breastfeeding or exclusively breastfeeding. The results from this study indicate that the Pacify application could be used during this transition period to educate working mothers, and perhaps their partners, about breast pumping, milk storage, bottle feeding, and other tips to improve self-efficacy and breastfeeding success.

Any Breastfeeding at 6 Months Postpartum.

The six month time point is critical because it aligns with the recommendation that all infants be exclusively breastfed for the first six months of life, followed by the introduction of foods and continued breastfeeding for an additional 6 months (AAP, 2012). Exclusive breastfeeding is recommended because it provides optimal nutrition for the infant and is associated with several health, financial, and socioeconomic benefits for both the infant and the mother when compared to mix-feeding or formula feeding (Amin et al., 2000; Martin et al., 2014; Rollins et al., 2016; Salone et al., 2013; Services, 2011; Weimer, 2001).

Overall, 40.4% of women who downloaded the Pacify application reported any breastfeeding at six months. This was slightly higher than the state average of 35.4%, but lower

than the national average among women enrolled in WIC of 44.5% (CDC, 2018). In addition, this rate was more than 20% below the HP 2020 objective of 60.6% (USDHHS, 2018). When comparing groups, women who downloaded the Pacify application had rates of any breastfeeding at six months that were 13.5% higher than the WIC only group (Table 12). This difference indicated that women downloading the Pacify application was significantly more likely to be breastfeeding at six months (AOR 2.01). This finding was consistent with the positive outcomes observed from the grouped odds ratio (1.29, 1.05-1.58) reported from 15 randomized trials utilizing lactation consultants of for any breastfeeding between 3 and 6 months (Patel & Patel, 2016).

Exclusive Breastfeeding at 6 Months Postpartum.

Downloading the Pacify application was also associated with a higher rate of exclusive breastfeeding (breastmilk only) at six months (AOR 2.06), with women in the Pacify group having rates that were 13.5% higher than the WIC only group (Table 13). Overall, 14.9% of women who downloaded the Pacify application reported exclusive breastfeeding at six months. This was higher than the state average of 13.0%, but lower than the national average of 17.8% among women enrolled in WIC (CDC, 2018). However, this rate was much lower than the national average of 24.9% and the HP 2020 objective of 25.5% (USDHHS, 2018).

Downloading the Pacify application was associated with higher rates of any and exclusive breastfeeding at six months compared to the WIC only group. However, it is unlikely that mothers were utilizing the Pacify application for lactation consultations at this point in time. Most breastfeeding problems would have been addressed while the mother was learning to successfully breastfeed within the first two months. In addition, issues around breastfeeding and returning to

work (e.g. breast pumping, milk storage, bottle feeding) were likely addressed in months two through four. It seems likely that the differences between the groups may have been associated with stronger breastfeeding intentions, or early breastfeeding success, both of which have been shown to decrease the risk of early breastfeeding cessation (DiGirolamo et al., 2005). In addition, earlier visits with lactation consultants may have improved breastfeeding self-efficacy, which has been shown to impact breastfeeding success (Labbok, 2013; Meedya et al., 2010).

Pacify Uptake.

Uptake of the Pacify application was low with only seven percent (819) of women initiating breastfeeding downloading the application (Table 10). The low uptake may have been impacted by poor access to a smart phones and broadband internet among this population. In 2018, only 67% of adults in the United States in low-income households (under $30,000 per year) reported owning a smartphone and 45% reported having access to broadband internet (Pew Research Center, 2018a, 2018b). In addition, only 61% of households in Mississippi reported having a broadband internet subscription in 2015, which was the lowest in the country (Ryan & Lewis, 2017). However, a recent qualitative study among women enrolled in a study using the Pacify application in Rural Pennsylvania found that access to broadband internet was a minor issue, but this was not a WIC population (Demirci, Kotzias, Bogen, Ray, & Uscher-Pines, 2018). Mothers without access would have to travel to a location with public internet access, such as a coffee shop or library, and these are not ideal locations for lactation consultations to occur.

Several other factors may have impacted the low uptake of the application. Many women may not have been interested in or had a low intention of breastfeeding. Women that were interested may have been unaware that they could have downloaded the application until their first WIC appointment, which may have been past the most critical time period for breastfeeding

initiation and support (Hedberg, 2013; Tenfelde et al., 2012). In addition, some women may prefer to receive face-to-face support or want to use a provider that is local or someone they know. Participants do not get to pick their provider while using the Pacify application as it randomly assigns the call to an available IBCLC who could be located anywhere in the country.

Study Population Demographics.

Women who downloaded the application had significantly smaller household size (3.74 vs. 4.06, $p<.001$) than those who did not download the application (Table 10). The smaller household size may indicate no previous children or breastfeeding experience, but these data were not included in the database. A mothers past breastfeeding experience, either positive or negative, has been correlated with subsequent breastfeeding duration (Thulier & Mercer, 2009). Mothers who had problems breastfeeding in the past may have been less likely to utilize the application, because they had low breastfeeding intentions (Grummer-Strawn et al., 1997). Conversely, mothers who successfully breastfed in the past, may have the knowledge and support to succeed and, therefore, may not have downloaded the application. Accounting for previous breastfeeding experiences could help WIC target efforts to provide the mothers most at-risk of not breastfeeding with the breastfeeding support they may need.

In addition, women who downloaded the application were significantly less likely to be Hispanic (2.4% vs. 8.5%, $p<.001$) than those not downloading the application. This is interesting because nationally, Hispanics have high rates of breastfeeding initiation (84.6%) indicating a potential need for support services (CDC, 2018). A survey assessing technology use among pregnant or postpartum women found that while 94 % of Hispanic women used a mobile phone, they were less likely to use a smartphone or the internet compared to African American or White women (Chilukuri et al., 2015). Another factor that could have impacted uptake among Hispanics

was language. While the Pacify application does offer services in Spanish the application may not have been promoted effectively to this population.

There was not a significant difference in the age of the mother at infant birth between the groups (p=.095). The WIC only group did have a slightly older population, with 9.3% over the age of 35 compared to 7.3% among the Pacify group. This may have impacted the choice to not download the Pacify application, because use of mHealth applications has been associated with younger populations (Krebs & Duncan, 2015).

Breastfeeding Rates by Group and Race.

Women that reported a race of African American or Black accounted for 52.3% of the study population and 7.3% of women in this group downloaded the Pacify application (Table 10). African American women who downloaded the Pacify application were found to have significantly higher rates of any breastfeeding at three (p<.001) and six months (p<.001), and exclusive breastfeeding at three (p<.001) and six months (p<.001) compared to the WIC only group (Table 15). In comparison to the average rates for the State of Mississippi, African American women who downloaded the Pacify application had higher rates of any breastfeeding at six months (39.4 vs 35.4%) and lower rates for exclusive breastfeeding at 3 months (24.9 vs. 28.2%) and six months (11.4 vs 13.0%; CDC, 2018). Lower rates were also observed among African Americans downloading the Pacify application when compared to the National Averages among African Americans for any breastfeeding at six months (39.4% vs 44.7%), exclusive breastfeeding at three months (24.9% vs 36.0%), and exclusive breastfeeding at six months (11.4% vs 17.2%; CDC, 2018).

Women reporting a race of White accounted for 44.5% of the study population and 7.9%

of women in this group downloaded the Pacify application (Table 10). White women who downloaded the Pacify application were found to have significantly higher rates of any breastfeeding at three ($p=.048$) and six months ($p<.001$), and exclusive breastfeeding at three ($p<.001$) and six months ($p<.001$) compared to the WIC only group (Table 15). In comparison to the average rates for the State of Mississippi, White women who downloaded the Pacify application had higher rates of any breastfeeding at six months (41.2 vs 35.4%) and exclusive breastfeeding at 3 months (28.5 vs. 28.2%) and six months (18.1 vs 13.0%; CDC, 2018). Lower rates were also observed when compared to the National Averages among Whites for any breastfeeding at six months (41.2% vs 62.0%), exclusive breastfeeding at three months (28.5% vs 53.0%), and exclusive breastfeeding at six months (18.1% vs 29.5%; CDC, 2018).

Over the past 10 years, breastfeeding rates in the United States have been increasing among all racial and ethnic backgrounds, but African American infants still have the lowest rates of breastfeeding for all indicators (CDC, 2013b, 2018). This was confirmed by the lower rates of exclusive breastfeeding observed among African American women, which were much lower than White women in both the Pacify group and the WIC Only group (Table 15). However, the rates of any breastfeeding were comparable or higher among African American women. These findings indicate that a comparable proportion of both races attempt breastfeeding, but fewer African American women were able to continue exclusively breastfeeding beyond three months. This disparity may be related to research that has shown that African American women return to work sooner and are less likely to be employed by organizations with breastfeeding friendly environments (Johnson et al, 2015). If this is true, the WIC program should work to ensure that mothers and their families are prepared to transition to breast pumping before returning to work. This should include: (1) assisting with acquiring a breast pump and milk storage supplies; (2)

training the mother on how to correctly use the breast pump; (3) providing tips on milk storage and infant bottle feeding to both the mother and father; and (4) ensuring the mother understands her breastfeeding rights and employer responsibilities.

Pacify Utilization.

The goal of research aim 3 was to determine if the number of times the Pacify application was used was associated with breastfeeding duration or exclusivity. The number of times women called a lactation consultant did not significantly impact rates of any breastfeeding at three months (p=.171) or six months (p=.162), and exclusive breastfeeding at three months (p=.144) and six months (p=.489; Table 16). The total number of calls was low with only 851 video calls made to lactation consultants among the 819 women in this group of which 295 (36.0%) made no calls, 376 (45.9%) called once, 80 (9.8%) called twice, and 68 (8.3%) called 3 or more times. This conflicts with a study that found a higher breastfeeding rates associated with visiting a lactation counselor more than one time (Witt, Smith, Mason, & Flocke, 2012).

A potential reason no difference was observed was that all of the women downloading the application received educational push notifications from Pacify. These notifications provide reasons why breastfeeding is important and address common breastfeeding questions which may impact breastfeeding. A recent pilot study tested the feasibility of adding educational text messages to a WIC peer counselor program, which did not significantly increase exclusive breastfeeding rates at 2 weeks postpartum (Harari et al., 2017). Similar programs such as the Text4Baby program, that provide educational text messages to mothers have demonstrated positive associations with uptake of influenza vaccinations and reduced alcohol intake (Bushar, Kendrick, Ding, Black, & Greby, 2017; Evans et al., 2015).

Finding no difference in breastfeeding rates among women that never made a call

compared to women calling one or more time, suggests that self-selection bias may be impacting the results. This may be due to mothers in this group having higher breastfeeding intentions than the unexposed group. This is supported by the fact that all of these mothers initiated breastfeeding and spent their time and effort downloading a breastfeeding support application, indicating that they were preparing to succeed, even if they never used the application. Identifying approaches to enroll more mothers earlier in their pregnancy may provide more insight into the efficacy of lactation consultations among a more diverse population.

Pacify User Perceptions.

An additional review of the Pacify data were conducted to identify the most common breastfeeding problems reported to lactation consultants during video calls. Overall, perceived insufficient milk supply was the most common issue addressed by the lactation consultants. This finding is consistent with the results from a systematic review including 20 studies, which indicated that about 35% of women reported perceived insufficient milk supply as the primary factor contributing to early breastfeeding cessation (Gatti, 2008). Furthermore, perceived low milk supply was found to be the most common reason for supplementation with formula, which hinders mothers from exclusively breastfeeding. It is important to note that the mother's perception of low milk supply is often incorrect and could be addressed by a lactation consultant. A limitation of the Pacify application would be the inability to physically weigh the infant pre-and-post feeding to demonstrate actual milk supply. However, the lactation consultants could teach mothers how to identify infant feeding cues, monitor wet diapers, and other tips to provide a more accurate estimation of milk supply. Other barriers that were addressed during Pacify calls included latching problems/nipple pain, pumping, and drug interactions, which have been identified as common barriers to successful breastfeeding (Hedberg, 2013; Lewallen et al., 2006). These are all common

issues that lactation consultants are trained to address.

Some limitations may arise when using video calls when compared to in person visits. The main problems reported in user comments by women in this study were related to technical difficulties, such as poor sound quality, poor video quality, and disconnections, which are most likely related to the poor access to broadband internet in Mississippi (Ryan & Lewis, 2017). Previous work has identified apprehension about video calls and low perceived need as other common barriers (Demirci et al., 2018). Many mothers may prefer a face-to-face appointment with a person as opposed to an unknown person on a screen. However, conducting a test call was able to reduce this barrier (Demirci et al., 2018). Another potential barrier that may exist is the limitation of the screen size, which may limit the effectiveness of breastfeeding demonstrations. More work is needed to clarify the limitations of the application.

Despite the potential limitations, women enrolled in the Mississippi WIC program that used the Pacify application were satisfied with their experience. Overall, the average rating reported after video calls was 4.67 out of 5 and mothers indicated that the lactation consultants were friendly, helpful, and knowledgeable. Similar results were found from a qualitative study examining the perspectives of rural mothers, providers, and lactation consultants on the Pacify application reporting that the application was convenient and increased breastfeeding confidence by having the mothers actively participating (Demirci et al., 2018).

Study Limitations

This study analyzed data collected by the Mississippi WIC program and the Pacify application. WIC provides services to low-income families and serves a higher proportion of minorities, and therefore the study population may not be representative of the overall population. This limits the generalizability of the results, but the use of a multivariate regression to calculate

an adjusted odds ratio helped improve the significance of the findings (Pourhoseingholi et al., 2012). However, the dataset was limited to the available sociodemographic variables collected (mother age, household size, race and ethnicity). A major limitation was the inability to determine how many children each mother had delivered and if they had previously breastfed, both of which impact breastfeeding intentions and success (Thulier & Mercer, 2009). In addition, the study collected data for 24 months and it was possible that some mothers may have had more than one child. Other variables that would have strengthened the analyses include education level, marital status, internet access, smartphone ownership, and primary language spoken. Another limitation was the inability to account for medical issues that may have impacted breastfeeding such as premature delivery, tongue tie, HIV/AIDS, and others.

The use of self-reported data which could result in self-report bias was another limitation of this study. However, the only way to measure breastfeeding rates among the participants is through self-reported data provided to WIC centers. The staff at the WIC centers ask mothers if they are non-breastfeeding (formula only), partial breastfeeding (formula and breastmilk), or fully breastfeeding (exclusive breastfeeding) during each monthly visit. Some mothers may have wanted to receive formula from WIC even if they were not using it, and therefore may have incorrectly self-report. Mothers may also miss appointments or withdraw from the program, making it difficult to identify the exact length of any or exclusive breastfeeding. Missing or unreported data were not included in the analyses to reduce the impact of these limitations.

The last limitation was self-selection bias, which is common in retrospective cohort studies (Euser et al., 2009). In this study, participants self-selected their group status by either downloading the application or not, and it was not possible to perform random sampling. It is possible that mothers downloading the application had characteristics that would make them more

likely to breastfed or exclusively breastfeed. For example, these mothers may have had a stronger intention to breastfeed and have been more likely to reach out for help with breastfeeding problems resulting in successfully breastfeeding for a longer time.

Conclusions

Overall, this study has shown that downloading the Pacify application was associated with improvements in *any* and *exclusive* breastfeeding at three and six-months postpartum. The overall impact was similar to other studies that increased access to in person lactation consultations, indicating that the use of telelactation applications should be considered in populations with limited access to IBCLCs, such as low-income women enrolled in WIC programs. However, utilization was low, and the observed results may be overestimated due to selection bias. Nevertheless, it appears that telelactation applications may be a tool that can use to improve breastfeeding rates and meet the Healthy People 2020 objectives.

This study also identified three critical time points for utilization of a telelactation application. Programs considering implementation should attempt to schedule or refer visits during the following time points.

1. Prenatal Visit
2. Post-hospital discharge visit
3. Pre-employment visits

The first visit is the *prenatal visit* is recommended to introduce the mother to breastfeeding and address any misconceptions and questions. This visit would allow the mother to download and test the application before any breastfeeding issues emerge. This visit may improve breastfeeding

intentions and result in higher breastfeeding initiation rates, which were quite low in this population. In addition, the Pacify application could provide access to educational material on via the application, which may also increase knowledge and attitudes.

The second is a *post-hospital discharge visit,* which is recommended to provide support during a period when many issues emerge but when most women have a gap in care. Most women would have had breastfeeding support in the hospital but, once discharged they would have to wait until a follow-up appointment with a provider or WIC to receive support. If the new mothers have downloaded and tested the application, they will have 24-hour access to support which may improve breastfeeding success. It is recommended that all programs promote at least one visit during this period and a topic that should be covered is the perception of insufficient milk supply.

The third is a *pre-employment visit*, which is recommended to address issues related breastfeeding after returning to work. This visit should teach mothers how to obtain and use a breast pump, store breastmilk, bottle feed, and obtain support from family, childcare, and employers. This visit should occur at least two weeks before mothers return to work. This will be around 10 weeks for most women, because the majority return to work around week 12. This will allow time for the mother to digest the information and develop a breastfeeding plan.

This study demonstrated a positive association between downloading the Pacify application and breastfeeding duration and exclusivity. These findings may not be generalizable to higher-income populations, or even other WIC populations. Future research should utilize randomized controlled trials among populations with low access to IBCLCs to determine the effectiveness of the application in improving breastfeeding rates, knowledge, attitudes, and behaviors. The impact of poor broadband internet access also needs to be further evaluated. In

addition, the cost-effectiveness of telelactation programs should be determined. Results from these studies would be valuable to policy makers when developing breastfeeding improvement programs. In addition, the information could provide justification for reimbursement for lactation services provided via telelactation applications.

Appendix A: Selected Study Summary Table

Overview of studies conducting interventions to improve breastfeeding outcomes among WIC participants

Author	**Study Population/ design**	**Intervention**	**Category**	**Primary Outcome**	**Secondary Outcome**	**Key findings**
(Caulfield et al., 1998)	N = 242; 100% Black, randomized trial	4 arm WIC Clinic-based intervention: 1: Peer Counselor Contact: 3 prenatal visits and weekly contact through 16 weeks 2: BF promotion video/pamphlets 3: PC and Video/pamphlets 4: Control	Peer Counselor Educational Video and pamphlets	BF initiation % (OR, 95% CI) 1: 62% (3.84, 1.44-10.21) 2: 50% (1.36, 0.52-3.54) 3: 52% (1.92, 0.78-4.76) 4: 26%	BF at 7-10 days % (OR, 95% CI) 1: 30% (1.11, 0.34-3.61) 2: 38% (0.79, 0.25-2.52) 3: 38% (1.52, 0.50-4.59) 4: 14%	Women enrolled in the PC intervention were more likely to breastfeed, but the significance decreased when accounting for breastfeeding intention, which was found to be the strongest predictor of both breastfeeding with only 18% of women changing intention.
Gross et al 1998 (Gross et al., 1998)	N = 115; 100% Black, randomized trial	WIC Clinic-based intervention: 1: Peer Counselor Contact: 3 prenatal visits and weekly contact through 16 weeks 2: BF promotion video/pamphlets 3: PC and Video/pamphlets 4: Control	Peer Counselor Educational Video and pamphlets	BF at 7-10 days 1: 72% 2: 67% 3: 80% 4: 53%	BF at 8 weeks: 1: 75% 2: 75% 3: 70% 4: 23% BF at 16 weeks: 1: 52% 2: 48% 3: 40% 4: 0%	Women in the intervention clinics were twice as likely to be breastfeeding at 8 weeks and 16 weeks postpartum compared to control, indicating that both peer counseling and educational videos can improve BF rates among African-American women.

(Chezem et al., 2017)	N = 100, randomized trial	1: Control. 2: Postpartum women had 2 home visits and three phone calls by lactation educator	Home visits and phone call by lactation educator	BF at 16 weeks; 1: 38% 2: 46% Not significantly different (p > .05).	African American women were more likely than White women to stop breastfeeding before 16 weeks (p =.005)	Combination of professional support provided in person and by telephone did not improve breastfeeding rates at 16 weeks, indicating that phone calls may not be effective in this population.
(Edmunds, Lee, Eldridge, & Sekhobo, 2017)	N =1670 Quasi-experimental prospective cohort design	You Can Do it Initiative, three cohorts 1: Baseline cohort 2: Non-BAPT study cohort 3: BAPT study cohort: a. administered BAPT during 1st trimester to develop custom counseling plan. b. Individual follow-up counseling session 2nd trimester c. Group counseling during 3rd trimester d. Contacted by PC within 1 week of delivery	BAPT assessment tool Peer Counseling	BAPT vs. Baseline Exclusive breastfeeding (OR [95% confidence interval], 7days: 1.6 [1.2–2.3] 30 days: 1.9 [1.3–2.8] 60 days: 2.1 [1.4-3.1]	BAPT vs. non-BAPT Exclusive breastfeeding (OR [95% confidence interval], 7 days: 1.6 [1.1–2.5] 30 days: 1.6 [1.0–2.5] 60 days: not significant	Use of the BAPT in combination with peer counseling, during both prenatal and postnatal periods, improved exclusive breastfeeding rates within the first 30-60 days postpartum.
(Bortree, 2013)	N = 281 Case control study, using historical controls	1: Historical Controls a. Old food package b. peer counselors c. usual care 2: You Can Do It Intervention	BAPT assessment tool Peer Counseling	Exclusive breastfeeding 4 weeks: 1: 39% 2: 55% 3 months:	Exclusive breastfeed due to food packages alone (Non-study sites) 4 weeks: 53% vs 42%	Use of the BAPT and peer counseling did increase rates of exclusive breastfeeding among participants. However, the new food package could account

		a. New WIC Food Package b. Intensified, coordinated care c. BAPT d. Peer counselors: 3 prenatal contacts and 4 postpartum visits/phone calls	New food package	1: 22% 2: 43% 6 months: 1: 34% 2: 16%	3 months: 37% vs 28% 6 months: 29% vs 21%	for a large percentage of the improvements.
(Hildebrand et al., 2014)	N = 465 Quasi-experimental design	1: Traditional-model groups (control) received services prior to the intervention 2: Influence-model groups (experimental) received services after changes in the physical and social environment	Changes in WIC environment, staff training	Breastfeeding initiation: Women in the influence model were 1.5 times more likely to initiate breastfeeding compared with women in the traditional model, controlling for parity, mother's age, and race.	Breastfeeding initiation: Mothers were less likely to initiate breastfeeding if they had more than one child, were younger than 27 years old, or American/Alaska Indian	Breastfeeding initiation rates increased with improvements to the social and physical environment of WIC centers such as improved friendliness, providing pertinent information, and demonstrating breastfeeding as the social norm.

(Reeder, Joyce, Sibley, Arnold, & Altindag, 2014)	N = 1948 Stratified Random design	Telephone peer counseling intervention with 3 study arms: 1: no peer counseling 2: 4 telephone contacts (2 prenatal, 2 postnatal) 3: 8 telephone contacts (2 prenatal, 6 postnatal)	Telephone Peer Counselor Program	BF at 3 months Higher among women in the treatment groups (adjusted relative risk of 1.22, 95% CI: 1.10–1.34)	BF at 6 months Higher only for Spanish-speaking clients (adjusted relative risk: 1.29; 95% CI: 1.10–1.51).	No differences were found between the 4 and 8 call groups, indicating that fewer calls may improve non-exclusive breastfeeding rates. Only Spanish speakers had improvements in exclusive breastfeeding rates.
(Lee, O'Leary, Kirk, & Lower, 2017)	N =68,915 (intervention: Group 1 n = 15,290; Group 2 n = 3,582). Non-randomized treatment and control analysis	Determining the effect of the Loving Support Peer Counseling Program (LSPCP) on BF rates compared WIC facilities pre-and post-implementation of the LSPCP	Loving Support Peer Counseling Program	Pre-Post LSPCP implementation BF Initiation increased from 90.2% to 93.2% (P < .001) among Group 1 BF Initiation increased from 81.8% to 88.6% (P < .001) among Group 2	Pre-Post LSPCP implementation BF for >6 months increased from 50.7% to 54.7% (P < .001) among Group 1 BF for >6 months increased from 31.3% to 37.2% (P < .001) among Group 2	While LSPCP increased breastfeeding initiation and duration, similar increases were found when comparing clinics with and without a LSPCP, weakening interpretation and indicating other factors were impacting rates.

(Pugh et al., 2010)	N = 328 Randomized Control Trial	Two arm WIC intervention 1: Control 2: 24-week postpartum Breastfeeding Support Team (nurse and peer counselor) intervention a. Daily hospital visits after delivery b. 3 home visits c. telephone support from peer counselor d. 24-hour pager access to nurse	Nurse and Peer Counselor support via home visits and telephone support	BF rates at 6 weeks were significantly different between groups 1: 56.9% 2: 66.7% (OR, 1.71; 95% CI, 1.07–2.76).	Breastfeeding at 12 and 24 weeks were not statistically significant.	Utilizing a community nurse in addition to a peer counselor improved breastfeeding rates at 6 weeks, but the gains weakened as time proceeded.
(Petrova, Ayers, Stechna, Gerling, & Mehta, 2009)	N = 104 (87.5% Hispanic) Randomized Control Trial	Two arm WIC intervention 1: Control 2: One-to-one support from a lactation consultant a. 2 prenatal visits b. 4 postnatal visits	Prenatal and postnatal access to lactation consultant	Exclusive breastfeeding at 1 week 1: 28.9% 2: 45.6% (OR 2.05, 95% CI 0.82-5.13)	Exclusive breastfeeding at 3 months 1: 10.5% 2: 13.9% (OR 1.37, 95% CI 0.73-5.69)	Increasing access to lactation consultants for education sessions did not result in significant increases of exclusive breastfeeding at three months among a majority Hispanic population.

(Harari et al., 2017)	N = 58 Pilot study, randomized control trial	Lactation Advice thru Texting Can Help (LATCH) intervention 1: Peer counseling without text messaging 2: Peer Counseling with text messaging (automated educational text messages and option to text peer counselor)	Peer counseling with text messages	Exclusive breastfeeding at 2 weeks 1: 31.8% 2: 50.0% (p =0.197)	Contact with PC within 48 hours of deliver 1: 23.7% 2: 86.6% (p < .001)	This small pilot study demonstrated that peer counseling with text messaging may improve breastfeeding rates, but a long-term study is needed.
(Hopkinson & Konefal Gallagher, 2009)	n = 522 (100% Hispanic) Randomized Control Trial	Two arm trial among mixed feeding mothers 1: 2: Mothers were assigned to a breastfeeding clinic with IBCLCs within 1 week postpartum	Counseling from IBCLC at hospital clinic	Exclusive breastfeeding at 4 weeks 1:10.0% 2: 16.4% (p = .045)	Report of breast pain was less common in intervention group 1: 76.7% 2: 68.0% (p = .037)	Intervention demonstrated that proving access to IBCLC at a hospital clinic could help mixed feeding mothers return to exclusive breastfeeding.
(Kellams et al., 2016)	N = 522 Randomized Control Trial	Two arm WIC intervention 1: Control 2: 25-minute educational breastfeeding video shown during 3rd trimester clinic visit	Educational Video	Breastfeeding Initiation No significant differences between groups (unadjusted OR 1.03; 95% CI, 0.70-1.50)	Exclusive breastfeeding No significant differences between groups during hospital stay	Overall, an educational breastfeeding video alone was ineffective in improving breastfeeding practices of low-income women during hospital stay after delivery.

(Lovera, Sanderson, Bogle, & Vela Acosta, 2010)	N = 200 (100% Hispanic) Cohort Study	The pilot Peer Dad Program 1: Control 2: Enrolled in the pilot Peer Dad Program (peer counselors provided counseling and education during prenatal and postnatal periods)	Peer Dad Program/ Male support	Breastfeeding > 6 months was not significant 1: 54.6% 2: 63.4% (P=0.20)	Breastfeeding for 6-12 months was not significant 1: 24.2% 2: 32.7% (p = .30)	Providing peer counseling to Hispanic fathers slightly increased breastfeeding rates, but not significantly. Larger studies are needed.
(Pollard, 2011)	N = 86 Randomized two-group experimental design	Two group design 1: Control 2: Completed a daily breastfeeding log for a minimum of 3 weeks	Breastfeeding Log	Breastfeeding at 6 months was not significant 1: 33% 2: 37%	Exclusive breastfeeding among women still breastfeeding at six months 1: 23.1% (3/13) 2: 85.7% (10/14) (p < .001)	A breastfeeding log did not increase breastfeeding duration, but it may be useful in helping women that do breastfeed, achieve exclusive breastfeeding for 6 months.
(Schafer, Vogel, Viegas, & Hausafus, 1998)	N = 72 (100% rural) Non-randomized trial, group assigned by county	Two arm intervention 1: Control (counties without peer counselor program) 2: Peer counselor intervention a. in-home, one-to-one education b. Informal contact to answer questions or help with concerns	Peer Counselor	Breastfeeding initiation 1: 31% 2: 82% (p <.001)	Breastfeeding at 4 weeks 1: 10% 2: 56% (p <.001)	The volunteer peer counseling program increased breastfeeding initiation and duration rates among low-income mothers living in rural areas

(Sciacca, Dube, Phipps, & Ratliff, 1995)	N = 68 Randomized by participant list	Two arm intervention 1: Control (no incentives, but receive education) 2: Incentives given to women and their partners to participate in a breast-feeding class for expectant couples and 5 educational sessions on childbirth.	Incentives and male involvement	Exclusive Breastfeeding at: Hospital Discharge: 1: 55.2% 2: 88.5% (p = .003) 2 weeks postpartum 1: 34.5% 2: 80.8% (p < .001)	Exclusive Breastfeeding at: 6 weeks postpartum: 1: 24.1% 2:50.0% (p = .023) 3 months postpartum 1:17.2% 2: 42.3% (p = .021)	The use of incentives provided for attending breastfeeding and child birth education classes significantly increased exclusive breastfeeding rates among WIC participants.
(Washio et al., 2017)	N = 36 (100% Puerto Rican) Randomized trial	Two are randomized trial 1: Control 2: Financial incentive for demonstrating breastfeeding to WIC staff	Financial incentives	Breastfeeding at 3 months 1: 17% 2: 89% (P < .001)	Breastfeeding at 6 months 1: 72% 2: 0% (P < .001)	Trial found cash incentives significantly increased breastfeeding through 6-month postpartum among WIC-enrolled Puerto Rican mothers; but the sample size was small, and results are not generalizable to diverse populations.
(Gill, Reifsnider, & Lucke, 2007)	N = 200 100% Hispanic Quasi-experimental design, non-randomized	Two are WIC intervention 1: control 2: intervention (prenatal education/postpartum telephone calls and home visits with IBCLC)	Access to IBCLC	Breastfeeding Initiation 1: 67.1% 2: 82.3% (OR 2.31, 95% CI 1.10-4.96)	Breastfeeding at 6 months 1: 21% 2: 43% (OR 3.15)	Access to bilingual lactation consultants via home visits and telephone calls improved breastfeeding initiation and duration among Hispanic WIC participants.

Appendix B: IRB Approvals

UNLV Biomedical IRB - Exempt Review
Exempt Notice

DATE:	June 5, 2018
TO:	Jennifer Pharr, PhD
FROM:	Office of Research Integrity - Human Subjects
PROTOCOL TITLE:	[1219451-1] The effectiveness of a video lactation consultation mHealth application in improving breastfeeding duration and exclusivity among low income mothers in Mississippi: a retrospective cohort study
ACTION:	DETERMINATION OF EXEMPT STATUS
EXEMPT DATE:	June 5, 2018
REVIEW CATEGORY:	Exemption category # 4

Thank you for your submission of New Project materials for this protocol. This memorandum is notification that the protocol referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46.101(b) and deemed exempt.

We will retain a copy of this correspondence with our records.

PLEASE NOTE:
Upon final determination of exempt status, the research team is responsible for conducting the research as stated in the exempt application reviewed by the ORI - HS and/or the IRB which shall include using the most recently submitted Informed Consent/Assent Forms (Information Sheet) and recruitment materials.

If your project involves paying research participants, it is recommended to contact Carisa Shaffer, ORI Program Coordinator at (702) 895-2794 to ensure compliance with the Policy for Incentives for Human Research Subjects.

Any changes to the application may cause this protocol to require a different level of IRB review. Should any changes need to be made, please submit a **Modification Form**. When the above-referenced protocol has been completed, please submit a **Continuing Review/Progress Completion report** to notify ORI - HS of its closure.

If you have questions, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 702-895-2794. Please include your protocol title and IRBNet ID in all correspondence.

Office of Research Integrity - Human Subjects
4505 Maryland Parkway . Box 451047 . Las Vegas, Nevada 89154-1047
(702) 895-2794 . FAX: (702) 895-0805 . IRB@unlv.edu

MISSISSIPPI STATE DEPARTMENT OF HEALTH

February 23, 2018

Aaron Hunt, MPH
Principal Investigator
University of Nevada, Las Vegas
8061 Crystal Haven Lane
Las Vegas, NV 89213

Re: *The effectiveness of video lactation consultation mobile health (mHealth) application in improving breastfeeding duration and exclusivity among low income mothers in Mississippi: a retrospective matched cohort study.*
MSDH IRB Protocol #062817

Dear Mr. Hunt:

Your request for modification of the above referenced protocol was approved by expedited review of the MSDH IRB chairperson. Please refer to protocol **#062817** on all documents or correspondence with the IRB concerning this research.

Please be informed that the IRB must review the status of the research at least annually. Continued approval of this study is contingent on informing this office of any changes in the research protocol. If the study continues beyond one year from the IRB approval date, you must request a continuation. It is suggested that you submit a continuation to the IRB at least 60 days in advance of end of the approval period on **August 2, 2018**.

Please refer to Section 4.0 of the MSDH general agency manual for information related to IRB submission and review.

Sincerely,

Meg Pearson, PharmD, MS
Chair, Institutional Review Board

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Wojcicki, J. M., Gugig, R., Tran, C., Kathiravan, S., Holbrook, K., & Heyman, M. B. (2010). Early Exclusive Breastfeeding and Maternal Attitudes Towards Infant Feeding in a Population of New Mothers in San Francisco, California. In Breastfeed Med (Vol. 5, pp. 9-15).
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Wright, A. L. (2001). The rise of breastfeeding in the United States. Pediatr Clin North Am, 48(1), 1-12.

Curriculum Vitae

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EDUCATION

09/2015-09/2018 (Graduation date)	PhD program in Public Health University of Nevada, Las Vegas
09/2010-05/2013	Master of Public Health, M.P.H. University of Nevada, Las Vegas
09/2002-05/2007	Bachelor of Science, Nutritional Science University of Nevada, Reno

AWARDS AND HONORS

05/2013	Outstanding Thesis Award School of Community Health Sciences University of Nevada, Las Vegas

PROFESSIONAL APPOINTMENTS

2018-Current	PCTE Grant Program Coordinator: A.T. Still University, School of Osteopathic Medicine in Arizona, Mesa AZ
2016-Current	Public Health Lecturer: Undergraduate online and in person classes. School of Community Health Sciences, University of Nevada Las Vegas
2013-2017	Biological Field Technician: Department of Homeland Security. University of Nevada Las Vegas
2012-2016	Program Coordinator: NIH/PEPFAR Collaboration for Advancing Implementation Science in Prevention of Maternal-Child HIV Transmission (NIH 1R01HD075050-01). University of Nevada School of Medicine/University of Nevada Las Vegas
2012-2016	Administrative Officer for the HealthySunrise Foundation which is a non-Profit organization focused on improving maternal child health outcomes through effective interventions around the globe. www.healthysunrise.org
2012-2015	Program Coordinator: Ryan White Title IV Women, Infants, Children, Youth and Affected Family Members AIDS Healthcare Program (HRSA H12HA24832). University of Nevada School of Medicine

2012-2013 Program Coordinator: Nevada Care Program, Maternal-Child HIV Program. HRSA/AAP Healthy Tomorrow Partnership (HRSA H17MC21712). University of Nevada School of Medicine

2011-2012 Graduate Research Assistant: Emerging Diseases Laboratory. Department of Environmental and Occupational Health, School of Community Health Sciences University of Nevada Las Vegas

2010-2011 Research Analyst: The Nevada Institute for Children's Research and Policy (NICRP). University of Nevada Las Vegas

2007-2010 Research Assistant: Cellular, Molecular and Microbial Biology Laboratory, Division of Biological Sciences, University of Montana

PEER REVIEWED JOURNAL PUBLICATIONS

1. Using a Cultural Framework to Understand Factors Influencing HIV Testing in Nigeria. Ehiri JE, Iwelunmor J, Iheanacho T, Blackstone S, Obiefune MC, Ogidi AG, Ahunanya FU, Nnadi D, Patel D, **Hunt AT**, Ezeanolue EE. Int Q Community Health Educ. 2016 Dec 28:272684X16685258. doi: 10.1177/0272684X16685258. [Epub ahead of print] PMID: 28030987
2. What do You Need to Get Male Partners of Pregnant Women Tested for HIV in Resource Limited Settings? The Baby Shower Cluster Randomized Trial. Ezeanolue EE, Obiefune MC, Yang W, Ezeanolue CO, Pharr J, Osuji A, Ogidi AG, **Hunt AT,** Patel D, Ogedegbe G, Ehiri JE. AIDS Behav. 2017 Feb;21(2):587-596. doi: 10.1007/s10461-016-1626-0. PMID: 27933462
3. Prevalence of Sickle Cell Trait and Reliability of Self-Reported Status among Expectant Parents in Nigeria: Implications for Targeted Newborn Screening. Burnham-Marusich AR, Ezeanolue CO, Obiefune MC, Yang W, Osuji A, Ogidi AG, **Hunt AT,** Patel D, Ezeanolue EE. Public Health Genomics. 2016;19(5):298-306. doi: 10.1159/000448914. PMID: 27614873
4. Effect of a congregation-based intervention on uptake of HIV testing and linkage to care in pregnant women in Nigeria (Baby Shower): a cluster randomised trial. Ezeanolue EE, Obiefune MC, Ezeanolue CO, Ehiri JE, Osuji A, Ogidi AG, **Hunt AT**, Patel D, Yang W, Pharr J, Ogedegbe G. Lancet Glob Health. 2015 Nov;3(11):e692-700. doi: 10.1016/S2214-109X(15)00195-3. PMID: 26475016
5. Impact of male partner's awareness and support for contraceptives on female intent to use contraceptives in southeast Nigeria. Ezeanolue EE, Iwelunmor J, Asaolu I, Obiefune MC, Ezeanolue CO, Osuji A, Ogidi AG, **Hunt AT,** Patel D, Yang W, Ehiri JE. BMC Public Health. 2015 Sep 10;15:879. doi: 10.1186/s12889-015-2216-1. PMID: 26358642
6. Ebola Outbreak in Nigeria: Increasing Ebola Knowledge of Volunteer Health Advisors. Patel U, Pharr JR, Ihesiaba C, Oduenyi FU, **Hunt AT**, Patel D, Obiefune M, Chukwumerije N,

Ezeanolue EE. Glob J Health Sci. 2015 May 17;8(1):72-8. doi: 10.5539/gjhs.v8n1p72. PMID: 26234990

7. Why are Children Still Being Infected with HIV? Impact of an Integrated Public Health and Clinical Practice Intervention on Mother-to-Child HIV Transmission in Las Vegas, Nevada, 2007-2012. Ezeanolue EE, Pharr JR, **Hunt A**, Patel D, Jackson D. Ann Med Health Sci Res. 2015 Jul-Aug;5(4):253-9. doi: 10.4103/2141-9248.160189. PMID: 26229713
8. Knowledge and awareness of personal sickle cell genotype among parents of children with sickle cell disease in southeast Nigeria. Ezenwosu OU, Chukwu BF, Ikefuna AN, **Hunt AT,** Keane J, Emodi IJ, Ezeanolue EE. J Community Genet. 2015 Oct;6(4):369-74. doi: 10.1007/s12687-015-0225-5. PMID: 25869330
9. The roles of transcription and genotoxins underlying *p53* mutagenesis *in vivo*. Wright, B. E., Schmidt, K. H., **Hunt, A**. **T.**, Lodmell, J. S., Minnick, M. F., & Reschke, D. K. (2011). Carcinogenesis, 32(10), 1559-1567.
10. Evolution of coordinated mutagenesis and somatic hypermutation in *VH5*. Wright, B. E., Schmidt, K. H., **Hunt, A. T**., Reschke, D. K., & Minnick, M. F. (2011). Molecular Immunology, 49(3), 537-548.
11. Correlations between secondary structure stability and mutation frequency during somatic hypermutation II. Wright, B. E., Schmidt, K. H., Davis, N., **Hunt, A. T.**, & Minnick, M. F. (2008). Molecular Immunology, 45(13), 3600-3608.

Abstracts

1. Infant Mortality in Sub-Saharan Africa: Results from the Healthy Beginning Initiative (2013-2014). Slinkard SA, Pharr J, Bruno T, Ogidi A, Obiefune M, **Hunt AT,** Patel D, and Ezeanolue, EE. Under review APHA 2017.
2. "Deluxe Dad" a breastfeeding education and support group intervention for new fathers in Las Vegas, Nevada. **Hunt AT** and Pharr J. Under review APHA 2017.
3. **Intervention for Sustained Testing and Retention (iSTAR) among HIV-infected Pregnant Women. Jadhav R,** Bruno T, Ogidi A, Obiefune M, **Hunt AT,** Patel D, and Ezeanolue, EE. APHA 2016, Denver CO.
4. State Health Department Handling of Sickle Cell Trait Results Identified Through the Newborn Screening Programs. Tuaño KR, **Hunt A**, Shahani S, Whitten-Shurney W, Ezeanolue EE. First place award Nevada Chapter, American College of Physician annual meeting, Las Vegas Jan. 12, 2013. WSMRF 2013 David Lupan Outstanding Oral Presentation Award. Journal of Investigative Medicine 2013; 61 (1): 191.
5. The presence of methicillin resistant *Staphylococcus aureus* (MRSA) on environmental surfaces in healthcare facilities pre-and post- cleaning. **Hunt, A.**, Cruz, P., Buttner, M. P. (2013). 6th Annual Interdisciplinary Research Scholarship Day, University of Nevada, Las Vegas.
6. Ebola outbreak in Nigeria: Volunteer health advisors as information disseminators. Patel, U., C. Caius I Ihesiaba, F. U. Oduenyi, **A. T. Hunt**, D. Patel, J. Pharr, M. Obiefune, N. Chukwumerije, and E. E. Ezeanolue. *Annals of Global Health* 81, no. 1 (2015): 7-8.
7. Prevalence of sickle cell trait among whites: Results from Nevada 2005-2012. Keane, J., **A. T. Hunt**, E. E. Ezeanolue, J. Kvam, M. Pennington, and Y. Mohamednur. *Journal of*

Investigative Medicine vol. 63, no. 1, pp. 117-118. Philadelphia, PA: Lippincott, Williams & Wilkins, 2015.

COMPLETED GRANT APPLICATIONS

March 2016- RFA-GH-16-005 Operations Research (Implementation Science) for Strengthening Program Implementation through the Presidents Emergency Plan for AIDS Relief (PEPFAR)

April 2015- RFA-DA-15-019, Seek, Test, Treat and Retain Youth and Young Adults Living with or at High Risk for Acquiring HIV (R01)

March 2015- PAR-14-028, Mobile Health: Technology and Outcomes in Low and Middle Income Countries (R21) Funded

Jan 2015- HRSA-15-022, Ryan White HIV/AIDS Program Part D Grants for Coordinated HIV Services and Access to Research for Women, Infants, Children, and Youth (WICY) Existing Geographic Service Areas-Funded

Jan 2015- RFA-HD-017, Increasing Access and Uptake of HIV Testing and Counseling (HTC) and Appropriate HIV-related Services for Adolescents in Low and Middle-income Countries-Funded

May 2014- PAR-14-080, International Research in Infectious Diseases

Jan 2014- PAR13-323, Increased Knowledge and Innovative Strategies to Reduce HIV Incidence IKnow Projects (R01)

Jan 2014- PA-14-024, NIH/PEPFAR Collaboration for Implementation Science (Admin Supp) Funded

Jan 2013- PAR-13-055, Dissemination and Implementation Research in Health (R01)-Funded

July 2013- PAR-13-126 Limited Competition: Fogarty HIV Research Training Program for Low-and Middle-Income Country Institutions (D43)

TRAININGS/CERTIFICATIONS

California-Nevada Public Health Training Center

- 7/11/12 All About Grants: Plan, Write, Manage, Evaluate
- 6/27/13 Strategies to Reduce the Spread of Infectious Disease
- 8/8/12 Hospital Acquired Infections
- 6/17/13 Personal Leadership for Public Health Professionals

CITI-Collaborative Institutional Training Initiative

- Human Research Curriculum Completion

INTERNSHIP PROJECT

2012 The Creation of a Methicillin-Resistant *Staphylococcus aureus* (MRSA) Infection Prevention Toolkit for Healthcare Facilities A partnership between The Nevada State Health Division Office of Public Health Informatics and Epidemiology and the University of Nevada, Las Vegas, School of Community Health Sciences

PROFESSIONAL SOCIETIES

2018- Member, Arizona Public Health Association

VOLUNTEER ACTIVITIES

Aid for AIDS of Nevada (AFAN), AIDS Walk Volunteer

American Lung Association, Fight for Air Walk Volunteer

American Cancer Society, Relay for Life Volunteer