



University of Bergen

Faculty of Medicine and Dentistry. Department of Clinical Medicine 1

Master Thesis

Health care service delivery and infant feeding practices in KwaZulu-Natal, South Africa: results from a cross-sectional survey at 14 weeks of age

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Abstract

Background

Breastfeeding support, guidance and optimal infant feeding practices are of key importance to ensure child survival. Sub-optimal infant feeding is still an important issue in South Africa, despite strong recent efforts to promote exclusive breastfeeding (EBF). The delivery of health care services affects EBF practices which in turn has consequences for child morbidity and mortality. In South Africa, the health system consists of two parts: hospitals/clinics and community health workers. Community health workers have a variety of roles in the local community, such as home-based care and maternal and child health care.

This thesis has a double objective: primarily to assess the impact of health care quality on infant feeding modality and secondly to assess the effect of HIV status on health system services and in turn on infant feeding modality.

Method

This thesis is based on data from the The KwaZulu-Natal Initiative for Breastfeeding Support (KIBS). KIBS was a cross sectional study launched to 1) provide breastfeeding estimates in all districts of KwaZulu-Natal and 2) to evaluate progress in breastfeeding rates after interventions implemented to support and promote breastfeeding. The project was started in 2014 and lasted for three years. A total of 4059 interviews were conducted across the KwaZulu-Natal province, most of them with the child's biological mother.

To map how infant feeding counselling is provided we created a "gold standard" model of health care that the mother is supposed to get during pregnancy, birth and post pregnancy. The model is based on the recommendations given in South Africa at the time of the survey and comprises variables targeting protection and promotion of breastfeeding.

Our analysis identified factors associated with poor, medium and good health care. We wanted to examine the impact of health care services impact on infant feeding outcome and identify risk factors. Infant feeding outcome was divided into in three categories: "never initiated breastfeeding", "breastfeeding cessation" and "still breastfeeding".

Results

The analysis showed that poor health care score had a high effect on the infant feeding outcomes "never initiating breastfeeding" and "breastfeeding cessation". Interfering factors such as mother returning to work shortly after giving birth, positive HIV status and child support grant turned out to have an impact on both health care and infant feeding outcome.

In the poor health care score group, we found a significantly higher share of HIV-negative mothers still breastfeeding, compared to HIV-positive mothers. In the same health care score group, there was a significantly higher share of HIV-positive mothers who “never initiated breastfeeding” compared to HIV-positive mothers. This suggests that HIV status affects infant feeding outcome strongly.

Conclusion

The “gold standard” health care score used in this thesis shows that optimal health care is decisive for infant feeding modality. Poor health care score combined with positive HIV status poses a major risk for never initiating breastfeeding. Improved health care is therefore of great importance. Further practical use of the health care score model is advisable, but an optimization of the score as a tool for measuring health care performance should be considered.

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Operational definitions

Exclusive breastfeeding (EBF)

The infant receives only breastmilk and no other liquids (including water) or solid foods. Exceptions include oral rehydration solutions, drops or syrups of vitamins, minerals or medicines (1, 2).

Mixed feeding (MF)

The infant is being breastfed, but is also given other liquids or solid foods together with the breastmilk, such as water, formula milk or solid food (2).

Non breastfeeding (NBF)

The infant is only given breast milk substitute and is never put to the breast.

Breastfeeding cessation

The mother has breastfed at some point earlier, but at the time of assessment the child is only receiving formula or replacement foods.

Abbreviations

AFASS	Acceptable, Feasible, Affordable, Sustainable, Safe
ART	Antiretroviral Therapy
BF	Breastfeeding
BFHI	Baby-Friendly Hospital Initiative
CBHS	Community Based Health Services
CHW	Community Health Workers
CSG	Child Support Grant
DHS	Demographic Health Survey
EBF	Exclusive Breastfeeding
FAO	Food and Agriculture Organization of the United Nations
HAZ	Height-for-Age Z-score
HIV	Human Immunodeficiency Virus
ICMBS	The International Code of Marketing of Breastmilk Substitutes
IYCF	Infant and Young Child Feeding
KIBS	KwaZulu-Natal Initiative for Breastfeeding Support
LAZ	Length-for-Age Z-score
LMIC	Low- and Middle Income Countries
MBFI	Mother-Baby Friendly Initiative
MF	Mixed Feeding
MGRS	Multicentre Growth Reference Study
MIYCN	Maternal, Infant and Young Child Nutrition
NBF	Non Breastfeeding
PC	Principal Component
PCA	Principal Component Analysis
PMTCT	Prevention of Mother-To-Child Transmission
RRR	Relative Risk Ratio
SAM	Severe Acute Malnutrition
SDG	Sustainable Development Goals
SD	Standard Deviations
SES	Socio Economic Score
SIDS	Sudden Infant Death Syndrome
UHC	Universal Health Coverage

UN	United Nations
UNICEF	United Nations Children's Fund
WHA	World Health Assembly
WHO	World Health Organization
WHZ	Weight-For-Height Z-score

Background

Global Focus on Optimal Nutrition

Sufficient nutrition during infancy and early childhood (0-23 months) is critical to ensure optimal health, growth and development. Infant and child feeding practices will directly affect the nutritional status of children, and also on have an impact on child survival (3). Optimal feeding practices, including exclusive breastfeeding (EBF), are of key importance to reduce childhood morbidity and mortality, but also provide benefits extending into adulthood (4). In the policy documents mentioned below infant feeding is put into a life cycle perspective including pre-pregnancy nutrition, pregnancy care and nutrition, and adolescent health.

About 2,7 million children under the age of 5 die every year due to malnutrition (5). Children's survival, health and wellbeing improved during the period of the Millennium Development Goals (MDGs) where annual child mortality decreased from more than 12 million to less than 6 million. There are renewed targets under the Sustainable Development Goals (SDGs) from 2015 onwards, some of them focusing particularly on nutrition, (SDG number 2 - Zero hunger, and SDG number 3 - Good health and well-being) (6). In 2012, the World Health Assembly (WHA) with 194 member states set the global targets to improve nutrition, with six main focus areas: stunting, exclusive breastfeeding, wasting, anemia, low birth weight and overweight (4). The specific goal for EBF is to increase the rates within the first 6 months of life to 50 % by 2025. In 2016, 37% of children younger than 6 months were exclusively breastfed in low- and middle-income countries (LMIC). To meet EBF targets an estimated investment of 5,7 billion dollars is needed. This would lead to 105 million more children being exclusively breastfed, and approximately 823 000 lives could be saved per year (4, 7).

Breastfeeding support and guidance are cost-effective interventions to promote child survival. The countries with the highest increase in EBF levels are the ones with politics and recommendations that come close to the WHO/UNICEF recommendations (3). A group of 20 countries had an average increase of more than 20 % in EBF rates, due to a strong commitment to improve infant and young child feeding (8).

In this context we will sum up the main infant feeding categories and the most important research findings regarding the different practices. We will also highlight current challenges that are of importance to feeding counselling. Although the WHO recommendations on infant

feeding practices are clear, there is lack of information on how the health systems should communicate these recommendations to populations. Further, even though breastfeeding has been recommended for decades, the HIV epidemic distorted prior breastfeeding initiatives. There is an ongoing discussion on the best ways to convey the nutritional recommendations, and in this context, we will describe the past and current infant feeding counselling strategies that are relevant to this thesis.

Infant Feeding Practices, Benefits and Challenges

Exclusive Breastfeeding

EBF takes place when the infant receives only breastmilk and no other liquids (including water) or solid foods from the time of birth. Exceptions include oral rehydration solutions, drops or syrups of vitamins, minerals or medicines (1, 2). EBF for the first 6 months of infancy provides many benefits for both mother and child. Breastmilk is an important source of energy and micronutrients, but it also affects the child's health by protecting against respiratory infections, gastrointestinal infections, and other potentially life-threatening conditions (3, 4). Breastmilk works as the child's first immunization because it contains immunoprotective substances such as lymphocytes and antibodies. Furthermore, because the mother is exposed to most of the microbes in the environment, the breastmilk is so to speak "tailormade" for the environment the child is born into (9). EBF also protects the child from infections by preventing exposure to bacteria and viruses in the drinking water, unclean bottles and unsafe foods, which in many settings will be the alternative to EBF. In recent years, different studies have shown that EBF can have protective, or at least beneficial, effect against obesity later in life, type 1 and type 2 diabetes (3), allergies (10), sudden infant death syndrome (SIDS) and leukemia. It also contributes to better cognitive development and higher IQ, and may also provide psychosocial benefits (11).

Mixed Feeding

If EBF is not possible to implement in the first months of a child's life, some breastfeeding is better for the infant than no breastfeeding at all. This is due to the short- and long-term benefits breastfeeding provides for mother and child (7). The child will receive breastmilk combined with suitable complementary food such as formula milk. The infant still gets many of the important effects of the immunoprotective substances from the breastmilk and receives a tailormade nutrition-source as a part of the total diet.

Non-Breastfeeding

If the infant does not get any breastmilk at all, this is defined as non-breastfeeding (NBF). In this case the child's food comes from other sources, including various animal milk sources. In wealthier economies, the infant's main source of nutrition is baby formula milk which is later supplemented with solid foods and a mixture of the two over time (12). In areas where infrastructure, hygiene and sanitation are poor, access to a safe formula is an issue, and there are many challenges related to mixed feeding and NBF.

Complementary Feeding

At some point, breastfeeding alone does not meet the nutritional demands in a child's life (13). This is when complimentary feeding should start. It is important that the food given to the child is safe, nutritious and having a texture which does not cause respiratory difficulties or other possibly dangerous situations (13). Proper knowledge of safe and nutritious foods is of great importance in health counselling to mothers who implement complementary foods to infants (14).

Breastfeeding Duration

The duration of breastfeeding affects the mother's health. Long duration has been seen to be beneficial for the mother: it reduces the risk of breast problems such as mastitis or abscess and also the risk of ovarian and breast cancer (7, 15). It may as well help to space pregnancies, due to the hormonal effect that contributes to lack of ovulation, although this is not considered a safe birth control method (15). To summarize current research: Breastfeeding contributes to lifelong health benefits for both mother and child, and socioeconomic benefits for the child as EBF has been related to better school performance and thereby better socioeconomic status later in life (4).

Early Infant Feeding Practices

Early infant feeding practices involve initiation time of breastfeeding, the use of colostrum and the use of prelactal feeding. It is recommended to start breastfeeding within the first hour after birth. This stimulates the production of milk and enhances bonding between mother and child. It also has a positive effect on later breastfeeding practices (16), and on maternal/postpartum depression which in turn can affect breastfeeding duration. It also has an impact on the mother's receptiveness to counselling (17-19).

The initial breastmilk, colostrum, is higher in antibodies and proteins than mature breastmilk (20). This is primarily to protect the vulnerable, newborn baby from disease. However colostrum also has a mild laxative effect (21) which is important as it contributes to the infant's first stool and clear excess bilirubin, decreasing the risk of jaundice which potentially could cause brain damage (22). In certain cultures, there is a belief that colostrum is dirty and must not be given to the newborn (23). For this reason, counselling in certain African cultures should include information on the value of putting the child to the breast immediately and feed the colostrum, both for the protective effects and to establish a successful breastfeeding routine.

Breastfeeding Challenges

For some women, breastfeeding can be challenging. Not all babies and mothers have the right technique, and various difficulties in the mother-child interaction contribute to making it hard for the baby to attach to the breast and collect the breastmilk properly (24). This can lead to the baby getting frustrated due to ineffective lactation of milk. The swallowing of air is another problem which in many cases gives the baby stomach ache. All these factors may lead to a stressful breastfeeding situation for both mother and child and at worst result in insufficient intake of milk, poor nutritional status and other health concerns (24). Technical difficulties may also affect the mother's breast health and give rise to engorgement, mastitis, abscesses, cracked nipples and pain. Sometimes these infections can turn into sepsis and quickly become life threatening to the mother (24). Knowledge of recommended breastfeeding-positions, feeding techniques and severe breast health conditions is of great importance for health care workers giving breastfeeding counselling to both pregnant and breastfeeding women (24, 25).

Challenges at Birth

Birth complications can cause early breastfeeding challenges. A survey from 2012, showed that mothers who experienced complications breastfed for a significantly shorter time than those who did not have complications (26). Complications associated with shorter breastfeeding duration were caesarean deliveries, fetal distress and failure to progress during birth and postpartum hemorrhage (26). The reasons given for discontinuing breastfeeding were pain and physical difficulty, possibly due to medications received which can both weaken the infant's suckling and strength, as well as the mother's strength (26).

Optimal and early neonatal care is important for the outcome of breastfeeding. A newborn who is alert within the first hour after birth and placed on the mother's chest can without assistance locate the odor of breastmilk and crawl up to the breast and latch on the nipple itself (19, 24). Immediate skin-to-skin contact after birth and early breastfeeding initiation is essential to a successful breastfeeding outcome. It also helps the infant transit from the intrauterine to the extrauterine life circumstances (19). Skin-to-skin contact helps establishing nursing behaviors and a baby ruled feeding pattern. It also promotes regulation of temperature and comfort on the part of the baby (19). Delayed breastfeeding initiation increases the risk of neonatal mortality (27). A study conducted in Ghana showed that the longer breastfeeding initiation was postponed after birth, the higher was the neonatal mortality risk (27).

Cord clamping is another factor affecting infant mortality risk, development and strength. Delayed cord clamping for at least one minute is recommended, and this reduces hospital mortality in preterm infants (28, 29). A randomized controlled trial from 2011 showed that iron status and iron deficiency at 4 months postpartum strongly improved with delayed cord clamping (30). Iron deficiency (not yet clinically defined anemia) in infants has been associated with impaired development (30).

Other Structural, Bodily and Psychological Challenges

These challenges are interlinked. The structural challenges can be described as various factors interfering with breastfeeding initiation and duration such as work-place, social and family barriers and support-mechanisms (31). Mothers of preterm newborns may experience poor lodging facilities and prolonged separation from the infant, and this will affect the practice of exclusive breastfeeding negatively (32). Further on, infrequent visiting of the child in clinic or hospital due to poverty, sibling's care or substance abuse are also contributors to poorly sustained breastfeeding (32).

Bodily challenges may appear immediately after birth. It can be difficult for a mother to maintain lactation, especially if the birth has caused severe illness or other health related issues (32). According to a list published by WHO breastfeeding is contraindicated by several conditions. The WHO recommendations were given prior to the later HIV and infant feeding guidelines (2013 and 2016). They include HIV, Hepatitis B and C, Ebola, herpes simplex virus type 1, untreated and active tuberculosis, substance use or use of medications which can pass on to the infant through the milk and cause damage (33).

When it comes to psychological challenges postpartum depression is a common and severe condition. Approximately 12-14 % of women are affected during the first three months after birth (34). Postpartum depression often has a bearing on breastfeeding outcome. The mother finds it difficult to breastfeed and this combined with feelings of inadequacy, low self-confidence and guilt may disturb the mother-infant relationship. It has also been found that depressed mothers interact less with their infants both physically and emotionally (35). An overwhelming feeling of lack of energy leads to missing infant cues (34). Reduced awareness to the infant's signs and cues of hunger can cause delayed feeding, which in turn triggers distress and makes it hard to calm down and latch the baby on the breast (35). Postpartum depression has also been found to be a main determinant for breastfeeding cessation (36). In this way untreated maternal depression can have an extended negative impact on a child's growth and development in later life (37), such as underweight and stunting (38). For this reason, it is important for health workers to have sufficient knowledge of maternal depression and address the problem at an early stage so that treatment can be started.

Current Discussion on Optimal Duration of Exclusive Breastfeeding

Breastmilk is designed to cover the infant's nutritional needs the first months of life. In 2001, the breastfeeding recommendations stated that exclusive breastfeeding should take place up to six months of age, and combined with complementary feeding up to two years of age or beyond (39). Following a recent debate on whether or not breastmilk alone is sufficient to cover the nutrition and energy needs of a 4 to 6 months old child, a systematic review of current data was done in 2001 (39). No growth deficit in infants exclusively breastfed up to six months was found, and only one country showed impaired iron-status in 6 months old infants when exclusively breastfed (39).

The current recommendations suggest exclusive breastfeeding up to six months of age, followed by combined breastfeeding and complementary feeding up to two years of age or beyond (40). Recent research has found that breastmilk does not cover all energy and nutrient requirements for all children up to six months (41). Especially iron has brought concerns and a study from 2007 showed that US infants who were exclusively breastfed up to six months had a higher risk of anemia (41). The iron levels in breast-milk will depend on the mother's iron status before pregnancy and her diet during pregnancy and the period of breastfeeding (41). Early cord clamping will also affect the infant's iron status negatively, and this combined with poor iron levels in the breastmilk may lead to low serum ferritin levels and anemia in the child (41). In addition, a large proportion of diets in LMICs are suboptimal, either in very poor areas where food is scarce or in areas of food transition where excess energy and low nutritional value occur, leading to deficiency of iron and folic acid (42). Supplementation of iron and folic acid to pregnant women in high anemic areas improve birth outcomes such as fewer low birth weight and fewer small for gestational age infants (42).

In addition to breastmilk not being enough for the child at six months of age, prolonged EBF for more than 6 months has an impact on taste development (41). It is believed that there is a window between 4 and 6 months that is optimal for introducing new tastes (43). Especially vegetables, which often have a bitter taste should be introduced during this window, because they are an important source of calcium, iron, and vitamins A, C, K and B (41). Even though the recommendations suggest exclusive breastfeeding up to six months of age, in many high-income countries complementary foods are introduced during this window (43). In settings where clean water and safe foods are in place, this is no problem, but in low income areas, the mortality risk increases (39).

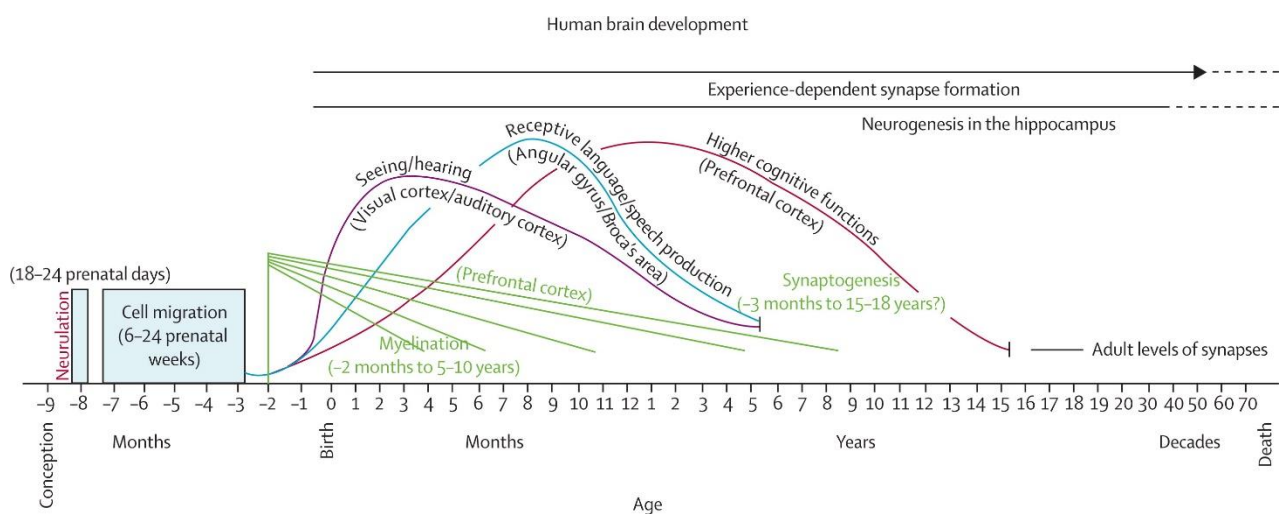
Micronutrient Needs and Malnutrition

During the early lifecycle stages, pre-pregnancy and pregnancy, the woman's need for micronutrients is higher than usual. The consequences of micronutrient deficiency can be fatal to the fetal development (44). The effects of malnutrition and micronutrient deficiency in these early stages of life are likely to cause irreversible consequences for the lifespan of both mother and child. It increases the risk of impaired development and death (45). Maternal iron and calcium deficiency adds to the risk of maternal death, and iron deficiency during pregnancy is related to <2500 g infant birth weight (45). Maternal undernutrition during pregnancy can lead to reduced fetal growth and combined with deficiencies of iron and iodine the risk of both death and stunting by the age of 2 years increases for the child. Deficiency of folic acid during pregnancy may cause neural tube defects (45). Maternal vitamin A deficiency is associated with increased low birth weight and higher infant mortality. Zinc is a key micronutrient with an important role in DNA replication, protein synthesis and other biological functions, and deficiency augments the death risk. (45). Iodine deficiency during pregnancy causes cretinism which leads do impaired growth and mental retardation for the child (45).

Thus, the importance of proper nutrition during these early life stages is vital to the child.

Infant Feeding Counselling Strategies

A considerable amount of research shows a window lasting for the first 1000 days of life, from conception until the age of two years, where optimal nutrition is critical and can save lives. Insufficient nutrition during this period of a child's life, is a potential high risk factor when it comes to mortality and suboptimal development. Among other things it can lead to stunting which is irreversible and linked to reduced performance at school and at work, due to impaired cognitive ability (46). Figure 1 gives an overview of human brain development and as we can see most of the development takes place within the first 1000 days.



The Lancet 2007 369, 60-70 DOI: (10.1016/S0140-6736(07)60032-4) (47).

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Figure 1: Brain development processes from conception till the end of life (47).

As shown in Figure 2 many programs and interventions have been developed to improve maternal and infant nutritional status as. These are applicable at different stages, such as pregnancy, neonates and infants and children.

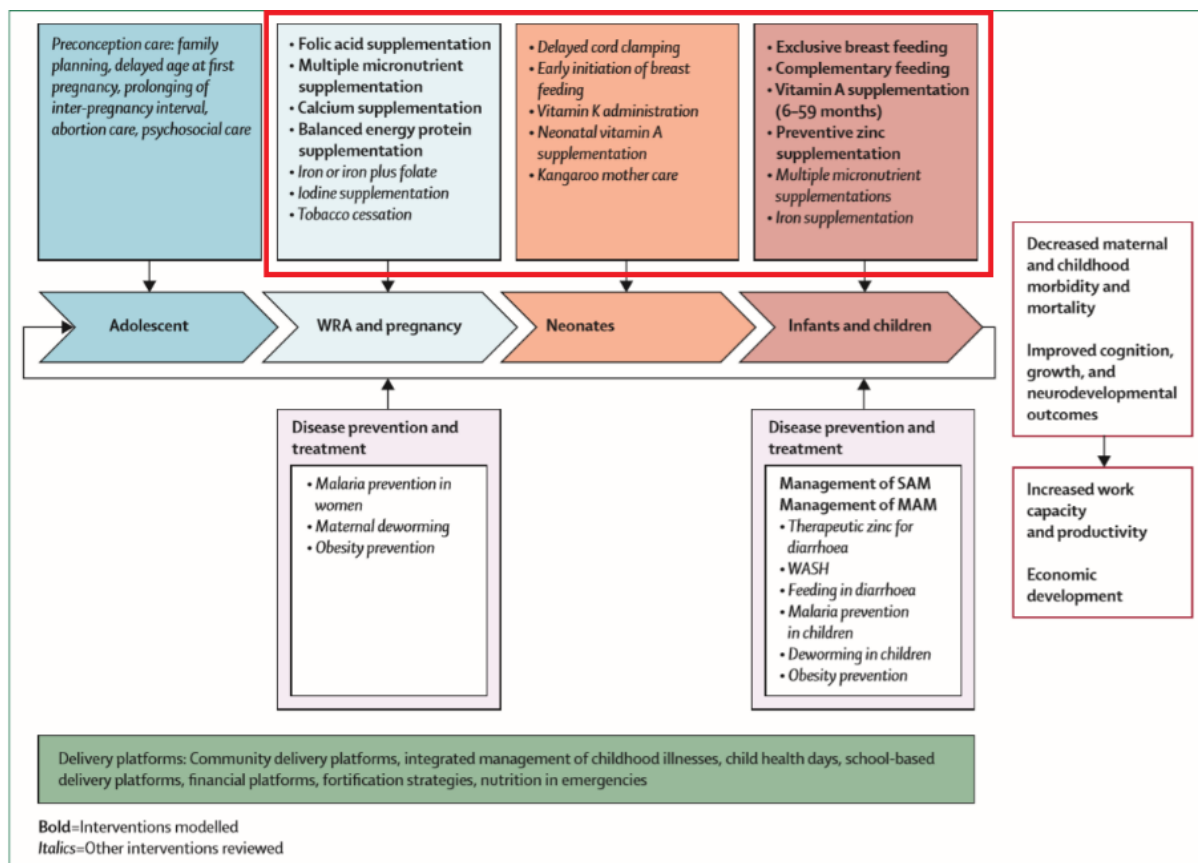


Figure 1: Conceptual framework

WRA=women of reproductive age. WASH=water, sanitation, and hygiene. SAM=severe acute malnutrition. MAM=moderate AM.

Figure 2: Programs and interventions improving maternal and infant nutritional status (48).

As regards pregnancy interventions the following are listed:

- A Cochrane review on daily iron supplementation for pregnant women showed that anemia was reduced to term by 70% and that the incidence of low birth weight declined by 19%. WHO recommend daily folic acid and iron supplementation during pregnancy in populations at risk of deficit(48).
- In some LMIC settings a multiple micronutrient supplementation is recommended because deficiencies in micro nutrients often coexist in these settings(48).
- Calcium supplementation is recommended to lower the risk of maternal mortality by reducing gestational hypertensive disorders and the risk of preterm birth (48).
- Iodized salt is the most common intervention in regions affected by iodine deficiency, but this is not always enough. A review showed that cretinism was reduced by 73% and children's developmental scores increased by 10-20% when iodine supplementation was given during pregnancy (49).

For neonates the interventions are completed before the mother leaves the clinic. The following are listed(48):

- Optimal iron status must be ensured in cases of delayed cord clamping, as mentioned above.
- Neonatal vitamin K supplementation is given after birth to prevent bleeding, but this is mainly done in health facilities.
- Neonatal vitamin A supplementation is shown to reduce mortality in very low birth weight infants.
- Kangaroo mother care promotes skin-to-skin contact after birth, early initiation and continued breastfeeding. This has been shown to increase breastfeeding rates and duration of breastfeeding.

For infants and children, the interventions are mainly promoting and supporting EBF from birth up to 6 months of age, and from 6 months breastfeeding combined with complementary feeding with guidance and focus on nutritionally rich and safe foods (14). Further, preventing deficiencies by supplementation of vitamin A, iron and zinc is shown to reduce anemia and mortality rates (48).

The lives lost and the consequences of malnutrition lead to lost global productivity and increased health care costs (4). Supporting strategies are critical to ensure health services for women and children the first 1000 days, when their requirements are high, and the risk of under- and malnutrition is even higher (46). For this reason, it is important to implement the breastfeeding recommendations.

Recommendations, Health Care Services, Initiatives and Breastfeeding Programs

The Baby-Friendly Hospital Initiative

There have been many initiatives through the years to promote exclusive breastfeeding in addition to embracing and protecting mother and child the first period of a child's life.

In 1991, WHO and UNICEF launched the first breastfeeding recommendations. Since then, several changes have been made to adjust the recommendations to recent research. The current recommendations from 2016 state that the goals are: “to initiate breastfeeding within an hour after birth, exclusive breastfeeding for the first 6 months, and continued breastfeeding for two years or more, together with safe, nutritionally adequate, age appropriate, responsive complementary feeding starting in the sixth month together with continued breastfeeding up to 2 years of age or beyond” (40, 50)

Next to the original recommendations WHO and UNICEF also introduced the Baby-Friendly Hospital Initiative (BFHI), “which is a global effort to implement practices that protect and support breastfeeding” (51).

BFHI includes Ten Steps to Successful Breastfeeding, among others:

- Skin-to-skin contact immediately after birth
- Breastfeeding initiation within the first hour of life
- Self-regulated baby, i.e. breastfeeding on demand
- Rooming-in (allowing mothers and infants to remain together 24 hours a day)
- Not giving the baby any other foods or drinks than breastmilk (unless it is medically necessary)
- Supportive health services to all caregivers, feeding counselling during antenatal care, postnatal care and immunization visits
- Community support to the mothers with support groups and health promotion activities

Mothers who breastfeed are highly responsive to support from their surroundings.

Breastfeeding rates should therefore be positively affected if the right support is provided when it comes to infant feeding choice and facilitation. Likewise, the mother should be encouraged to implement the ten steps of BFHI (51). Still, many countries have developed infant feeding cultures that promote supplementary feeding and so called “pre-lacteal feeds” for the newborn (52). Initiatives like the protein-energy malnutrition initiative have “authorized” the use of formula as supplemental or main infant feeding, instead of exclusive

breastfeeding (53). In addition formula milk companies have, over the years, sold their products quite aggressively, and this has led some mothers to believe that formula milk is just as good as breastmilk for the child (54). Further, marketing, availability and free formula samples both in supermarkets and in some health facilities contribute to high bottle-feeding rates (55, 56).



Figure 3: Aggressive formula milk promotion with the slogan “Non-Stop Learning”, and a gift included in the purchase, in this case a backpack trolley for the child. Photo: Kristine Vinje.

The International Code of Marketing of Breast Milk Substitutes

In 1981, the World Health Assembly adopted the International Code of Marketing of Breast Milk Substitutes (ICMBS) to protect and promote breastfeeding (57). The code aims to end inappropriate marketing of breast milk substitutes and stipulates that there should be absolutely no promotion of formula milk and feeding bottles in public. Also, no health facilities or health professionals should in any way promote breast milk substitutes. The industry has used different arguments and slogans which substantiate formula feeding and may seem appealing (as seen in Figure 3). Substitutes are presented as an “easy fix” feeding

option for the mothers, since breastfeeding can be both challenging and difficult for many women (55).

This way of marketing may have contributed to low breastfeeding and high formula-feeding rates. Furthermore, it may also have added to the high infant mortality rates in southern and eastern Africa where these rates are among the highest in the world (58).

Another challenge when it comes to the choice of infant feeding is HIV. There have been conflicting messages from health authorities all over the world as progress in the HIV treatment has been made. This has given room for confusion, insecurity and even better opportunities for the milk formula companies to promote and sell infant formula milk. In South Africa from 2001 to 2011, free formula milk was provided to HIV-positive women in the cases when formula feeding was considered acceptable, feasible, affordable, sustainable and safe (AFASS) (2). Even though new WHO guidelines on HIV and infant feeding were published in 2010, promoting exclusive breastfeeding as long as the mother was adherent to ART, many mothers still have chosen formula feeding for their infants in fear of transmitting HIV (59). South Africa implemented the ICMBS by a law entering into force in December 2012 (60). Compared to other countries such as e.g. Norway this was late. In 1983 the children's food industry in Norway agreed with the Ministry of Health and Care Services to comply with the ICMBS (61). The fact that South Africa was late implementing the ICMBS combined with mixed messages regarding breastfeeding and HIV has been a large contributor to the low EBF rates at 6 months of age (59).

The PMTCT Program, Infant Feeding in the Context of HIV

In 2010, WHO recommended antiretroviral therapy (ART) drug interventions for the first-time to prevent HIV transmission, both during pregnancy and the postnatal period through breastfeeding (62). Before this, WHO recommended that in cases where the mother was HIV-positive, an individualized approach should be chosen. This included counselling on feeding options from community or health workers taking their household circumstances into account. Other feeding options than breastfeeding (such as formula feeding), were only recommended when it was affordable, feasible, available, sustainable and safe, otherwise EBF was recommended for the first 6 months (3).

In 2016, updated guidelines on HIV and infant feeding was presented by WHO. It is now recommended to “give lifelong ART for everyone from the time when any adult (including pregnant and breastfeeding women) or child is first diagnosed with HIV infection” (58).

When HIV-positive mothers are under ART and adherence is good, the risk of HIV

transmission is low. Therefore, it is strongly recommended for them to “breastfeed for at least 12 months and may continue breastfeeding for up to 24 months or longer while being fully supported with ART adherence” (55). As a result, the risk of HIV-transmission through breastmilk is no longer a reason not to breastfeed.

South Africa Today

A country’s child mortality rate is an important indicator of social development and health system availability and quality (63). South Africa is considered to have made no progress in reducing mortality among children under five years old between 1990 and 2008. The mortality rate for this group increased from 56 to 67 deaths per 1000 live births, where about 28% of the deaths were attributable to HIV/AIDS followed by the other common causes like pneumonia, diarrhoea and undernutrition (64). Statistics from SADHS 2016 report an overall under 5 years mortality rate of 42 per 1000 live births, so lately the mortality rate has been decreasing (65).

Breastfeeding practices in South Africa were sub optimal even before the outbreak of the HIV-epidemic (66). Breastfeeding initiation has been high, but EBF has been very low and did not improve much from 1998 (7 % of children under 6 months EBF) to 2003 (8 % of children under 6 months EBF), - a period of 5 years (63, 67). The South Africa Demographic and Health Survey from 2016 shows improvement in EBF rates. The percentage of children under 6 months who are exclusively breastfed has risen to 32 % in 2016 (65). This is an encouraging increase, but in spite of many initiatives during the years, the breastfeeding rates in South Africa are still low (65).

In 2001, the Prevention of Mother-to-Child HIV Transmission (PMTCT) program was launched. New guidelines regarding infant feeding when the mother was HIV-positive, were released from the Department of Health. For HIV-positive women who chose to breastfeed, the guidelines recommended cessation at 4 months of age in line with the WHO recommendations at that time. The provision of free formula milk from public health care facilities to HIV-positive women choosing not to breastfeed was one of the contributors to formula milk as a feeding option still affecting breastfeeding rates as much as they do today (67). Formula milk has been in common use in South Africa for a long time as a part of the “Protein Energy Malnutrition Scheme”(68) to rehabilitate malnourished children, so this policy was not unusual at the time. From 2001 to 2010 no investments were made to promote

breastfeeding, and fears of HIV-transmission through breastmilk partially played a role in this (67). In 2010, South Africa adopted the promotion of exclusive breastfeeding as a National Infant Feeding Strategy and removed free formula milk from the Prevention of Mother-to-Child Transmission program (PMTCT) (69).

In August 2011, South Africa announced, “The Tshwane Declaration for Support of Breastfeeding in South Africa” (70). It was based on the 2010 WHO HIV & Infant feeding Guidelines, recommending HIV-infected mothers to exclusively breastfeed and be adherent to ART. It suggested that only trained, qualified health professionals should provide free formula milk to those with special, medical needs, and public health facilities could no longer issue free formula milk (31). Further, it stated that national regulations on the the International Code of Marketing of Breast Milk Substitutes (ICMBS) should be promoted and set by law within 12 months from the meeting, and one year later, in 2012 ICMBS was implemented by the government in South Africa and regulations on infant and young child foodstuff were in place (31). The Tshwane Declaration led to an increase in EBF rates when we compare numbers from 2003 (8%), with 2016 (32 %).

Before 2011 there was no legislation or enforcement on formula-promotion commercials. In 2012, South Africa also implemented the Framework for Accelerating Community-based Maternal, Neonatal, Child and Woman’s Health and Nutrition Interventions, the main goal being to improve health and nutrition status in mothers and children via community based interventions (71).

South Africa is committed to actively support and promote breastfeeding, but the process has been slow due to insufficient understanding of the benefits of breastfeeding, and strong fear among families of HIV-transmission from mother to child (44). In 2012, Doherty et al. published a study on factors associated with early cessation of breastfeeding. According to this study the strongest predictors for breastfeeding cessation by 12 weeks postpartum were the introduction of other fluids than breastmilk, and that the women had not decided whether to breastfeed or not before having the baby (67). The study concluded that “early cessation of breastfeeding is common amongst both HIV-negative and HIV-positive women in South Africa”.

Social and cultural circumstances can also interfere with infant feeding and may often lead to an early introduction of formula milk (69). Some of these are attitudes towards breastfeeding, mothers’ age and education level, mothers experiencing breastfeeding problems and doubting

their breastfeeding ability (low breastfeeding efficacy) and easily accessible infant formula (67). In addition, lack of support from family members when making critical decisions about early infant feeding, lack of support from employer (if the mother must return to work shortly after giving birth), media and health services can all influence feeding decisions and infant feeding modality (69, 72). There are many studies on the importance of good breastfeeding counselling regarding frequency and duration, and infant morbidity is influenced by the feeding choices the mother makes. Support to mothers, fathers and family members at household level has also shown improved breastfeeding rates (55).

The South African Health System

South Africa has both public and private health systems. Most of the population is served by the public sector, the wealthiest 20 % by the private sector (73). There are 10 teaching hospitals managed by the national Department of Health, and medical training is done exclusively in the public sector. There are in total more than 400 public hospitals, and more than 200 private hospitals, still over 70 percent of the doctors are working in the private sector (74). Further, the health care system is divided into regional subsystems, with a hierarchical model for each district. In each region there are hospitals offering specialist-services, other hospitals offering general health services, and district hospitals or clinics, offering a variety of health services usually given by trained nurses. The district hospitals or clinics are normally not run by qualified doctors, but by a medical officer not always having medical training (75).

The distribution of health professionals between rural and urban areas is disproportional, with fewer working in the rural areas than the urban areas (76). Recruitment of health professionals to the rural areas is difficult, and only approximately 20% of the trained health professionals in South Africa work in these areas where almost 50 % of the population are living (76).

The under 5 years mortality rate in South Africa was 42 per 1000 live births according to the SADHS report 2016 (65). It is estimated that 60% of these deaths could be avoided by already existing treatment options from the health system if coverage and capacity in the most vulnerable communities were in place (77). Available coverage of antenatal and postnatal care (including infant feeding support and PMTCT interventions) is of major importance to reduce the mortality rates for women and children (78).

16,9 % to 37,4% of pregnant women in South Africa are HIV-positive depending on region. Despite medical help being available in clinics and health care facilities, the mother and child

mortality rates are still high (79). Over 50% of all child deaths happen outside the health facilities, often due to late arrival in cases of severe illness. Training the families to recognize symptoms of severe illness is crucial to reduce the mortality rates, and in this field community health workers can play an important part (76).

Health System Delivery of Breastfeeding Counselling

In many countries worldwide, community health workers have a key role in delivering health programs to the population. Community health workers (CHW) are in general chosen by their community to support or give health interventions at household level (80). In many areas the health care coverage is underserved, and CHWs can provide care closer to the families (81). CHWs are linked to the health system, but have shorter training than professional health workers (80). In South Africa, CHWs have a variety of roles in the local community, such as home-based care, adherence to antiretroviral treatment and tuberculosis treatment, and maternal and child health care (82). Support and guidance of new mothers at home in their postnatal period is of great importance to breastfeeding outcome and helps the mother recognize problems in herself or the infant so that she can seek health care in time, thereby reducing maternal and child mortality (83).

According to information from our collaborators, it can be difficult for the mother to receive adequate breastfeeding counselling while in the clinic since it is normal for women in rural areas to leave the clinic three hours after giving birth. The window when the nurses can help the mother with breastfeeding is very narrow and breastfeeding may not be properly established before departure. Further, the uniforms of the nurses come in countless versions, and it is not possible for the mother to identify the education and training of the counselling nurse. In addition, in the hierarchy of the clinic the nurses enjoy great respect and the mothers may feel it is hard to discuss breastfeeding challenges or lack of motivation with the nurses. A CHW can most likely provide more support to the mothers when there are breastfeeding challenges or other issues during the postnatal period.

Rationale for the Proposed Research

Sub optimal infant feeding is still an important issue in South Africa, despite strong recent efforts to promote EBF. Mixed messages regarding breastfeeding have been given due to fear of HIV-transmission, and the South African Demographic Health Survey (SADHS) from 2016 shows that only 32% of the children under 6 months are being exclusively breastfed (65). According to the KIBS study EBF levels in the region of KwaZulu-Natal are higher than the national levels reported by the SADHS, but still they do not reach 50% which is the global target of WHA.

The delivery of health care services has an impact on EBF practices which in turn has consequences for child morbidity and mortality (4). This thesis will investigate the link between health care services and infant feeding practices. Furthermore, to fully understand how the mothers can take advantage of infant feeding advice, this thesis will also provide a comprehensive model on how infant feeding counselling should take place within the existing system.

We will also look into possible differences between health care provided to HIV-positive and HIV-negative women. The first ones are supposed to receive more care due to ART, including more breastfeeding counselling and reassurances that breastfeeding is safe as long as they are adherent to the ART.

To conclude, this thesis will report on the health care services given in KwaZulu-Natal, South Africa, and the impact these services have on various infant feeding practices.

General Objective

Primary Objective

To assess the impact of health care quality on infant feeding modality.

Secondary Objective

To assess the effect of HIV status on health system services and in turn on infant feeding modality.

Method

Study Site: KwaZulu-Natal, South Africa

KwaZulu-Natal is a province in eastern South Africa. Durban is the largest city with 3.5 million inhabitants.



Figure 4: Map of South Africa, Durban is marked with red (84).

In KwaZulu-Natal, there have been several initiatives to promote breastfeeding over the last 20 years, and in 1995 the Mother-Baby Friendly Initiative (MBFI) was implemented. By 2012, 44 out of 56 hospitals in the region were classified as mother and baby friendly (85).

In 2014 a three-year project called The KwaZulu-Natal Initiative for Breastfeeding Support (KIBS) was launched to “provide reliable estimates of breastfeeding at 14 weeks of age in all districts in KwaZulu-Natal, to evaluate whether improvements to EBF rates are being achieved going forward as a result of the broad ranges of interventions being implemented by the KwaZulu-Natal Department of Health and other role players to promote and support breastfeeding” (85).

In 2016, the final baseline report was presented. It showed that at 14 weeks of age, 47,5% of the children were being exclusively breastfed in Kwazulu-Natal (85). This thesis is part of the KIBS project and is based on data from KIBS I, the baseline data collection.

Study Design

KwaZulu-Natal Initiative for Breastfeeding Support (KIBS)

The KwaZulu-Natal Initiative for Breastfeeding Support (KIBS) was a cross sectional study conducted in all 11 districts in the province between May 2014 and March 2015 (85). The intervention included four components: Training and improving skills of health workers to provide support of infant feeding within the health system, establishing Human Milk Banks (one facility in each of the 11 districts in KwaZulu-Natal), a media campaign and a cross sectional survey “to estimate feeding practices at 14 weeks in each district in KwaZulu-Natal at the start and the end of the project” (85).

Ethical Approval

The KIBS study was approved by the Biomedical Research Ethics Committee (BREC), Durban, KwaZulu-Natal, South Africa (Reference number BE064/14). On 4th of January 2018, the Norwegian Regional Ethical Committee confirmed that no additional ethical approval was required since only anonymous data would be transferred.

Study Setting and Participant Inclusion Criteria

The study was conducted in primary health care clinics in all 11 districts of KwaZulu-Natal, and both fixed and mobile clinics were included. All caregivers older than 15 years were encouraged to participate, and this was done as they attended the clinics with infants aged 13- <16 weeks (91-111 days). All participants provided written informed consent.

Randomization and Sample Size

The sample size was calculated to provide district level estimates of EBF rates at 14 weeks for each of the 11 districts in KwaZulu-Natal. Multistage stratified random sampling was used to select health facilities in each district, and nine clinics were randomly selected for inclusion in the study, giving a total of 99 clinics in the sample. All carers of infants aged 13- <16 weeks were qualified to participate. Data collection took place simultaneously in all selected clinics in each district, until the required sample (369 interviews in each district) was obtained for that district, therefore resulting in a self-weighted sample (85).

A total of 4059 interviews were done across the KwaZulu-Natal province of which 3659 interviewees were the child’s biological mother, the remaining other caregivers. Participants

were interviewed by trained personnel in isiZulu (local language) or English, using a standardised questionnaire with structured questions.

Data Cleaning and Management

Data was collected using an android tablet data collection system and uploaded to a centralised server in real time using proprietary software. Data quality checks were done by a quality control team to provide data validity and completeness.

Data cleaning was first conducted using Stata 13 for Windows. The survey settings were applied to the analysis to generate the appropriate 95 % confidence intervals. Second, all scores coded as “missing” were changed to “no”, due to information from the research team that the interviewer often refrained from marking “no”, and only marked “yes” when the interview was conducted.

Statistical Analysis

The analysis for this thesis was done with Stata 14 for Windows (86).

Dependent Variables

Risk association analyses were done on outcomes listed in Table 1. Socio-economic score was the primary exposure factor of interest in the model investigating factors associated with infant feeding outcome.

Table 1: Overview of dependent variables included in the two regression analyses.

Name	Description	Type of variable
Infant feeding modality	Categorized in three referring to breastfeeding situation at the time of the interview: Never breastfed: The mother has never put the baby to the chest. Breastfeeding cessation: Breastfeeding has stopped by the time of the interview and the child receives supplementary foods and/or formula. Still breastfeeding: The child receives breastmilk, represented as “any breastfeeding”.	Categorical variable
Health care score	Constructed from scales formed from total points received in health care. Categorized by tertiles as poor, medium and good	Ordinal variable

Construction of a Health Care Score

To map how infant feeding counselling is provided we created a “gold standard” model of health care that the mother should receive during pregnancy, delivery and post pregnancy. Only data from the mothers (n=3659) were included in this construct. The model comprises variables describing services targeting promotion and protection of breastfeeding that the mother should have received, or which should have been practiced during her contact with health care facilities according to the given recommendations at the time of the survey. Thus, the model is a ‘construct’, based on current recommendations and optimal public health delivery services. The model is not validated against any other norms, and to our knowledge, no such normed construct for protection of breastfeeding within the health system existed when this study was designed. However, our scale will be discussed against other health system scoring indicators.

Characteristics used to create the health care score are presented separately below. The score differed according to HIV status because a positive HIV status would require more services than a negative HIV one.

The variables were weighted through value scores depending on whether they were promoting breastfeeding outcomes (value plus 1) or contributing negatively to breastfeeding outcomes (value minus 1). Two of the variables were given two more points than the others since we know they are more decisive for breastfeeding outcome than the rest. These were skin to skin contact immediately after birth and breastfeeding initiation within an hour after birth. In total, the scores for a HIV-infected woman could range from -1 (lowest value) up till 14 points if she received full health care. The corresponding values for HIV-negative women were -1 to 13.

A health care score variable was constructed in two steps, first by creating two separate health care score variables, one for HIV-positive and one for HIV-negative mothers. Then the respective health care score variables were divided into tertiles. Finally, a new variable was generated providing a tertile score for all women where those in the lowest tertile got least health care and those in the highest tertile got most health care. The distribution within the tertiles is listed in Table 2, see Appendix 1.

Table 3 lists the variables included in the health care score. Appendix 2 provides descriptive statistics on primary, facility and community health care with subsequent scores among women infected and uninfected with HIV.

Table 3: Overview of variables included in the health care score, all categorical variables with yes/no answer options

Health Care Score Variables	All categorical variables presented by yes/no
Feeding advice in clinic	Mother receives feeding advice after birth
HIV-tested during pregnancy	Part of the PMTCT ² programme
Currently on ART ³	Adherence to ART ³
Skin-to-skin after delivery	Baby put to mother's chest after delivery
Breastfeeding within one hour	Breastfeeding initiation within one hour
Breastfeeding initiation help	Support and guidance in the breastfeeding situation
Feeding advice after birth	Counselling by a health care worker before departure
Never initiated breastfeeding	Never put the baby to the chest
Prelactal feeding	The infant was given something else before breastfeeding initiation. Exceptions include oral rehydration solutions, drops or syrups of vitamins, minerals or medicines.
CHW ¹ home visit after birth	Visit after mother and child have arrived from hospital
CHW ¹ home visit more than once	Follow-up
CHW ¹ feeding advice after birth	Given in home surroundings after breast feeding initiation
CHW ¹ home visit during pregnancy	Supposed to take place four times during pregnancy (87)
CHW ¹ feeding advice during pregnancy	Given at the same time as the home visit

¹CHW: Community health worker

²PMTCT: Prevention of Mother to Child Transmission

³ART: Anti retro viral therapy

Independent Variables

The independent variables are factors which may interact or confound the relationship of investigation. A brief explanation of the independent variables used in the analysis appears from table 4.

Table 4: Overview of independent variables included in the bivariable regression-analyses.

Name	Description	Type of variable
HIV status	Mothers' self-reported HIV status.	Categorical variable
Mothers' age	Mothers' self-reported age in years.	Ordinal variable
Education	Categories are primary school or less, completed grades 8 to 11, and completed grade 12 or higher.	Ordinal variable
Number of children	Stratified on one child or more than one child.	Categorical variable
Household information	Describes the living situation for the participating mothers.	Categorical variable
Household geographic area	Living in rural or urban areas.	Categorical variable
Water source	Describes access to water, either private or public. This will largely depend on where the participants live, similar for toilet type and electricity.	Categorical variable
Type of toilet	Divided in flush toilet or other, other being pit latrine, bucket or bush/veld/no toilet.	Categorical variable
Electricity	Divided into having or not having electricity	Categorical variable
Returned to school	Mothers have returned to school.	Categorical variable
Work	Mothers work-situation categorised in three: Has no paid work, has paid work but has not returned and has returned to work	Categorical variable
Child support grant	Mothers who apply for this receive it from the government, and it amounts to 350 Rand which is approximately 26.2\$.	Categorical variable
Maternity grant	Mothers who receive grants from employer while on maternity leave.	Categorical variable
Disability grant	People who have health issues making them unfit for work for a period longer than 6 months can apply for this. The maximum amount a person can receive is 1700 rand, which is approximately 127.6\$. (This variable is included in the descriptive statistics but not in the regression due to only one person receiving this grant).	Categorical variable
Money from partner	The mother is financially supported by her partner.	Categorical variable
Money from family	The mother is financially supported by her family	Categorical variable

Socioeconomic score	Constructed from scales based on assets using principal components analysis. Categorized by tertiles as poor, medium poor and least poor.	Ordinal variable
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Construction of a Socioeconomic Status Variable

A Principal Component Analysis (PCA) was used to find the socio-economic score (SES) of the mothers included in the study. A PCA converts the correlations between the variables into a 2D-graph. Variables that are highly correlated cluster together. Variables with the largest variation between cells will be more influential on the principal components (PC). Having a phone was an example of an asset that was considered to be an asset for det least poor, but removed from the final model, as it did not add any value to that model. A phone was owned by the majority and had no value as an indicator for SES.

The 1st principal component accounts for most of the variation in the data. The PCA was run several times to decide which variables had impact on the socio-economic score and which did not. It turned out that most of the variation was accounted for in PC1. Then the PCA result-score was divided into quintiles, and the groups 1&2 and 3&4 were merged, based on the assumption that the distribution in these groups would be even, and that the minority with the highest socioeconomic score (group 5) would be in the last group. In this way the variable for socioeconomic score was constructed.

The distribution within the tertiles are listed in Table 5, Appendix 3.

The variables included in the PCA are the following: Paid work for the last 12 months, money-source (child support grant, maternity grant, disability grant, from partner, from family), water-source, material in house walls/floors/roof, electricity, toilet, fridge, stove, computer/iPad, TV, satellite dish, cattle.

Descriptive Statistics

The descriptive statistics consist of a baseline table showing the general characteristics and distribution of the population. Also, we evaluated the distribution of infant feeding modality-stratified for health care score. Further, two separate tables were stratified on HIV status to capture characteristics important for breastfeeding in the two groups.

The results are listed, described and followed by figures that show the distribution in: health care scores for HIV-positive women by infant feeding modality (Figure 5 A) and health care scores for HIV-negative women by infant feeding modality (Figure 5 B), total healthcare score for all participants (Figure 6 A), health care scores by infant feeding modality (Figure 6 B). These are described consecutively. Categorical data are presented with percentages, while continuous data are presented with relative risk ratios (RRR) and confidence intervals.

Relative risk is the ratio between the probability of an event in two groups. The relative risk is calculated by:

$$RR = \frac{\text{Risk of an event in group X} = a/(a + b)}{\text{Risk of an event in group Y} = c/(c+d)}$$

Multinomial Logistic Regression

Risk factor assessment for detection of potential association between a factor and the outcome was done for two outcome variables as mentioned, the health care score and the infant feeding practice.

The first regression analysis assesses factors associated with poor, medium and high health care. We wanted to examine how health care services impact infant feeding outcome.

In the first step of the multinomial analysis we examined each of the variables individually to see if any of them turned out significant. In the second step we included all significant variables from step one, to identify risk factors that strongly indicate effect on the reception of different health care categories.

The second regression analysis assesses factors determining infant feeding practice: never breastfeeding, breastfeeding cessation and still breastfeeding. In this analysis we wanted to identify risk factors associated with infant feeding outcome. In the first step of the multinomial analysis model we addressed each of the variables individually to see if any of them turned out significant. In the second step of the analysis we included all significant

variables from step one, in order to find which risk factors indicate effect, and rate of impact on infant feeding outcome.

Multinomial logistic regression (MLR) is used when the dependent variable (the outcome variable or risk factor dependent variable) has more than two categories (88). Each of the variables addresses the risk of outcome in each category, compared to a chosen base or reference category (88).

MLR techniques have many advantages (89): MLR is considered a more “robust method for assuming multivariate normality across groups; it is easier to interpret diagnostic statistics with MLR than linear regression; there is no assumption of linear relationship between the dependent and independent variables and the independent variables need not to be interval”.

Multinomial logistic regression was used due to dependent outcome variables with more than two outcomes. In the first regression analysis the outcomes were “poor”, “medium” and “good” healthcare, and in the second “never breastfed”, “no longer breastfeeding” and “still breastfeeding”. For all independent variables in each category of the dependent variables, (here being breastfeeding outcome), odds ratios are determined. The reference category is omitted from the tables and is equal to 1, reference value is not shown.

In the first part of each regression analysis, each of the variables were treated as individual outcome variables (“Crude”). In the second part of the regression analysis all the significant factors from the first part of the analysis were included to provide information of how the factors adjust to each other when all of them are included in the same analysis. Criteria for the adjusted analysis were significance level < 10 percent.

Declaration

I, the author of the thesis, developed the study design of this thesis including the protocol containing the design of the health care score and the data analysis plan. I also did the data analysis including the construction of the SES composite variables using the principle component analysis and the modelling. The survey data had been collected, and the data were fully managed upon my introduction to the research team. I travelled to South Africa, learnt about the health system, the KIBS project and the infant feeding situation in KwaZulu-Natal before designing the analysis. Throughout the entire process from study design till dissemination I have been collaborating closely with the wider KIBS research group including the KIBS Principle Investigator (CH).

Results

The results are presented as quantitative data in tables and figures. An overview of the tables and their contents is presented in Table 6.

Table 6: Explanation of the tables

Table number	Title	Contents	n (number)
7	Baseline table	Includes all mothers	n total = 3659
8	Distribution of breastfeeding initiation and prelactal feeds	Includes all mothers	n total = 3659
9	Distribution of reasons for never initiating breastfeeding	Includes mothers who never initiated breastfeeding	n total = 346
10	Distribution of reasons for breastfeeding cessation	Includes mothers who have stopped breastfeeding	n total = 588
11	Distribution of breastfeeding duration for stopped breastfeeding	Includes mothers who have stopped breastfeeding	n total = 608
12	Distribution of health care scores by HIV and feeding modality	Variables given scores due to impact on infant feeding modality	n total = 3659
13	Regression analysis No. 1 – factors related to health care scores	Includes all mothers	n total = 3659
14	Regression analysis No. 2 – factors associated with infant feeding outcome	Includes all mothers	n total = 3659

Baseline table: Characteristics by infant feeding status and HIV status

A total of 3569 mothers in a total of 99 clinics were interviewed at the 14 weeks check-up of the infant (aged between 13-15 weeks).

All the baseline characteristics were stratified according to both HIV status (Table 7) and infant feeding outcomes (Appendix 4), classified as “never initiated breastfeeding”, “breastfeeding cessation”, or “still breastfeeding”.

Disregarding HIV status, almost 50 percent of the mothers with poor socioeconomic score were still breastfeeding. Further, the largest share of least poor mothers had never initiated breastfeeding, and the least poor mothers also constituted the smallest group still breastfeeding with approximately 15 percent, also disregarding HIV status.

Almost 50 % of the HIV-positive women in the “never initiated breastfeeding” group and “breastfeeding cessation” group were in the older age group, over 30 years old. Most young mothers were HIV-negative and in the “breastfeeding cessation” or “still breastfeeding” groups.

More of the HIV-positive mothers received child support grant across infant feeding groups, compared to HIV-negative mothers, and more of the women live in urban areas than rural areas, disregarding HIV status.

For mothers living with electricity, the main distribution was found among those who never initiated breastfeeding and had stopped breastfeeding, disregarding HIV status. For the mothers living without electricity, the main distribution was in the “still breastfeeding group”, disregarding HIV status.

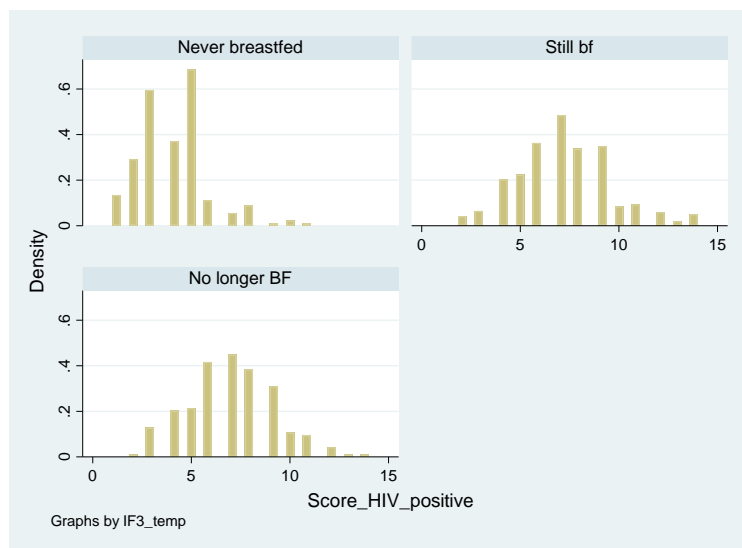
Table 7: Baseline table, characteristics by infant feeding status and HIV status

Categorical Variable	Items	Stratified by HIV status				Total	
		HIV pos		HIV neg			
		N	%	N	%	N	%
Socio-economic status	Poor	537	42.2	934	39.2	1471	40.2
	Middle	525	41.2	982	41.2	1507	41.2
	Least poor	212	16.6	469	19.7	681	18.6
Mothers' age	< 20 years	92	7.2	610	25.6	702	19.2
	20-24 years	331	26.0	860	36.1	1191	32.6
	25-29 years	367	28.8	491	20.6	858	23.5
	>30 years	484	38.0	424	17.8	908	24.8
Parity-	Primipara	348	27.3	1300	54.5	1648	45.0
	Multipara	926	72.7	1085	45.5	2011	55.0
Education	Primary school or less	167	13.1	1717	7.2	338	9.2
	Completed Grades 8 to 11	676	53.1	1208	50.7	1884	51.5
	Complete Grade 12 or higher	431	33.8	1006	42.2	1437	39.3
Returned to school	No	1244	97.6	2169	91.0	3413	93.3
	Yes	30	2.4	216	9.1	246	6.7
Work	No work	866	68.0	1913	80.2	2779	76.0
	Has work, not returned	262	20.6	322	13.5	584	16.0
	Has returned to work	146	11.5	150	6.3	296	8.1
Child support grant	No	298	23.4	916	38.4	1214	33.2
	Yes	976	76.6	1469	61.6	2445	66.8
Maternity grant	No	1222	95.9	2300	96.4	3522	96.3
	Yes	52	4.1	85	3.6	137	3.7
Disability grant	No	1266	99.4	2371	99.4	3637	99.4
	Yes	8	0.6	14	0.6	22	0.6
Money from partner	No	437	34.3	738	32.1	1203	32.9
	Yes	837	65.7	1619	67.9	2456	67.1
Money from family	No	973	76.4	1490	62.5	2463	67.3
	Yes	301	23.6	895	37.5	1196	32.7
Household geographic area	Rural	845	66.3	1653	69.3	2498	68.3
	Urban	429	33.7	732	30.7	1161	31.7
Electricity	No	466	36.6	919	38.5	1385	37.8
	Yes	808	63.4	1466	61.5	2274	62.2
Water Source	Piped in house/yard	687	53.9	1336	56.0	2023	55.3
	Public/other	587	46.1	1049	44.0	1636	44.7
Toilet	Other	991	77.8	1795	75.3	2786	76.1
	Flush toilet	283	22.2	590	24.7	873	23.9

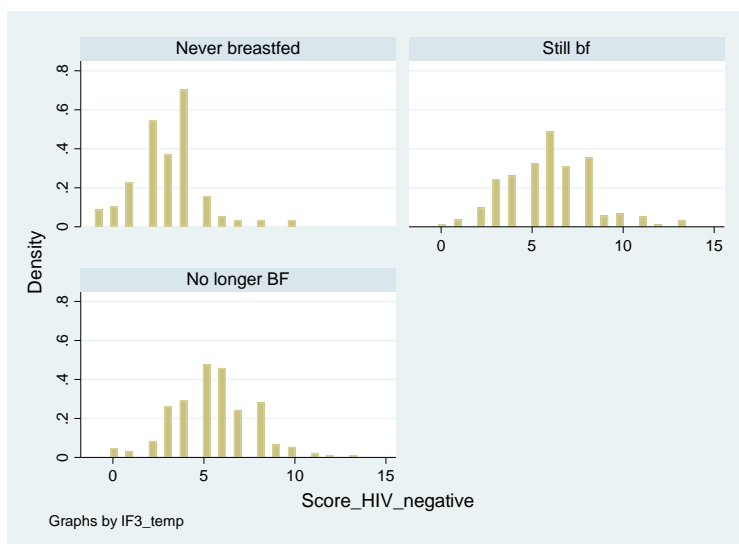
Infant feeding

Infant Feeding and HIV Status

Figure 5 A) and 5 B) show distribution of infant feeding outcome for HIV-positive and HIV-negative mothers respectively. In both figures, the main population in the “never initiated breastfeeding” group the main population accumulates in the lower parts of the health care scores. The groups “still breastfeeding” and “no longer breastfeeding” have a normal distribution pattern (test of normality not done).



A)



B)

Figure 5 A)-B): Displaying distribution of health care scores for A) stratified by infant feeding status among HIV-positive women and B) stratified by infant feeding status among HIV-negative women.

A comparison between the data on health care scores and infant feeding modality shows a very similar distribution between the HIV-positive and HIV-negative mothers.

Prelactal feeds

Distribution of breastfeeding initiation and prelactal feeds

A total of 474 mothers reported no breastfeeding initiation after birth, and 396 of these reported prelactal feed. Almost half of the prelactal feeds were reported to be water, and 25 % reported giving formula milk. 17 % reported breastmilk as prelactal feed, then by cup, syringe or bottle. When prelactal feed was breastmilk, it was not specified if it was the mother's colostrum/milk or from a donor.

Table 8: Distribution of breastfeeding initiation and prelactal feeds

Variable	Items	Frequency	Percent
Was he/she breastfed after birth?	No	474	12.99
	Yes	3274	87.01
After he/she was born, was there given any other foods or fluids despite breastmilk?	No	2759	87.53
	Yes	396	12.47
First fluid given to child after birth	Water	194	46.19
	Formula milk	105	25.00
	Breastmilk	73	17.38
	Other	19	4.52
	Someone else gave first feed	5	1.19
	No response	24	5.72

Never Initiated Breastfeeding

Distribution of reasons for never initiated breastfeeding

A total of 346 mothers never started breastfeeding after birth. Table 9 shows the distribution of frequencies for the different reasons reported. Four of them stand out and these are:

Perception of mother not having enough milk, mother had to go back to work, positive HIV status and mother was sick at the time.

Table 9: Distribution of reasons for never having initiated breastfeeding

	Why did you decide not to breastfeed?		
	Answer options	Frequency	Percentage
1	I do not like breastfeeding	22	6.36
2	I was too busy	22	6.36
3	I had to go back to work	66	19.08
4	I was sick	45	13.01
5	I did not have enough milk	76	21.97
6	Baby was crying all the time	10	2.89
7	My mother/partner/family member advised me to not breastfeed	4	1.16
8	A health worker advised me not to breastfeed	8	2.31
9	Because of my HIV status	49	14.16
10	Other/no response	44	12.72
	Total	346	100.00

Breastfeeding Cessation

Distribution of reasons for breastfeeding cessation

A total of 608 mothers had stopped breastfeeding by 14 weeks after birth. The questionnaire allowed more than one answer, so a total of 758 answers were collected among the 608 mothers. Table 10 shows the distribution of reasons given by the mothers. Three of them stand out: Perception of mother not having enough milk, mother had to go back to work and baby was crying all the time.

Table 10: Distribution of reasons for breastfeeding cessation

	Why did you decide to stop breastfeeding (name)?		
	Answer options	Frequency	Percentage
1	I do not like breastfeeding	15	1.98
2	I was too busy	51	6.73
3	I had to go back to work	121	15.96
4	I was sick	61	8.05
5	I did not have enough milk	168	22.16
6	Baby was crying all the time	91	12.00
7	Breastfeeding was painful	53	6.99
8	My baby was not gaining weight	14	1.85
9	My mother/partner/family member advised me to stop breastfeeding	16	2.11
10	A health worker advised me not to breastfeed	17	2.24
11	Because of my HIV status	34	4.49
12	Other/no response	117	15.43
	Total	758	100.00

Breastfeeding duration among the mothers who stopped breastfeeding

The table shows distribution of breastfeeding duration in week intervals and the respective frequencies and percentages. The main part of the group (69 percent) stop breastfeeding during the first four weeks after birth. After this a share of 13 percent stop breastfeeding between seven to eight weeks after birth.

Table 11: Distribution of breastfeeding duration among the mothers stopped breastfeeding

For how long did you breastfeed him/her?	Frequency	Percentage
Less than one week	113	18.6
One to two weeks	133	21.8
Three to four weeks	176	28.9
Five to six weeks	38	6.2
Seven to eight weeks	78	12.8
Nine to ten weeks	19	3.1
Eleven to twelve weeks	32	5.5
Thirteen to fourteen weeks	19	3.1
Total	608	100.0

Health Care Score and Feeding Modality

Distribution of health care scores by HIV status and feeding modality.

HIV-positive: Of the HIV-positive mothers with poor health care scores, 44 percent were still breastfeeding when the baby was 14 weeks old, and 43 percent had never initiated breastfeeding. In the medium group, 75 percent were still breastfeeding 14 weeks after the birth, and only 4 percent had never initiated breastfeeding. In the group with good health care scores 80 percent were still breastfeeding, and only 1 percent had never initiated breastfeeding. For the HIV-positive women having stopped breastfeeding, there was a smaller difference between the scores: poor health care score by 12 percent, medium health care score by 21 percent and good health care score by 19 percent.

HIV-negative: Of the HIV-negative mothers with a poor health care score, 71 percent still breastfeed, and 11 percent have never initiated breastfeeding. For the women who have scored a medium or good health care score 84 and 85 percent respectively still breastfeed after 14 weeks. In the HIV-negative group with a poor health care score, 11 percent have never initiated breastfeeding. In the medium and good health care score groups the corresponding score is only 1 percent in both groups.

When comparing the groups by HIV status, for the mothers receiving poor health care score the “still breastfeeding” rate were over 25 percent higher for HIV-negative compared to HIV-positive mothers. The rate of “never initiated breastfeeding” were 32 percent higher for HIV-positive mothers with poor HCS, compared to HIV-negative mothers with poor health care score. When including medium and good health care scores the rate of never initiated breastfeeding went from 1 percent to 4 percent. The HIV-positive women receiving poor health care score therefore has minimum almost 40 percent higher chance to never initiate breastfeeding compared to the mothers receiving medium or poor health care scores, regardless of HIV status.

Table 12: Distribution of health care scores by HIV status and feeding modality.

	Poor				Medium				High				Total	
	HIV-negative		HIV-positive		HIV-negative		HIV-positive		HIV-negative		HIV-positive		n	%
	N	%	N	%	n	%	n	%	n	%	n	%		
Never	125	11.4	185	43.4	5	0.7	23	4.1	4	0.75	4	1.38	346	9.46
Stopped	196	17.8	52	12.2	115	15.3	117	21.0	74	13.8	54	18.6	608	16.6
Still	778	70.8	189	44.4	631	84.0	418	74.9	457	85.4	232	80.0	2705	73.9
Total	1099		426		751		558		535		290		3659	100

Infant Feeding and Health Care Scores

Figure 6 A) displays the distribution of health care scores for the whole population. The majority is concentrated between scores from 3 to 8, which is equivalent to low to medium health care.

Figure 6 B) displays the distribution of health care scores stratified by infant feeding. The “never initiated breastfeeding” group accumulates in the lower range of the health care score. For the groups “breastfeeding cessation” and “still breastfeeding” the scores are normally distributed.

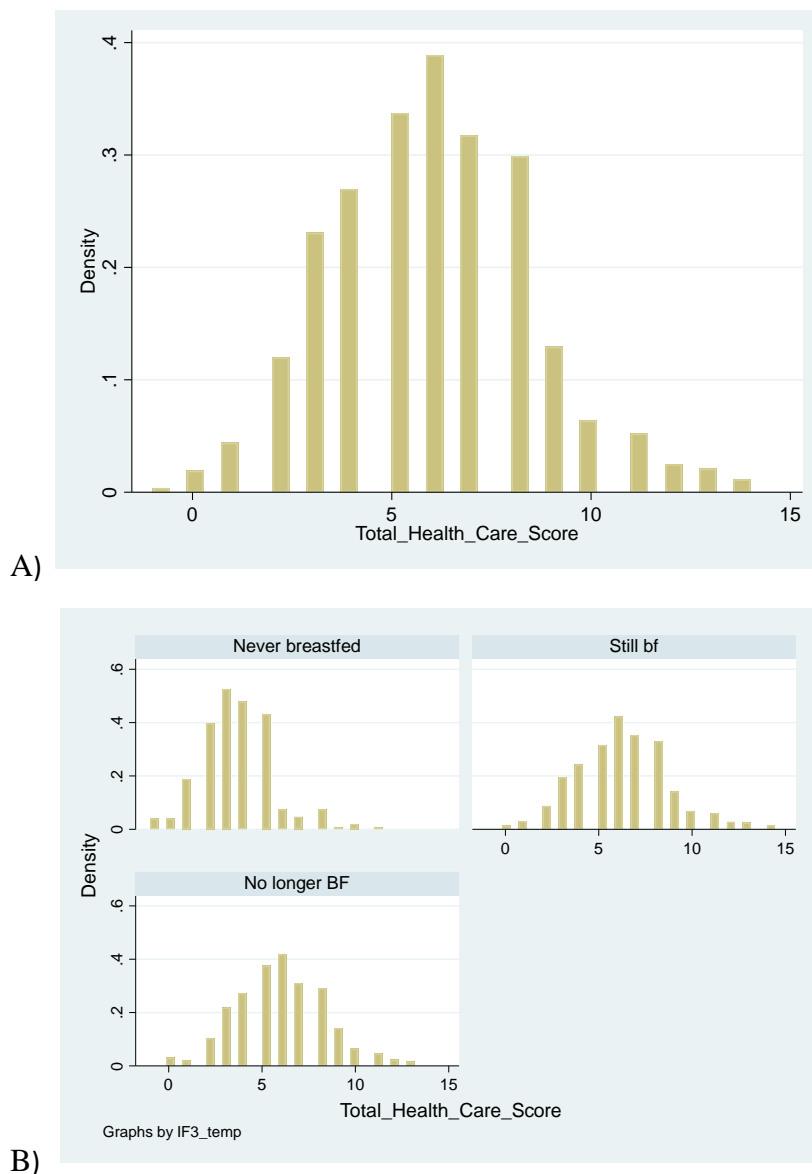


Figure 6 A)-B): Displaying distribution of health care scores for A) the whole research population, B) health care scores stratified by infant feeding status

Regression Analysis No. 1 – Factors Related to Health Care Scores

In the first step of this regression analysis, all the variables were treated separately to find the effect on the health care score. The following variables in the bivariable analysis were significant, labelled “Crude” in Table 13: Positive HIV status, poor and middle socioeconomic score, mother returned to work, no money from partner or family, no child support grant, no maternity grant, rural geographic living area, no electricity and other lavatory facilities than flush toilet.

The second analytical stage included significant variables from the bivariable analysis were included in a multi-variable analysis. That determined the rate of reciprocal impact to all factors in the multinomial model.

The variables associated to poor health care score were: The factors mother returned to work (1.05 (1.04-2.15)) and positive HIV status (1.48 (1.22-1.79)) were statistically significantly linked to more effect on poor health care score in the regression analysis.

Furthermore, the following factors were significantly associated with lower impact on poor health care score and seem protective on good health care score: Not receiving money from partner (0.79 (0.66-0.96)), not receiving money from family (0.76 (0.59-0.86)), not receiving child support grant (0.69 (0.57-0.84)) and living in rural areas (0.50 (0.40-0.61)).

Variables related to medium health care score: Lavatory facilities other than flush toilet (3.33 (2.04-5.43)) were significantly associated with more impact on medium health care score. Not receiving money from family (0.82 (0.67-0.99)), positive HIV status (0.74 (0.61-0.89)) and living in rural areas (0.64 (0.52-0.80)) were significantly associated with lower impact on medium health care score and seem protective on good health care score.

Table 13: Regression analysis No. 1 – factors associated with health care scores

Variable		Poor				Medium				High
		Crude (RRR)	95%CI	Adjusted	95%CI	Crude (RRR)	95%CI	Adjusted	95%CI	Ref
HIV status	Negative	1	1	1	1	1	1	1	1	
	Positive	1.40	1.16-1.68	1.48	1.22-1.79	0.73	0.61-0.87	0.74	0.61-0.89	
Mothers' age	>30 years	1	1			1	1			
	25-29 years	0.90	0.71-1.16			1.0	0.77-1.27			
	20-24 years	0.87	0.70-1.1			0.93	0.74-1.18			
	< 20 years	0.84	0.65-1.08			0.79	0.60-1.03			
Parity	Multipara	1	1			1	1			
	Primipara	0.99	0.83-1.17			1.05	0.88-1.25			
Socioeconomic status	Least poor	1	1	1	1	1	1	1	1	
	Middle	0.77	0.61-0.99	0.94	0.71-1.23	1.07	0.83-1.39	1.10	0.83-1.47	
	Poor	0.58	0.46-0.74	0.79	0.56-1.11	0.87	0.67-1.12	0.98	0.69-1.39	
Education	≥ 12	1	1			1	1			
	8 - 11	0.99	0.82-1.18			1.08	0.89-1.29			
	Primary ≥	0.96	0.70-1.31			1.22	0.89-1.68			
Returned to school	No	1	1			1	1			
	Yes	0.90	0.64-1.26			1.11	0.78-1.59			
Work	No work	1	1	1	1	1	1	1	1	
	Not returned	1.26	1.0-1.59	1.06	0.82-1.36	0.99	0.77-1.26	0.85	0.65-1.10	
	Has returned	1.95	1.39-2.74	1.50	1.04-2.15	1.28	0.89-1.84	1.03	0.70-1.50	
Money from partner	Yes	1	1	1	1	1	1	1	1	
	No	0.83	0.69-0.99	0.79	0.66-0.96	0.88	0.73-1.06	0.87	0.72-1.06	
Money from family	Yes	1	1	1	1	1	1	1	1	
	No	0.76	0.64-0.91	0.71	0.59-0.86	0.82	0.68-0.98	0.82	0.67-0.99	
Child support grant	Yes	1	1	1	1	1	1	1	1	
	No	0.63	0.53-0.76	0.69	0.57-0.84	0.86	0.71-1.05	0.81	0.67-1.0	
Maternity grant	Yes	1	1	1	1	1	1	1	1	
	No	2.17	1.32-3.57	1.41	0.82-2.40	1.24	0.72-2.13	1.11	0.63-1.98	
House geo. area	Urban	1	1	1	1	1	1	1	1	
	Rural	0.44	0.36-.054	0.50	0.40-0.61	0.61	0.50-0.75	0.64	0.52-0.80	

Electricity	Yes	1	1	1	1	1	1	1	1	
	No	1.42	1.19-1.69	1.01	0.80-1.29	1.31	1.09-1.56	1.16	0.91-1.47	
Water Source	In house/yard	1	1			1	1			
	Public/other	1.16	0.98-1.38			1.00	0.84-1.19			
Toilet	Flush toilet	1	1	1	1	1	1	1	1	
	Other	1.52	1.24-1.86	0.98	0.76-1.27	1.08	0.87-1.34	3.33	2.04-5.43	

Bold means statistically significant at p-value <0.10.

Regression Analysis No. 2 – Factors Associated with Infant Feeding Outcome

All the variables were analysed separately in a bivariable regression model to see association on infant feeding outcome. The following variables came out as significant to breastfeeding outcomes “never initiated breastfeeding” and “breastfeeding cessation”, labelled “Crude” in Table 14:

Poor health care score, positive HIV status, mothers’ age < 20 to 29 (divided in groups), more than one child, poor and middle socioeconomic score, education level 8-11 grade, return to school, mother not returned and returned to work, no money from partner or family, no child support grant, no maternity grant, rural geographic living area, no electricity, public water source and other lavatory facilities than flush toilet.

The second analytical step was a multi-variable model included significant variables from the bi-variable analysis to determine the rate of reciprocal impact on all factors in the multinomial model.

Variables related to “Never initiated breastfeeding”:

Poor health care score is significant with very high impact on never having initiated breastfeeding (23.66 (13.86-40.39)). Return to work had a strong significant effect on never initiated breastfeeding (3.60 (2.37-5.46)) and the same for mothers’ receiving no child support grant (1.38 (1.02-1.87)).

Also significant, and associated with less effect on “never initiated breastfeeding”, thereby protective for “still breastfeeding” are the following: Parity (0.65 (0.46-0.92)), middle socioeconomic status (0.61 (0.42-0.87)), education level 8-11 grade (0.61 (0.45-0.84)), mothers age 20-24 years (0.57 (0.39-0.85)), poor socioeconomic status (0.51 (0.31-0.84)), mothers’ age less than 20 years (0.38 (0.20-0.69)), primary or less education level (0.36 (0.20-0.66)), mother returned to school (0.17 (0.10-0.31)) and positive HIV status (0.15 (0.11-0.20)).

Variables related to “Breastfeeding cessation”:

Returned to work (4.0 (2.93-5.47)) had a strong significant effect on “breastfeeding cessation”. Poor health care score (1.31 (1.03-1.67)) was also significantly associated with “breastfeeding cessation”.

The following variables were significantly associated with less effect on “breastfeeding cessation”, and thereby protective for “still breastfeeding”: Education level 8-11 grade (0.69 (0.55-0.87)), more than one child (0.66 (0.51-0.84)), positive HIV status (0.66 (0.53-0.81)),

mothers age 20-24 years (0.65 (0.49-0.87)), poor socioeconomic status (0.60 (0.41-0.86)), “primary \geq ” education level (0.58 (0.39-0.88), mothers age < 20 years (0.54 (0.36-0.80) and mother returned to school (0.26 (0.18-0.38)).

According to the analysis poor health care score has a strong negative impact on “never initiating breastfeeding”. So have mother return to work and mother receiving no child support grant. Mother returned to work was the strongest predictor for “breastfeeding cessation”, and poor health care score also is strongly related to “breastfeeding cessation”.

Table 14: Regression analysis No. 2 – factors associated with infant feeding outcome

Variable		Never initiated breastfeeding				Breastfeeding cessation				Still breastfeeding
		Crude (RRR)	95%CI	Adjusted	95%CI	Crude (RRR)	95%CI	Adjusted	95%CI	Ref
Health care scores	Good	1	1	1	1	1	1	1	1	
	Medium	0.97	0.49-1.91	1.06	0.53-2.11	1.08	0.85-1.36	1.06	0.83-1.36	
	Poor	14.7	8.82-24.51	23.66	13.86-40.39	1.32	1.06-1.64	1.31	1.03-1.67	
HIV status	Negative	1	1	1	1	1	1	1	1	
	Positive	0.28	0.23-0.36	0.15	0.11-0.20	0.78	0.64-0.93	0.66	0.53-0.81	
Mothers age	>30 years	1	1	1	1	1	1	1	1	
	25-29 years	0.72	0.54-0.96	0.79	0.56-1.11	0.86	0.67-1.10	0.80	0.61-1.05	
	20-24 years	0.45	0.34-0.60	0.57	0.39-0.85	0.74	0.58-0.93	0.65	0.49-0.87	
	< 20 years	0.28	0.19-0.42	0.38	0.20-0.69	0.76	0.58-0.99	0.54	0.36-0.80	
Parity	Multipara	1	1	1	1	1	1	1	1	
	Primipara	1.34	1.07-1.69	0.65	0.46-0.92	0.85	0.72-1.02	0.66	0.51-0.84	
Socioeconomic status	Least poor	1	1	1	1	1	1	1	1	
	Middle	0.46	0.35-0.60	0.61	0.42-0.87	0.66	0.53-0.83	0.82	0.62-1.06	
	Poor	0.29	0.21-0.38	0.51	0.31-0.84	0.36	0.28-0.46	0.60	0.41-0.86	
Education	≥ 12	1	1	1	1	1	1	1	1	
	8 - 11	0.61	0.48-0.77	0.61	0.45-0.84	0.66	0.55-0.79	0.69	0.55-0.87	
	Primary ≥	0.38	0.23-0.63	0.36	0.20-0.66	0.46	0.32-0.66	0.58	0.39-0.88	
Returned to school	No	1	1	1	1	1	1	1	1	
	Yes	0.65	0.43-0.99	0.17	0.10-0.31	0.43	0.32-0.59	0.26	0.18-0.38	
Work	No work	1	1	1	1	1	1	1	1	
	Not returned	2.32	1.76-3.07	1.40	0.98-1.99	1.37	1.08-1.75	1.23	0.94-1.61	
	Returned	6.24	4.48-8.69	3.60	2.37-5.46	4.73	3.57-6.27	4.0	2.93-5.47	
Money from partner	Yes	1	1	1	1	1	1	1	1	
	No	1.27	1.0-1.62	1.35	1.00-1.80	1.0	0.83-1.20	0.92	0.75-1.12	
Money from family	Yes	1	1	1	1	1	1	1	1	
	No	0.56	0.43-0.72	0.76	0.55-1.05	1.04	0.86-1.25	1.12	0.91-1.38	
Child support grant	Yes	1	1	1	1	1	1	1	1	
	No	0.92	0.72-1.16	1.38	1.02-1.87	0.80	0.67-0.96	1.03	0.84-1.27	

Maternity grant	Yes	1	1	1	1	1	1	1	1	
	No	3.57	2.29-5.57	1.59	0.91-2.80	2.44	1.62-3.67	1.26	0.80-2.00	
Household geographic area	Urban	1	1	1	1	1	1	1	1	
	Rural	0.56	0.45-0.71	1.01	0.75-1.35	0.64	0.53-0.77	0.83	0.68-1.03	
Electricity	Yes	1	1	1	1	1	1	1	1	
	No	2.23	1.72-2.88	1.38	0.94-2.03	1.98	1.63-2.41	1.27	0.97-1.66	
Water source	In house/yard	1	1	1	1	1	1	1	1	
	Public/other	1.52	1.21-1.92	0.91	0.66-1.26	1.59	1.32-1.90	1.03	0.83-1.29	
Toilet	Flush toilet	1	1	1	1	1	1	1	1	
	Other	1.95	1.54-2.49	0.97	0.67-1.40	1.59	1.31-1.94	0.86	0.66-1.11	

Bold means statistically significant at p-value <0.10.

Discussion

In South Africa, breastfeeding promotion and protection have been challenging. Due to the HIV-epidemic the general breastfeeding recommendations have been rapidly adjusted during a short period of time. The general objective of this thesis is to investigate how the quality of care affects infant feeding modality. We also look into the impact of HIV status on health system services and the subsequent effect on infant feeding modality.

Main Findings

Our analysis showed that health care score has a considerable effect on infant feeding outcome. Interfering factors such as mother returning to work shortly after giving birth, HIV status and child support grant also turned out to affect health care and infant feeding outcome. Our results strongly support existing research on the association between infant feeding modalities and associated factors.

Baseline Characteristics

Socioeconomic Score

Almost 50 percent of the mothers with poor socioeconomic score were still breastfeeding, disregarding HIV status. This may be caused by lack of work, lack of financial support, i.e. child support grant or money-support from partner or family. Formula milk is expensive and challenging to administer because of practical demands when it comes to sanitation and electricity.

The largest share of the least poor HIV-positive mothers had never initiated breastfeeding, and the smallest share of least poor HIV-positive mothers (with only 13 percent) were still breastfeeding. The least poor HIV-negative mothers in the still breastfeeding group had almost the same distribution (16 percent).

It is possible to assume that the least poor mothers who had never initiated breastfeeding or had stopped breastfeeding, would have financial opportunities not to breastfeed (90). Both the least poor and middle poor mothers may have had to go back to work within a short time after giving birth, and/or have a work-situation making breastfeeding challenging to maintain. They may therefore have decided that formula was their best option (90).

Electricity

The largest proportion of mothers living without electricity was found in the still breastfeeding group, disregarding HIV status. For mothers living with electricity the main distribution was in the “never initiated breastfeeding” and “breastfeeding cessation” groups, still disregarding HIV status.

These mothers have a higher socioeconomic score. Most likely, they can afford formula milk, and they may have a work-situation which is challenging when it comes to breastfeeding. These factors may have contributed to their decision.

Child Support Grant

Evenly distributed across the infant feeding groups, more of the HIV-negative than HIV-positive mothers do not receive child support grant. To apply for a child support grant in South Africa, the mother needs to have the child’s birth certificate, and it can take up to a year to get the documentation in place (91). Considering that the interviews were conducted 14 weeks after birth, many of the women may not have received their certificate yet. According to the health care score, HIV-positive women are in general supposed to have more contact with health care facilities to follow up their HIV diagnosis. This means more consultations and more opportunities to get the paper-work in place (91).

Parity and Age of Mother

Evenly distributed across the infant feeding groups, above 70 percent of HIV-positive mothers have more than one child. Among the HIV-negative mothers having more than one child, the distribution represents 60 percent of the “breastfeeding cessation” group, and around 50 percent in both the “never initiating breastfeeding” and “still breastfeeding” groups.

Around 50 percent of the HIV-positive mothers older than 30 years had never initiated breastfeeding, the same goes for mothers who had stopped breastfeeding. This may come from a higher socio-economic status due to longer education and thereby higher age before having children. HIV-positive women in the oldest age group have more children than the younger women.

Feeding Modality and Health Care Scores

Those who never initiated breastfeeding generally had lower health care scores than those who initiated breastfeeding immediately after birth.

One value stands out: HIV-positive mothers with poor health care score who have never initiated breastfeeding. According to the health care score model this indicates that HIV-positives receive poor health care, and this contributes to a high share of mothers never initiating breastfeeding.

Both the breastfeeding cessation and the still breastfeeding modalities had a normal distribution across the health system score scale, indicating no particular skewed effect from the health system score on those feeding modalities.

In general, the analysis shows that the better health care scores, the higher percentage still breastfeed at 14 weeks. 75 to 85 percent disregarding HIV status still breastfeed when HCSs are medium to good.

Prelactal Feeds

396 mothers reported prelactal feeds. 46 percent of these had chosen water and 25 formula. This feeding practise increases the risk of respiratory and gastrointestinal infections among others. In addition, the child misses the first immunisation that comes with breastmilk (3, 4). The morbidity and mortality risks also increase as the infant is exposed to potential bacteria and viruses from water and bottles. Further, the establishment of breastfeeding and skin to skin routines may be interrupted in order to give the infant prelactal feed. This can also inhibit breastfeeding initiation within the first hour after birth (92).

Never Initiated Breastfeeding and Breastfeeding Cessation

346 mothers never initiated breastfeeding. Four main reasons were reported, and these were perception of not having enough milk, mother having to return to work, positive HIV status and mother being sick at the time.

Further, 588 mothers reported breastfeeding cessation within 14 weeks after birth. The main reasons given were perception of not having enough milk, mother returning to work and baby crying all the time. Most often breastfeeding cessation happened within four weeks after birth. Around 70 percent of all cessations took place during this period. Another peak occurred between seven and eight weeks after birth.

For most women, breastmilk production has not started at birth. For those who never initiated breastfeeding, the perception of not having enough milk can be caused by a misinterpretation of physiology. During pregnancy hormone levels from the placenta of oestrogen and progesterone inhibit the milk producing hormone prolactin (24). At birth the placenta is being secreted and thereby the levels of the inhibitors drop, and prolactin can get its milk producing effect. For this reason, most women do not have milk until 2-3 days after birth (24). From this point on breastmilk production is determined by hormones and the amount and frequency of milk being extracted (24). Many women perceive not having enough milk for the infant, and do not put the baby to the breast. This leads to poor signals of extraction and frequency to the body, and the milk production does not increase.

A similar understanding can be applied to mothers reporting an insufficient amount of milk as a reason for breastfeeding cessation. If the mother is unaware of the hormone shift that is necessary to start breastmilk production, she may give up breastfeeding before the production has reached the desirable level. Also, the infant's stomach does not have much room for milk the first days after birth (day one 5-7 ml, day three 22-27 ml) (24). Frequent demands from the infant to breastfeed, together with only small amounts of colostrum or milk may therefore lead to the perception of not having enough milk. These factors can explain the high rate of breastfeeding cessation during in the first period after birth.

In some cases, returning to work or school may explain the choice of formula milk. A mother knowing she must go to work shortly after birth, may drop breastfeeding initiation to spare herself the challenges of establishing the breastfeeding routines described above (93).

Mothers returning to school or work usually do so after the 6 weeks check-up and immunisation of the child. It is reasonable to believe that many of those who breastfeed until this point experience challenges combining work/school and breastfeeding and therefore quit breastfeeding a week or two into their new daily life (94).

In the group that never initiated breastfeeding, 14 percent reported positive HIV status to be the reason. Possibly this reflects lack of information. They may not be aware of the fact that breastfeeding is safe as long as the mother is adherent to ART and virally suppressed. This corresponds with poor health care score for HIV-positive mothers – 43 percent of those with poor health care score had not initiated breastfeeding.

12 percent of the mothers reported dissatisfied child as the reason for breastfeeding cessation and implementation of formula feeding. This may also be a result of poor health care score

and lack of information from health facilities on new born infants. In many cases the infant's transition from life in the womb to life outside the mother's body can be challenging. They have problems keeping calm, get high stress levels, become uneasy and cry a lot in the adjustment phase (24). Many mothers interpret this as hunger and dissatisfaction, which may lead to a stressful and challenging breastfeeding situation. In the mother's search for a solution, formula milk may well be her choice (24).

Factors Related to Health Care Scores and Infant Feeding Outcome

The regression analysis found that health care score has a strong impact on infant feeding outcome. Mothers returning to work and positive HIV status were the factors with the clearest effect on poor health care score. If a mother is working during her pregnancy, she may have trouble leaving work to attend prenatal check-ups. In this way she can miss out on HIV checks/treatment and infant feeding advice during pregnancy. This can also prevent her from starting ART when needed, due to positive HIV status not being discovered. Of the total 1274 HIV-positive mothers in the population, 140 did not undergo ART. A study from 2010 found that if a working mother would return to work early (within 6 months after birth), this was a major barrier to breastfeeding initiation and duration in line with current recommendations (95).

Factors such as skin-to-skin contact after birth, breastfeeding initiation within one hour, breastfeeding initiation help and feeding advice after birth may be disturbed by birth complications or severe illness at the time. When the mother is too sick to care for the infant, prelactal feed is given, and this delays the establishment of breastfeeding routines. A study from 2010, found that prelactal feed was a key determinant for breastfeeding cessation (96). This together with a study from 2010 showing a dose-response relationship between skin to skin and exclusive breastfeeding underlines the importance of these factors for breastfeeding outcome. It also suggests that our model and our results are in line with current research in this field (97).

Poor health care score came out significant as a very strong predictor for never initiating breastfeeding, with an RRR of 23.66, together with mother returning to work and mother receiving no child support grant. According to our model this indicates that the amount of health care received by the mother has a huge impact on infant feeding modality.

For breastfeeding cessation, poor health care score and mother returning to work also had a significant effect on infant feeding modality. Therefore, in line with our model, poor health care is a strong predictor for both never initiating breastfeeding and breastfeeding cessation.

Current Situation in Health Care Services - Recommendations

Pre birth

The health care system in South Africa is both home-based and facility-based, and the existing manuals for CHWs suggest a template for the course of services the mother should get during pregnancy and in the postnatal period. According to the “CHW Household Tools Phase 1” the CHW should visit the mother four times during her pregnancy: Visit 1 at 14 weeks, visit 2-4 between 14 and 24 weeks, 24 and 28 weeks and 28 and 32 weeks respectively (87).

After birth

The mother and her child usually leave the hospital within three hours after birth. There is a check-up at the health facility after six days, mainly to care for the mother, control stitches and make sure that bleeding has abated. The next clinic appointment takes place six weeks after birth. Here the infant is prioritised, and immunisation is a main issue.

To make sure that postnatal health care is sufficient the CHW-manual also provides a template for this period.

According to the manual four visits from a CHW are recommended. The first one should take place within 24 hours after delivery or discharge from the hospital or clinic. Visit 2-4 should be carried out after 3 days, 7 days and 14 days respectively. The CHW should concentrate on essential postnatal care for mother and child, promoting and supporting exclusive breastfeeding, PMTCT dual prophylaxis for HIV-positive infants, symptoms of illness and progression of breastfeeding (87). Of the 3659 mothers in the population, only 391 (11 percent), reported CHW home visits during pregnancy. 339 of them (equal to 9 percent of the total population) received feeding advice.

During the postnatal period, only 453 mothers (12 percent) received the home visits prescribed by the template. All of them had more than one visit. 378 of them (equal to 83 percent of all the mothers reporting home visits) got feeding advice from the CHW.

According to information from our collaborators in KwaZulu-Natal, the CHW-system designed for pregnancy and the postnatal period, does not work very well today. This is reflected in our analysis.

When it comes to the high proportion of women never initiating breastfeeding or stopping breastfeeding within 14 weeks postpartum, (26 percent in total, evenly distributed between HIV-positive and negative mothers), it is reasonable to assume that a broader scope of counselling can increase the rates of exclusive breastfeeding. CHWs are in a position to educate and support mothers in a period characterized by major life changes. A study published in March 2019, showed that interventions in low-income settings increased breastfeeding knowledge and breastfeeding practices. This substantiates the importance of CHW guidance (98). One could therefore assume that with better community health services in KwaZulu-Natal, women would feel encouraged to follow and sustain the appropriate infant feeding guidelines.

In this context the high under 5 mortality rates in South Africa is a significant issue. As mentioned above, it is estimated that 60 percent of these deaths could be avoided with better health care coverage in the country. CHWs may have a key role in this case, too. Mothers should be trained to recognize possible symptoms of illness in the child so that they can seek health care at an early stage of the illness. Also, with more CHWs in the communities there will be someone to consult when a child falls ill, and proper care can be in place soon enough.

Breastfeeding Skills of the Community Health Worker – A Key Component

A thorough mapping was done in the process of collecting information on the current routines and manuals describing the roles and functions of different parts of the health system in South Africa. The CHW training manuals were carefully reviewed in order to understand the breastfeeding skill level reached by the CHW after training. BroadReach Healthcare, the company responsible for the CHW Training manual “Phase 1” and “Phase 2”, was consulted to ensure that we were in possession of the latest updated versions. The training manual has not been updated since 2012, and we discovered elemental errors regarding breastfeeding technique, which if instructed to a striving mother, will result in breastfeeding challenges and insufficient milk supply.

The error lies in the description of how to properly attach the child for optimal breastfeeding: “Tease the infant’s lower lip with the nipple, in order for the infant to open wide his/her mouth” (87). This recommendation is incorrect according to recent research and more updated manuals. If the child is put to the breast with its lower lip against the nipple, it will not open its mouth enough to get enough of the breast into its mouth and get an optimal attachment to the breast. The nipple will be pinched against the palate while the child lactates, and the

lactation will be ineffective and suboptimal. The nipple gets a “lip-stick”-shape which is painful for the mother. Over time ineffective lactation will lead to lower milk supply due to poor emptying of the breast. In turn this will trigger the use of formula supplement to cover the child’s need for milk to maintain growth and wellbeing (99).

For optimal attachment, the child should be put with its nose to the nipple. This stimulates reflexes such as opening the mouth, stretching and attaching well with much breast in the mouth (24, 100). This way, the nipple comes far into the mouth and a good and effective lactation can be established. The two ways of positioning the breast in the child’s mouth are pictured in Figure 7A) and 7B):



Figure 7 A): Optimal attachment with a good amount of breast into the mouth. The nipple comes far into the mouth and child can lactate effectively ((99) 1:29).

Figure 7 B): Shallow attachment and the child pinches the nipple to the palate, leading to poor lactation ((99) 2:17).

Optimal attachment between child and breast is essential for successful breastfeeding outcome. The fact that the CHW training manual is not updated according to recent knowledge on this critical point for breastfeeding outcome (101), may contribute to a high breastfeeding cessation rate among mothers, seeking help and advice from the CHW.

Methodological Considerations

Evaluation of the Study Design

The health care score is based on information provided by the study and addresses the function of the health care system at the time of the survey. It is not a tested and validated model, and due to the design and uncertainties about the model's internal validity, only associations can be described. No causal associations could be made. However, what we found in terms of HIV status, socioeconomic score and infant feeding modalities is similar to what other researchers have found (102, 103).

Evaluation of the Health Care Score

The ambition of the health care score model is to create a “gold standard” for optimal health care within the current health system, comprising pregnancy, birth and the postnatal period. The model takes into account variables with impact on the promotion of breastfeeding. It also describes services that the mother, according to the recommendations at the time, should have received during her contact with health care facilities. Thus, the model is a ‘construct’, based on current recommendations and optimal delivery of public health services.

The first issue to be highlighted is the number of factors included in the health care score. For example, since the CHW system is known to function sub optimally, and it is normal to have only one or two visits after birth, the health care score should include questions and points for each visit from a CHW, both pre and post birth.

Further, the questions regarding breastfeeding initiation guidance are unclear since the type of help is not specified. Mothers who get physical support may interpret the question as referring to practical guidance, while mothers who get breastfeeding advice only may understand it as breastfeeding initiation help. This is a source of bias and the answers may give a health care score which is wrong or not specific enough.

There should also be a fixed way of identifying the competence of the health care worker who gives the mother breastfeeding advice after birth. Educated breastfeeding counsellors should provide more points in the score than regular nurses. During the data collection for the KIBS study there were no educated breastfeeding counsellors and since there is a number of different uniforms in the clinics, the mothers had difficulties reporting the profession or education of the health worker in question.

Finally, the scoring system should be carefully developed for further use. A different value-system would possibly be more suitable, and user friendly, and new norms and submodels can be developed for implementation in the current model.

Evaluation of the Health Care Score and Other Systems

Over the last few decades WHO has published several reports on health care system performance. When countries fail to deliver on their potential, the result is disabilities, unnecessary suffering and deaths (104). A well functioning framework is the key to maintaining performance and to ensure good health in populations. In 2007 WHO described six building blocks needed for an optimal health system. These are shown in figure 8.

THE SIX BUILDING BLOCKS OF A HEALTH SYSTEM

- Good **health services** are those which deliver effective, safe, quality personal and non-personal health interventions to those that need them, when and where needed, with minimum waste of resources.
- A well-performing **health workforce** is one that works in ways that are responsive, fair and efficient to achieve the best health outcomes possible, given available resources and circumstances (i.e. there are sufficient staff, fairly distributed; they are competent, responsive and productive).
- A well-functioning **health information** system is one that ensures the production, analysis, dissemination and use of reliable and timely information on health determinants, health system performance and health status.
- A well-functioning health system ensures equitable access to essential **medical products, vaccines and technologies** of assured quality, safety, efficacy and cost-effectiveness, and their scientifically sound and cost-effective use.
- A good **health financing** system raises adequate funds for health, in ways that ensure people can use needed services, and are protected from financial catastrophe or impoverishment associated with having to pay for them. It provides incentives for providers and users to be efficient.
- **Leadership and governance** involves ensuring strategic policy frameworks exist and are combined with effective oversight, coalition-building, regulation, attention to system-design and accountability.

Figure 8: The six building blocks of a health system (105).

Further, according to WHO's Framework for Health System Performance Assessment a health system has three main goals: health, responsiveness and fairness in financing (106). The assessment of the level of functioning raises an important question: How can we measure the attainments or outcomes when it comes to optimal health, responsiveness and financial coverage (104)?

Community based health services (CBHS) will differ from country to country, and from region to region (107). One of the main challenges is that there is a large amount of academic papers on specific parts of the CBHS, but there are major shortcomings regarding papers on the overall perspective. Systematic documentation covering the total services of health workers (both highly educated health workers and community health workers) is deficient (107). When examining CBHS it is of great importance to look into the services as a whole.

Without this approach there will be inconsistent services, health system gaps and duplications of services (107). Such an approach is a prerequisite for Universal Health Coverage.

The term Universal Health Coverage (UHC) means that all people and communities receive the necessary health care without suffering financially. Necessary health care comprises services as close to the individual's location as feasible and covers everything from prevention of disease to medical treatment and palliative care (108).

WHO calculates that by 2030 18 million additional health workers are needed to ensure UHC (108). Further, WHO states that there are shortcomings of supply and demand for health care workers and community health workers in LMIC (108). This fact is reflected in our study. Only 10 percent of the total population had CHW home visits during pregnancy, and only 12 percent after birth. This shows that the system obviously does not work the way it should. Either the problem lies in recruitment and/or availability of CHWs, or it has to do with organization and task distribution at an administrative level. Approximately one of every ten women only gets the care she is entitled to during pregnancy and after birth.

According to WHO, UHC depends not only on *what* health care services are covered, but also on *how* they are delivered, funded and coordinated (108). There is a need for an elementary shift to ensure integrated services focused on individual and community needs. It is of utmost importance to strive for optimal and strong care coordination and to balance the distribution of community health services and hospital or clinic services (108).

WHO and the World Bank recommend that monitoring UHC one should focus on two factors: the share of a population that 1) have access to health care services of quality, and 2) to what extent a significant amount of the household financial budget is spent on health services (108). In both cases one should take into account the overall health care level and service coverage, together with a system contributing to financial security for the population, especially ensuring equal rights for those living in poverty or in remote rural areas (108).

Having to pay for health care services can in many cases lead to financial ruin and poverty. Health care in KwaZulu-Natal is partly in line with WHO recommendations on the budget share spent on medical assistance. The CHW services are free, and the CHWs receive a small grant for their work and assistance to the community. In the rural areas of KwaZulu-Natal many people cannot afford health care. The fee is 20 rand (approximately 1,50 USD), but if people are unable to pay, the health care services are free and financed by the government. However, the main financial challenge for people living in rural areas in KwaZulu-Natal is

transportation to health care facilities. In some cases, they have to travel long distances at a considerable cost. Occasionally the whole community contributes financially to get people transported to the health care facility. When it comes to UHC this becomes a discussion of responsibilities: Is the government responsible for covering transportation costs to avoid putting people into poverty, or is their responsibility to provide services closer to the people in need?

Pregnant women normally give birth at clinics or hospitals. Those who cannot afford transportation normally wait till they can call for a publicly funded ambulance. The small number of women giving birth outside health facilities are normally on their way in, but do not make it in time.

The Health Care Score used in this thesis is a constructed performance assessment based on the health care available in the current system and the quality of the services delivered. Some elements in the health care score are scored 1 point as overall breastfeeding promoters, some 2 points since they are much more decisive for breastfeeding outcome, and some -1 point because they are considered to harm breastfeeding outcome. In conclusion, the health care score is assumed to be a usable tool to reflect the level of health care access and quality in line with the WHO recommendations for measuring and monitoring health care.

Reverse Causality

Discussing breastfeeding outcome and breastfeeding counselling, we must comment on reverse causality. Reversed causality means that x is associated with y, but it is y that causes changes in x, and x is not responsible for the change in y (109). In our study x is equal to breastfeeding counselling, and y is equal to infant feeding outcome.

Different factors may count for reversed causality:

- 1) The never initiated breastfeeding group: Do they get poorer breastfeeding counselling because they have already decided to not breastfeed their baby, or have they not initiated breastfeeding due to lack of breastfeeding advice during pregnancy?
- 2) The breastfeeding cessation group: Do they stop breastfeeding as a result of poor follow up and poor breastfeeding counselling from the health system? Or is the breastfeeding counselling score poor because they have stopped breastfeeding?
- 3) The still breastfeeding group: Do they still breastfeed due to good breastfeeding counselling during pregnancy, in the hospital after birth and during CHW home-visits after birth? Or do they score high in breastfeeding counselling because they have had more advice and counselling since they still breastfeed?

More detailed questionnaires are necessary to examine these issues and address the degree of influence from reverse causality.

Bias

In research bias can occur at several stages. If bias is present, the results may be offset and will not match reality. Bias may cause under- or over-estimation, and this will affect the internal validity of a study (110).

Collecting good data on nutrition and breastfeeding is challenging, and there are several possible sources of bias in our study:

- 1) Recall bias means that the participants when asked about details or happenings back in time fail to recall correct information (110). It can be difficult for a mother to remember the exact breastfeeding initiation time, prelactal feed, how breastfeeding has been and when challenges arose, when asked in an interview 14 weeks after birth. It can also be challenging to recall pre-birth CHW home visits, the nature of the consultations and what advice was given.
- 2) Response bias can arise as a result of the phrasing of the questions in the questionnaire. In our case, the questions were first written in English, and then translated to the local language iZuzu. This means that the questions can have a slightly different meaning than intended because details have been lost in translation (110).
- 3) Social desirability bias means that the participant wants to be a good interviewee and tries to give the answers she thinks the person in charge of the interview wants to hear instead of the truth (110). Self-reported HIV status is an example. If a positive HIV-status is a taboo, the mothers in question may not report it. This is potentially a serious source of error since we have found a large difference between HIV-positive still breastfeeding mothers (839 participants) and HIV-negative still breastfeeding mothers (1866 participants). The true difference between the two groups may have been lost due to report bias.

In this context attention should also be drawn to breastfeeding policies and breastfeeding promotion in South Africa over the last few decades. It is possible that some mothers experience a breastfeeding pressure which makes them reluctant to tell the truth about their breastfeeding situation. Further, in South Africa there is a strong hierarchy between nurses and other health care professionals on one side, and the mothers on the other. This may also lead to social desirability bias.

- 4) The way the study was conducted also have caused unwanted bias. The interview took place at the 14 weeks' check-up, and there may have been disturbances. The

participants may also have been uncomfortable or stressed by the presence of the child.

All these different types of biases may affect the validity our study and have impact on the quality of the results.

Methodological Limitations

- In general, the health care score model is not validated against any other norms.
- Further, the questionnaire should have provided more information on the number of visits from a CHW during pregnancy and after birth and the amount of breastfeeding counselling. For example the mothers receiving home visit after birth were not asked if they got the first visit within 24 hours.
- It also would be interesting to know if the mothers attended groups or seminars at the clinic during pregnancy, and if they had additional contact with health care professionals during pregnancy and after birth.
- In retrospect, information on how long they stayed in the clinic after birth before travelling home, and what kind of breastfeeding guidance and/or support they got and from what kind of health care worker would have been useful. So would a mapping of attitudes and level of breastfeeding knowledge.

More detailed data would contribute to a better review of the health care score model and added valuable information on the assessment of the health system.

Strengths

The health care score model reflects the level of health care access and quality within the current system with existing variables. The study is cross-sectional and community-based with random selection of mothers with children. Thereby, the risk of selection bias is reduced.

Cross-sectional studies have practical advantages since they are quick to implement without long periods of follow-up. The data are collected only once, and multiple outcomes can be studied.

Despite limitations due to this being a new and untested model, the large number of participants strengthens the results. Further, the data will provide an insight into the current situation of the health system, since they are operational data from the clinics in KwaZulu-Natal.

As our results strongly support existing research on the association between infant feeding modalities and associated factors, this suggests that the model should be considered and evaluated as a future tool in assessing the function of health care systems.

Conclusion

This thesis has a double objective: primarily to assess the impact of health care quality on infant feeding modality and secondly to assess the effect of HIV status on health system services and in turn on infant feeding modality.

The analyses undertaken show that the delivery of optimal health care is of great importance to infant feeding modality. Interfering factors such as mother returning to work shortly after giving birth, HIV status and child support grant turned out to affect health care and infant feeding outcome. Our results strongly support previous research on this topic.

Further, we found that a poor health care is associated with positive HIV status and mother returning to work. Poor health care score is strongly significant with never initiating breastfeeding and breastfeeding cessation. HIV-positive women therefore constitute a vulnerable group in need of better health care for optimal infant feeding outcome.

A thorough understanding of the health care system is of critical importance when assessing its functioning and impact on infant feeding modality. According to the model we have developed, the gold standard score, health care system in KwaZulu-Natal does not work optimally.

We have concluded that our health care score seems to be an expedient tool for improvement because it reflects the level of health care access and quality within the current South African system, and also because it is in line with the WHO recommendations for measuring and monitoring health care.

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Appendix 1:

Total health care scores variable	Frequency	Percentage (%)
Poor health care	1525	41.7
Medium health care	1309	35.8
Good health care	825	22.5
Total	3659	100.0

Table 1: Distribution within the tertiles in the Total Health Care Scores Variable.

Appendix 2:

Construction of health care scores

	Points	HIV -	%	HIV +	%	Total	%	
Primary Health Care	Feeding advice in clinic							
	No/missing	0	453	19,0	157	12,30	610	16,7
	Yes	1	1932	81	1117	87,7	3049	83,3
	HIV tested during pregnancy							
	No/missing	0	57	2,4	26	2	83	2,3
	Yes	1	2328	97,6	1248	98	3576	97,7
	Currently taking ART							
	No/missing	0			140	11	2525	69
	Yes	1			1134	89	1134	31
Facility Health Care	Skin to skin							
	No/missing	0	820	34,4	435	34,1	1255	34,3
	Yes	2	1565	65,6	839	65,9	2404	65,7
	BF within 1 hour after birth							
	No/missing	0	1379	57,8	740	58,1	2119	57,9
	Yes	2	1006	42,2	534	41,9	1540	42,1
	BF initiation help							
	No/missing	0	1122	47	686	53,8	1808	49,4
	Yes	1	1263	53	588	46,2	1851	50,6
Feeding advice after birth								
No/missing	0	558	23,4	233	18,3	791	21,6	
Yes	1	1827	76,6	1040	81,7	2868	78,4	

	Ever been breastfeed							
	Never	-1	134	5,6	212	16,6	346	9,5
	Yes	0	2251	94,4	1062	83,4	3313	90,5
	Prelactal feed							
	No/missing	0	2089	87,6	1174	92,2	3263	89,2
	Yes	-1	296	12,4	100	7,9	396	10,8
Community Health Care	CHW home visit after birth							
	No/missing	0	2113	88,6	1093	85,8	3206	87,6
	Yes	1	272	11,4	181	14,2	453	12,4
	CHW visit more than once							
	No/missing	0	2111	88,5	1095	86	3206	87,6
	Yes	1	274	11,5	179	14,1	453	12,4
	CHW feeding advice after birth							
	No/missing	0	2159	90,5	1122	88,1	3281	89,7
	Yes	1	226	9,5	152	11,9	378	10,3
	CHW home visit during pregnancy							
No/missing	0	2159	90,5	1109	87	3268	89,3	
Yes	1	226	9,5	165	13	391	10,7	
CHW feeding advice during pregnancy								
No/missing	0	2195	92	1125	88,3	3320	90,7	
Yes	1	190	8	149	11,7	339	9,3	
Total		14	2385	100	1274	100	3659	100

Appendix 3:

Total socio-economic score variable	Frequency	Percentage (%)
Poor socio-economic status	1471	40.2
Middle socio-economic status	1507	41.2
Least poor socio-economic status	681	18.6
Total	3659	100.0

Table 5: Distribution within the tertiles in the Socio-economic Score Variable.

Appendix 4:

Baseline table:

Cate- gorical Variable	Items	<i>Never initiated breastfeeding</i>				<i>Breastfeeding cessation</i>				<i>Still breastfeeding</i>				Stratified by HIV status feeding modality					
		HIV pos		HIV neg		HIV pos		HIV neg		HIV pos		HIV neg		HIV pos		HIV neg		Total	
		<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>N</i>	<i>%</i>
Socio economic status	Poor	64	30.2	31	23.1	76	34.1	94	24.4	397	47.3	809	43.4	537	42.2	934	39.2	1471	40.2
	Middle	89	42.0	49	36.6	106	47.5	173	44.9	330	39.3	760	40.7	525	41.2	982	41.2	1507	41.2
	Least poor	59	27.8	54	40.3	41	18.4	118	30.6	112	13.4	297	15.9	212	16.6	469	19.7	681	18.6
Mothers age	< 20 years	10	4.7	23	17.2	15	6.7	99	25.7	67	8.0	488	26.1	92	7.2	610	25.6	702	19.2
	20-24 years	41	19.3	47	35.1	53	23.8	131	34.0	237	28.3	682	36.6	331	26.0	860	36.1	1191	32.6
	25-29 years	64	30.2	31	23.1	58	26.0	86	22.3	245	29.2	374	20.0	367	28.8	491	20.6	858	23.5
	>30 years	97	45.8	33	24.6	97	45.5	69	17.9	290	34.5	322	17.3	484	38.0	424	17.8	908	24.8
Parity	Primipara	58	27.4	73	54.5	62	27.8	236	61.3	228	27.2	991	53.1	348	27.3	1300	54.5	1648	45.0
	Multipara	154	72.6	61	45.5	161	72.2	149	38.7	611	72.8	875	46.9	926	72.7	1085	45.5	2011	55.0
Education	Primary school or less	15	7.1	4	3.0	20	9.0	18	4.7	132	15.7	149	8.0	167	13.1	171	7.2	338	9.2
	Completed Grades 8 to 11	100	47.2	55	41.0	116	52.0	166	43.1	460	54.8	987	52.9	676	53.1	1208	50.7	1884	51.5
	Complete Grade 12 or higher	97	45.7	75	56.0	87	39.0	201	52.2	247	29.4	730	39.1	431	33.8	1006	42.2	1437	39.3
Returned to school	No	206	97.2	112	83.6	212	95.1	325	84.4	826	98.4	1732	92.8	1244	97.6	2169	91.0	3413	93.3
	Yes	6	2.8	22	16.4	11	4.9	60	15.6	13	1.6	134	7.2	30	2.4	216	9.1	246	6.7
Work	No work	105	49.5	90	67.2	135	60.5	266	69.1	626	74.6	1557	83.4	866	68.0	1913	80.2	2779	76.0
	Has work, not returned	61	28.8	22	16.4	34	15.3	67	17.4	167	19.9	233	12.5	262	20.6	322	13.5	584	16.0
	Has returned to work	46	21.7	22	16.4	54	24.2	52	13.5	46	5.5	76	4.1	146	11.5	150	6.3	296	8.1
Child support grant	No	61	28.8	57	42.5	57	25.6	169	43.9	180	21.5	690	37.0	298	23.4	916	38.4	1214	33.2
	Yes	151	71.2	77	57.5	166	74.4	216	56.1	659	78.5	1176	63.0	976	76.6	1469	61.6	2445	66.8
Maternity grant	No	195	92.0	121	90.3	212	95.1	359	93.3	815	97.1	1820	97.5	1222	95.9	2300	96.4	3522	96.3
	Yes	17	8.0	13	9.7	11	4.9	26	6.7	24	2.9	46	2.5	52	4.1	85	3.6	137	3.7

Disability grant	No Yes	211 1	99.5 0.5	134 0	100.0 0.0	223 0	100.0 0.0	381 4	99.0 1.0	832 7	99.2 0.8	1856 10	99.5 0.5	1266 8	99.4 0.6	2371 14	99.4 0.6	3637 22	99.4 0.6
Money from partner	No Yes	68 144	32.1 67.9	30 104	22.4 77.6	74 149	33.2 66.8	129 256	33.5 66.5	295 544	35.2 64.8	607 1259	32.5 67.5	437 837	34.3 65.7	738 1619	32.1 67.9	1203 2456	32.9 67.1
Money from family	No Yes	171 41	80.7 19.3	99 35	73.9 26.1	175 48	78.5 21.5	223 162	57.9 42.1	627 212	74.7 25.3	1168 698	62.6 37.4	973 301	76.4 23.6	1490 895	62.5 37.5	2463 1196	67.3 32.7
Household geographic area	Rural Urban	98 114	46.2 53.8	47 87	35.1 64.9	88 135	39.5 60.5	148 237	38.4 61.6	243 596	29.0 71.0	537 1329	28.8 71.2	845 429	66.3 33.7	1653 732	69.3 30.7	2498 1161	68.3 31.7
Household connected to electricity	No Yes	50 162	23.6 76.4	35 99	26.1 73.9	71 152	31.8 68.2	92 293	23.9 76.1	345 494	41.1 58.9	792 1074	42.4 57.6	466 808	36.6 63.4	919 1466	38.5 61.5	1385 2274	37.8 62.2
Water Source	Piped in house/yard Public/other	128 84	60.4 39.6	89 45	66.4 33.6	131 92	58.7 41.3	256 129	66.5 33.5	428 411	51.0 49.0	991 875	53.1 46.9	687 587	53.9 46.1	1336 1049	56.0 44.0	2023 1636	55.3 44.7
Toilet	Other Flush toilet	154 58	72.6 27.4	73 61	54.5 45.5	172 51	77.1 22.9	254 131	66.0 34.0	665 174	76.3 20.7	1468 398	78.7 21.3	991 283	77.8 22.2	1795 590	75.3 24.7	2786 873	76.1 23.9