Newborn Care Practices in Northern Uganda

Studies on breastfeeding, decision-making and hypothermia

David Mukunya

Thesis for the degree of Philosophiae Doctor (PhD)
University of Bergen, Norway
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To my Lord and Savior Jesus Christ

My mother taught me the way of Acholi, and nobody should shout at me, because I know the customs of our people.

When the baby cries, let him suck milk from the breast.

There is no fixed time for breastfeeding.

When the baby cries, it may be he is ill; the first medicine for a child is the breast.

While the medicine man is being called from the beer party.

Okot P'Bitek: Song of Lawino and Song of Ocol [Nairobi, East African Educational Publishers, 2013].

Scientific environment

This research is a result of the collaboration between Makerere University, Uganda, University of Bergen, Norway, Gulu University, Uganda, Busitema University, Mbale, Uganda, and Juba University, South Sudan, under the Survival Pluss project. The project is funded by the Norwegian Programme for Capacity Building Development in Higher Education and Research for Development (NORHED) under the Norwegian Agency for Development Cooperation (NORAD), Norway. I have benefited from the support of the quota scheme programme that granted me a three-year PhD scholarship, and the Norwegian Research School of Global Health, which granted me numerous travel grants to attend courses and scientific conferences.

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Acknowledgments

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A luta Continua!

Figure 1: The Survival Pluss data collection team

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Abstract

Background: Early initiation and exclusive breastfeeding reduce neonatal morbidity and mortality. One of the key mechanisms through which optimal breastfeeding reduces neonatal mortality is by reducing neonatal hypothermia. However, there are no proper estimates of neonatal hypothermia in sub-Saharan Africa. Interventions that promote optimal breastfeeding are listed as priority interventions for achieving sustainable development target 3.2 of reducing neonatal mortality to less than 12 deaths/1,000 live births and mortality of children less than five years to less than 25 deaths/1,000 live births. There is a dearth of data on how to deliver effective interventions that promote optimal breastfeeding in sub-Saharan Africa and the agents through which these interventions should be delivered.
Objectives: 1) To assess the prevalence and determinants of delayed breastfeeding initiation 2) To determine the incidence and predictors of neonatal hypothermia 3) To determine the effect of peer counseling, mobile phone messages and mama kits on early initiation of and exclusive breastfeeding 4) To determine key decision makers and actors in selected newborn care practices.
Methods: We conducted a survey that included 930 mothers with infants less than two years old, and assessed the prevalence of delayed breastfeeding initiation, and the key decision makers and actors in selected newborn care practices. We then conducted a cluster randomized controlled study where we randomized 30 clusters to an intervention (peer counseling, mobile phone messaging, and distribution of mama kits) or control arm (standard of care). Mothers were enrolled during pregnancy and followed up until birth when the outcome (early breastfeeding initiation) was assessed. We assessed for neonatal hypothermia by taking a high axillary temperature using a lithium battery-operated digital thermometer. All statistical analyses were done while factoring in clustering. We used logistic regression models and generalised estimation equations for the Poisson family, with a log and identity link, assuming an exchangeable correlation.
Results: Almost half [448/930: 48.2% (95% Confidence Interval (CI) 44.3,52.1)] of mothers delayed initiation of breastfeeding. The incidence of hypothermia was 678/1330 [51.0%: 95% CI (46.9-55.1)]. Of these 32% (429/1330), 95%CI (29.5-35.2)] had mild hypothermia (temperature 36.0°C - <36.5°C), while 18.7% (249/1330), 95% CI (15.8-22.0) had moderate hypothermia (temperature 32.0°C - <36.0°C). At multivariable analysis, the factors associated with neonatal hypothermia included: home birth [Adjusted Risk Ratio (ARR) 1.9, 95% CI (1.4-2.6)], low birth weight [ARR 1.7, 95%CI (1.3-2.3)], and delayed breastfeeding initiation [ARR 1.2, 95%CI (1.0-1.5]. Sixty-four percent (337/511) of participants in the intervention arm initiated breastfeeding within the first hour after birth compared to 60% (255/423) in the control arm whereas 89% (804/904) of participants in the intervention arm exclusively breastfed their infants in the first month of life compared to 81% (656/813) in the control arm. Fathers most commonly decided on where a mother gave birth (54.3%, n = 505), but the mothers (31.1%, n = 289) were also common decision makers. Fathers also most commonly

decided on whether to seek care for a sick newborn child (47.7%, *n* = 92). Grandmothers most commonly bathed the baby immediately after birth (55.5%, *n* = 516), while mothers most commonly decided on when to initiate breastfeeding (53.7%, *n* = 499) and on whether to bottle-feed or not (73.6%, *n* = 684). Health workers were also commonly cited in the decision to initiate breastfeeding and to practice bottle-feeding.
Conclusion: The incidence of neonatal hypothermia was high, demonstrating that communities in tropical climates should not ignore neonatal hypothermia. Only half of mothers practiced early breastfeeding initiation, a protective factor for neonatal hypothermia. An intervention consisting of peer counseling, mobile phone messaging and mama kits delivered to both the mother and significant others like husbands and mothers-in-law increased the proportion of mothers who exclusively breastfed at one-month postpartum, but did not increase the proportion of women who initiated breastfeeding within the first hour after birth. Interventions that promote early breastfeeding initiation should consider involvement of people who conduct the deliveries if they are to be successful. Fathers, grandmothers, health workers and traditional birth attendants were key decision makers in newborn care, and should be targeted for interventions promoting newborn care.

Abbreviations

ARR:	Adjusted Risk Ratio
BFHI:	Baby Friendly Hospital Initiative
CI:	Confidence Interval
CRCT:	Cluster Randomized Controlled Study
EBF:	Exclusive Breastfeeding
EIBF:	Early Initiation of Breast Feeding
HIV:	Human Immunodeficiency Virus
ILO:	International Labour Organization
IQR:	Inter Quartile Range
IYCF:	Infant and Young Child Feeding
LMIC:	Low and Middle-Income Countries
NORHED:	Norwegian Programme for Capacity Development in Higher Education and Research for Development
PMTCT:	Prevention of Mother-to-Child Transmission of HIV-1
PR:	Prevalence Ratio
SD:	Standard Deviation
SES:	Socio-Economic Status
SMS:	Short Message Service
UBOS:	Uganda Bureau of Statistics
UDHS:	Uganda Demographic and Health Survey
UNICEF:	United Nations Children's Fund
VIF:	Variance Inflation Factor
WHO:	World Health Organization

Definitions

The breastfeeding definitions used in this thesis are adapted from the Infant and Young Child Feeding (IYCF) guidelines of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) [1].

Early Initiation of Breastfeeding (EIBF): is the process of putting a newborn to the breast within one hour of birth.

Exclusive Breastfeeding (EBF): is feeding an infant less than six months only on breast milk and no other liquids or solids, not even water, except for drops or syrups consisting of vitamins, mineral supplements or medicines.

Pre-lacteal feeding: this is when an infant is given any food or fluid before initiation of breastfeeding.

Optimal breastfeeding: this involves early initiation of breastfeeding, exclusive breastfeeding for six months, and continued breastfeeding with complementary foods for two or more years.

Hypothermia: Axillary temperature less than 36.5°C

Mild Hypothermia: Axillary temperature less than 36.5°C but not below 36.0°C (36.0°C - <36.5°C)

Moderate Hypothermia: Axillary temperature less than 36.0°C but not below 32.0°C (36.0°C - <36.5°C)

Severe Hypothermia: Axillary temperature less than 32.0°C (<32.0°C)

Key decision makers and actors: The most frequently cited decision maker or actor

Original papers

The thesis is based on the following papers:

Paper I: David Mukunya, James K. Tumwine, Victoria Nankabirwa, Grace Ndeezi, Isaac Odongo, Josephine Tumuhamye, Justin Bruno Tongun, Samuel Kizito, Agnes Napyo, Vincentina Achora, Beatrice Odongkara, Thorkild Tylleskar: ***Factors Associated With Delayed Initiation of Breastfeeding: a Survey in Northern Uganda.*** *Glob Health Action.2017; 10(1): 1410975. doi: 10.1080/16549716.2017.1410975*

Paper II: David Mukunya, James K. Tumwine, Thorkild Tylleskar, Agnes Anna Arach, Josephine Tumuhamye, Justin Bruno Tongun, Agnes Napyo, Vivian Zalwango, Vincentina Achora, Beatrice Odongkara, Grace Ndeezi, Victoria Nankabirwa: ***Incidence and factors associated with neonatal hypothermia in Northern Uganda: a community based Cohort*** *(manuscript)*

Paper III: David Mukunya, ThorkildTylleskar, Grace Ndeezi, Agnes Anna Arach, Josephine Tumuhamye, Justin Bruno Tongun, Agnes Napyo, Vivian Zalwango, VincentinaAchora, Beatrice Odongkara, James K. Tumwine and Victoria Nankabirwa: ***Effects of peer counseling, mobile phone messages, and mama kits on early and exclusive breastfeeding in Northern Uganda: a cluster randomized controlled study*** *(manuscript)*

Paper IV: David Mukunya, Victoria Nankabirwa, Grace Ndeezi, Isaac Odongo, Josephine Tumuhamye, Justin Bruno Tongun, Samuel Kizito, Agnes Napyo, Vincentina Achora, Beatrice Odongkara, Thorkild Tylleskar, James K. Tumwine**: *Key Decision Makers and Actors in Selected Newborn Care Practices: A Community-Based Survey in Northern Uganda***. *Int J Environ Res Public Health*. Pii: E1723. doi: 10.3390/ijerph16101723

All published articles are in open access peer reviewed journals.

Introduction

During the millennium development goal era (1990-2015), the death of children under five years reduced significantly from 12 million to 6 million [2, 3]. This decline was largely attributed to targeted interventions, political commitment and economic development [4, 5]. However, the reduction in deaths was not uniformly distributed across all age groups [5] and geographical locations. Globally, newborn deaths decreased by 42% between 1990 and 2015, compared to the 52% reduction of deaths in children less than 5 years [4]. As a result, over 40% (2.6 million) of deaths in children less than 5 years occur in the newborn period [2]. Most of these deaths occur in low and middle-income countries, particularly sub-Saharan Africa and Asia [2, 4, 6]. There is a renewed commitment to address child mortality in the sustainable development goals agenda, an agenda adopted by the 193 member states of the United Nations [7, 8]. The sustainable development goal target 3.2 aims at reducing deaths among children under five years to less than 25 deaths per 1,000 live births and deaths in newborns to less than 12 deaths per 1,000 live births by 2030 [7].

Under-5 year child mortality in Uganda was 62.4 deaths per 1,000 live births in 2016, which is higher than the global estimate of 38.4 deaths per 1,000 live births [6]. Neonatal mortality in Uganda was also high at 22.3 deaths per 1,000 live births compared to the global estimate of 16.7 deaths per 1,000 live births [6]. In high-income countries, the average under-5 year child mortality is 4.9 deaths per 1,000 live births and the neonatal mortality is 2.7 per 1,000 live births [6]. This marked difference in child deaths between high-income countries and low-income countries is an expression of the number of preventable deaths that occur in sub-Saharan Africa. It is estimated that available low-cost interventions can reduce 72% of all newborn deaths [9]. Interventions that are delivered in the early post-natal period have been shown to have the greatest impact on child health [10]. The most cost-effective interventions in the early post-natal period are interventions that promote optimal breastfeeding [10, 11]. It is estimated that the scale-up of breastfeeding could prevent 600,000 to 800,000 child deaths [12] and approximately

100,000 maternal deaths [13], and also result in economic gain of about USD 300 billion annually [13, 14].

Breast milk

Breast milk is a dynamic bio-active fluid [15], composed of both nutritional and non-nutritional bioactive factors that promote the growth and survival of infants. Macronutrients in breast milk include proteins (mainly casein, lactoferrin, serum albumin, immunoglobulin A, and alpha-lactalbumin), fats (mainly palmitic and oleic acids), and carbohydrates (mainly lactose and oligosaccharides) [15]. Micronutrients in breast milk include vitamin A, B_1, B_2, B_6, B_{12}, D, and iodine [15]. It is worth noting that breast milk is deficient in vitamin K, and neonatal supplementation is recommended. The non-nutritive bioactive components of breast milk include growth factors and immunological factors. The growth factors present in milk include epidermal, neuronal, insulin-like and vascular endothelial growth factors, erythropoietin, somatostatin and adiponectin [15]. Immunological factors include lactoferrin, cytokines, lysozymes, lymphocytes, macrophages, neutrophils, antibodies and oligo-saccharides [15, 16]. Recent studies show microRNA, stem cells, microbiota and cortisol as key immunological factors in breast milk [12]. The composition of breast milk shows that breast milk is not only a nutritive substance but also a medicinal and vaccinal substance [15]. The composition of breast milk varies between stages of lactation (colostrum, transitional and mature), time of the day, stage of nursing (fore and hind milk) and between term and pre-term infants [17]. Colostrum is produced in lower quantities than transitional or mature milk and is richer in secretory IgA, lactoferrin, leucocytes as well as the epidermal growth factor. However, colostrum has lower lactose than transitional / mature milk and this shows that it is primarily an immunological substance [15]. Pre-term milk and hind milk also tend to be higher in protein and fat [15]. The variation of breast milk has led to breast milk being referred to as the "ultimate personalised medicine" [12]. As an elaboration, Cesar Victora has labelled breastfeeding as a biological dialogue in

which the infant communicates its needs to the mother, and the mother responds by altering the quantity and composition of milk [18, 19].

Benefits of breastfeeding

Breastfeeding has both short- and long-term benefits to the infant and the mother. In the short term, breastfed infants have adequate nutrients for growth and development and lower infection-related morbidity and mortality [12, 20]. The reduction in infection-related morbidity and mortality is mainly a result of the decrease in diarrhea and pneumonia-related morbidity and mortality [21-23]. In the long term, there is some evidence that breastfed children are more intelligent [24], have lower chances of becoming overweight or diabetic and are less likely to have malocclusion [20, 25, 26]. Mothers that breastfeed have reduced risk of postpartum haemorrhage, postpartum weight gain, breast cancer, ovarian cancer and diabetes [12, 27, 28]. In addition, breastfeeding improves birth spacing [12]. The benefit of birth spacing is mostly effective if the mother exclusively breastfeeds the newborn; and this should be used alongside contraceptives. In order to maximally achieve the benefits of breastfeeding outlined above, breastfeeding should be done optimally (appropriately).

Optimal breastfeeding

Optimal breastfeeding includes early initiation of breastfeeding (within one hour of birth), exclusive breastfeeding up to six months of life and continuation of breastfeeding in addition to complementary foods for two or more years. The benefits of exclusive breastfeeding seem to be well appreciated by health workers and policy makers hence a lot of effort and advocacy in the last decade has focused on this low cost intervention. However, the concept of early breastfeeding initiation is less appreciated [29, 30].

Early initiation of breastfeeding

Early initiation of breastfeeding involves putting the newborn onto the breast within one hour after birth. The prevalence of mothers who practice early initiation of breastfeeding is low in Uganda [31] and the world at large [12] with only about half of mothers practicing early initiation of breastfeeding [12]. This practice independently and synergistically (with exclusive breastfeeding) reduces both morbidity and mortality among children under the age of five years [12, 32-36]. Consequently, the practice of early breastfeeding initiation is listed as a priority intervention to improve neonatal health and survival [10]. Children who are breastfed earlier experience fewer episodes of diarrhoea and other infectious diseases [37]. This is partly due to the ingestion of colostrum, which has immunological and anti-inflammatory benefits [29, 32]. In addition, children who start breastfeeding early are more likely to be breastfed exclusively and for a longer period [29, 38, 39]. Furthermore, early breastfeeding initiation confers long-term benefits to the immune system of newborns [40, 41]. There is a growing body of evidence that shows that the mother's immune cells are ingested by the baby during breastfeeding and gain access to the newborn lymphoid tissues during the immediate postpartum period when the newborn intestinal walls are highly porous [40-42]. The period of high porosity is thought to last for a short period after birth resulting in a "crucial gap period". Early initiation of breastfeeding facilitates the utilisation of this crucial period and results in life long benefits to the immune system of the newborn [42]. Finally, early breastfeeding initiation prevents and manages neonatal hypothermia, which is a major risk factor of neonatal mortality [43, 44].

Neonatal hypothermia

Neonatal hypothermia, defined as an axillary temperature less than 36.5 °C [45, 46], is associated with, and contributes to increased morbidity and mortality [43, 44, 47]. Countries with high neonatal mortality are observed to have high rates of neonatal

hypothermia [48]. Hypothermia mainly contributes to mortality by worsening outcomes of severe neonatal infections, pre-term birth and birth asphyxia.

It is estimated that 20% of deaths due to prematurity and 10% of deaths in term babies could be prevented by improved thermal care [49]. Neonatal hypothermia also results in reduced growth and development [50].

Newborns are unable to maintain their body temperature without thermal protection [51]. They are therefore susceptible to hypothermia, due to physical and environmental factors. Physical factors that predispose neonates to hypothermia include: a large surface area to volume ratio, thin skin and low amounts of insulating fat [48, 51-53]. Environmental factors that predispose neonates to hypothermia include: poor thermal practices around the time of birth such as bathing the newborn within 24 hours of birth [54], which is popular in Uganda and other settings in sub-Saharan Africa [55, 56]. Newborns are bathed early because they are perceived to be dirty; due to the visible vernix caseosa on their skin [55, 57-59]. In order to combat neonatal hypothermia, the World Health Organization recommends a warm chain which includes warming the delivery room, immediate drying, delayed bathing, skin to skin care, early and exclusive breastfeeding, appropriate clothing, keeping the baby with the mother, and raising awareness on the dangers of hypothermia [45]. However, these actions are often sub-optimal in many communities in sub-Saharan Africa [60].

Despite a significant proportion of births and deaths in sub-Saharan Africa taking place at home, most estimates of hypothermia in the region are obtained from health facility-based studies [53]. These estimates are therefore not generalizable to areas with high proportions of home births, like Northern Uganda. In order to enrich the scarce literature on neonatal hypothermia, investigators of various neonatal outcomes have been encouraged to incorporate axillary temperature measurements taken with standard inexpensive digital thermometers in their study protocols [53]. The additional benefit of reduction of hypothermia strengthens the argument for scale up of optimal breastfeeding.

Epidemiology of optimal breastfeeding

Generally, in sub-Saharan Africa, breastfeeding is the norm and it is often prolonged [12]. This is beneficial and should be supported. Almost all mothers initiate breastfeeding and continue breastfeeding up to one year [12]. However, early breastfeeding initiation and exclusive breastfeeding are not normative [19].

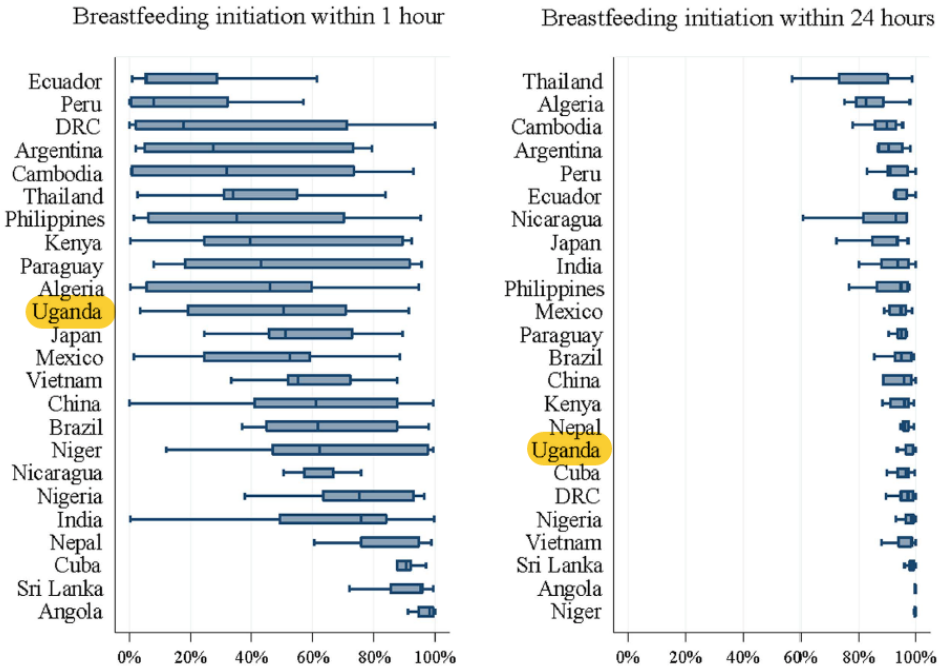

Figure 2: Initiation of breastfeeding practices at participating health facilities by country (median ranges and 25th and 75th percentiles) (Takahashi 2017)

In low- and middle-income countries, the proportion of infants that are initiated on the breast within the first hour after birth is about 50%, and the proportion of infants below 6 months of age that are exclusively breastfed is 40% [12]. However, this proportion varies within, and between countries [61] (fig 2). In the Ugandan demographic and health survey conducted in 2016, two thirds of infants under six months were estimated to have been exclusively breastfed. The prevalence of early breastfeeding initiation was similar.

However, the proportion of infants who were exclusively breastfeed has been stagnant between 2001-2016, while the proportion of infants who were breastfed early increased [62] (fig 3). The increase observed at national level however, was not observed in the region within which Lira district, the study district, is located (fig 4).

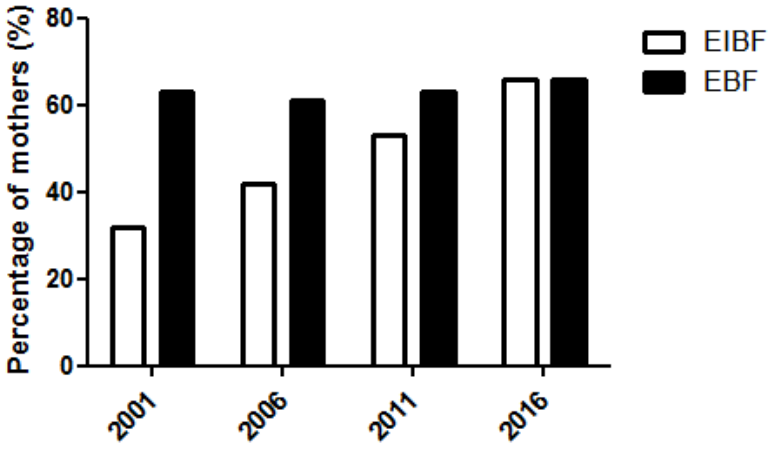

Figure 3: Proportion of mothers who practiced early initiation of breastfeeding (EIBF) and exclusive breastfeeding (EBF) between 2001 and 2016 in Uganda (UDHS 2001-2016)

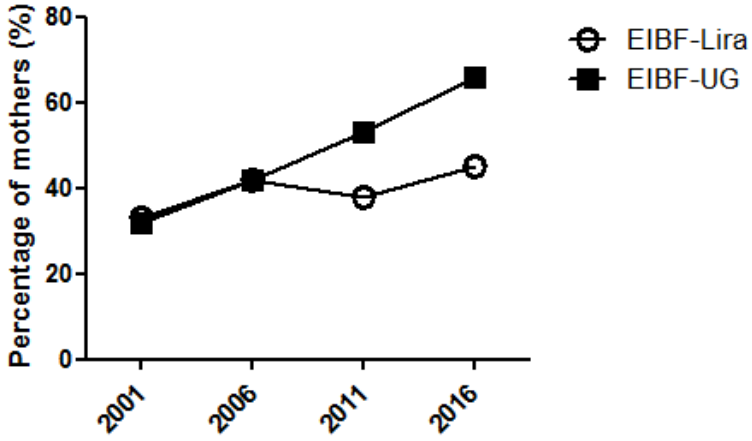

Figure 4: The trend in proportion of mothers who practiced early initiation of breast-feeding (EIBF) in Uganda and Lira District between 2001 and 2016 (UDHS 2001-2016)

Determinants of breastfeeding

Nigel Rollins and colleagues have proposed a new framework (fig 5) that looks at determinants of breastfeeding at the structural, setting and individual level [14]. Structural determinants of breastfeeding include socio-cultural and market-related factors. An example of a socio-cultural factor is the negative perceptions of breastfeeding in public spaces. Marketing of breast milk substitutes, which sometimes involves handing out free samples to mothers in the postnatal ward is an example of a market related factor. Determinants related to the setting include health system, family and community, employment and workplace-related factors. Health system factors include low health workers' knowledge and skills to support breastfeeding. Family and community-related factors include factors such as discarding colostrum, and attitudes of fathers and significant others, towards breastfeeding. Work and employment are major determinants of optimal breastfeeding. Mothers that have to return to work early after birth often choose not to breastfeed, or choose to introduce breast milk substitutes early. Individual factors include subjective norms and preferences, maternal confidence and self-efficacy. Poor breastfeeding techniques, anticipated difficulties and lack of support all prevent women from breastfeeding their infants.

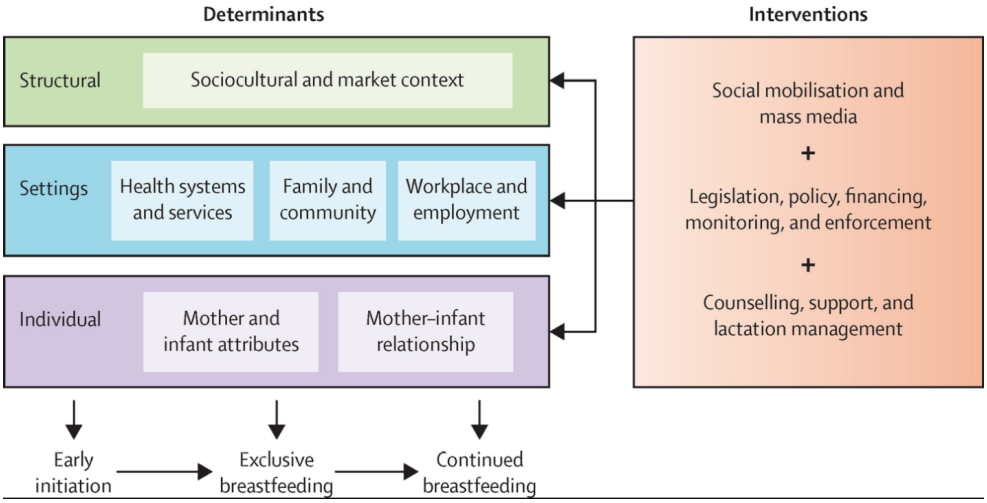

Figure 5: Determinants of breastfeeding (Rollins et al 2016)

Barriers to breastfeeding

There are very few scientifically valid reasons for not breastfeeding; some maternal, and others infant related [63]. Mothers with HIV infection, for whom replacement feeding is "acceptable, feasible, affordable, sustainable and safe" [63], can permanently avoid breastfeeding. Mothers with severe illness like sepsis or herpes simplex on the breast, as well as mothers ingesting medications that can affect the infant (such as psychotherapeutic drugs, anti-epileptic drugs, opioids, radioactive iodine-131, topical iodine, and cytotoxic chemotherapy), may temporarily stop breastfeeding [63]. Breastfeeding may continue under strict supervision and management by a physician in mothers with: hepatitis B or C, tuberculosis, mastitis, breast abscess or those that use substances such as nicotine, alcohol and cannabis. Infants with classic galactosemia, maple syrup urine disease, and phenylketonuria should not be breastfed and should not receive any other milk substitutes, as these are harmful to their health [63]. Infants that are at risk of hypoglycemia, or born weighing less than 1,500 g may receive other food, in addition to breastfeeding, for a limited period of time [63]. However, infants with genuine reasons for sub-optimal breastfeeding are few. Most infants are not optimally breastfed for a number of socio-cultural and health-related reasons. Several studies in sub-Saharan Africa have highlighted reasons why some mothers do not practice optimal breastfeeding [64-66].

A study conducted in Uganda highlighted mothers' lack of knowledge, particularly on early initiation of breastfeeding, as a major barrier to optimal breastfeeding [64]. Other barriers included cultural practices; giving the baby tomato soup to prevent infantile colic, the influence of cultural custodians, and burden of other responsibilities like gardening [64]. Similar findings have been reported in Ghana, but in addition, low breast milk production and sore nipples were cited as barriers to breastfeeding [65]. Another study from the Democratic Republic of Congo found that mothers' lack of decision-making power was a major barrier to optimal breastfeeding [66]. Significant others such

as mothers-in-law, fathers, and grandmothers were reported as being influential in the mother's decision to breastfeed optimally in South Africa [67].

A systematic review of barriers to optimal breastfeeding in low-income countries conducted by Bazzano and colleagues cited low breast milk production, household/work demands and family/peer influence as barriers [68]. Bazzano further found that some cultural beliefs such as breastfeeding altering the breasts of the mother, colostrum being harmful to the baby, and the perception that the baby was still hungry after breastfeeding, were barriers to optimal breastfeeding. Other barriers included: beliefs that giving the baby herbal drinks immediately after birth prevented the baby from getting ill, and that mothers should cease to breastfeed if they got pregnant before the child is two years old. Health system-related barriers were also noted and included low health workers' knowledge and skills on optimal breastfeeding, and lack of advice, counseling, or reassurance to mothers concerning breastfeeding [68].

Another systematic review of barriers to exclusive breastfeeding in low-income countries highlighted similar findings [69]. In addition, it was noted that maternal employment, lack of support from family and community, delayed onset of lactation, frequent crying by the baby, lack of workplace flexibility or lactation rooms, were barriers to optimal breastfeeding [69].

Negative cultural influences on optimal breastfeeding

Around 3-10 % of mothers in Uganda discard colostrum [70] and a quarter (27%) of all newborns in Uganda are given prelacteal feeds [62]. Colostrum discarding is often a result of a cultural belief, that colostrum is dirty, and could be harmful to the child [55, 71]. Prelacteal feeds are given due to a perception that the babies are thirsty or hungry and the perception that the mothers don't have enough milk [72]. In addition, many cultural rituals for the inclusion of babies into the clan or lineage involve giving the newborn something to taste for instance water, alcohol, herbal solutions, and cow's milk.

For example, newborns in certain parts of Karamoja are given butter or millet porridge as part of the naming rituals [72]. In parts of Central Uganda, newborns are given drops of a herbal mixtures called *Kyogero* to give them good luck and to prevent illnesses [73]. In other parts of the country, tomato juice is given to babies to prevent infantile colic [64].

Breastfeeding promotion

One of the most successful strategies to promote early infant feeding has been the Baby-Friendly Hospital Initiative, which was launched in 1991 by UNICEF and WHO. This initiative was an expansion of earlier guidelines published in 1989 and termed 'ten steps to successful breastfeeding' [74]. The Baby-Friendly Hospital Initiative summarized policies and procedures that "promote, protect, and support" breastfeeding at health facilities. It arose out of the Innocenti declaration on the protection, promotion and support of breastfeeding, which was adopted in Florence Italy in 1990 [75]. Other aspects of the Baby Friendly Hospital Initiative includes: individual or group counseling, immediate breastfeeding support after birth and lactation management [76].

However, the Baby Friendly Hospital Initiative is fundamentally a health facility oriented intervention and is therefore not ideal in settings were a large proportion of mothers give birth at home. In such settings, alternative or concurrent strategies have to be employed. Nigel Rollins categorizes these interventions into: workplace, family and community interventions [14]. Workplace interventions include provision of paid leave for up to six months, lactation rooms, and paid nursing breaks to lactating mothers. Family and community interventions include provision of antenatal support to mothers, fathers and significant others at their homes. Community health workers, peer and breastfeeding counselors/consultants or other health workers often provide this support. Among these, peer counselors have shown a lot of promise in sub-Saharan Africa particularly in the promotion of exclusive breastfeeding.

Peer counseling

Breastfeeding peer counsellors are local community women with experience in breastfeeding who have been trained to counsel their peers on breastfeeding [77]. Peer counsellors often have a common dialect, ethnic background and socio-economic status with the mothers [78]. This ensures that they understand the local beliefs and barriers of breastfeeding and are thus well suited to promote breastfeeding practices [77]. While peer counsellors have been shown to promote exclusive breastfeeding in Uganda [79, 80], their effectiveness in the promotion of early initiation of breastfeeding is equivocal [81, 82]. A Cochrane review, assessing interventions for promotion of early initiation of breastfeeding showed that the available evidence was of low quality and lacked generalizability to low-income countries [76]. Major limitations of peer counsellors include lack of adequate training or supervision and poor rapport with health workers [78]. Supplementing their work with mobile health interventions such as mobile phone messages can mitigate these limitations [83-86].

Mobile phone messages

Mobile health refers to the use of portable information and communication technologies, to support health [83]. A common example of mobile health is the use of short message service (SMS), to promote maternal and newborn health. Mobile phone messages provide clients with health information in between visits, and reminders to perform recommended practices [84]. This is particularly important in low-income countries, which have a chronic shortage of health workers. Mobile phone messages have been shown to improve both early breastfeeding initiation, and exclusive breastfeeding [83, 84, 86]. An added advantage with mobile phone messages is that they have been found to be very cost effective [87]. For any intervention to be effective, they must be targeted at key decision makers and actors [88, 89].

Key decision makers and actors in newborn health

One of the main barriers to scaling up interventions that promote newborn care has been the under-recognition of behavioural and socio-cultural aspects [88]. Traditionally, it has been assumed that mothers are the key decision makers in the perinatal period [90, 91]. This may not be true, particularly in sub-Saharan Africa. Mothers are often (or perceived to be) exhausted in the immediate post-partum period and older relatives often take over the role of caring for mothers and newborns [89]. Antenatal education usually promotes recommended care practices, like newborn care, timely health care seeking, optimal breastfeeding, and also educates mothers on danger signs in pregnancy [92]. The education is usually provided by health workers at health facilities and mainly targets pregnant women, and not the significant others [93]. As a result, the persons who take care of newborns seldom receive antenatal education concerning recommended practices in newborn care [94]. To design effective interventions that promote behavioural change in newborn care, it is important to identify the key decision makers and actors in newborn care [88]. While multiple players could be responsible for various actions in the newborn period, our experience with the study population showed that there was often a key decision maker or an actor, who was ultimately responsible for the action. Previous research highlighted some decision makers and actors, but these were largely obtained in qualitative studies [89, 95] hence could not estimate the magnitude, the relative contribution of different players and the generalizability to wider populations.

Conceptual framework

The conceptual framework (fig 6) is an adaptation of the UNICEF Conceptual Framework on under nutrition [96]. The framework assumes that distal determinants of early breastfeeding initiation influence intermediate determinants, which in turn influence proximal determinants that directly influence early breastfeeding initiation. Early breastfeeding initiation then works through exclusive breastfeeding and reduction of hypothermia to reduce neonatal morbidity and mortality. An intervention, consisting of peer counseling, mama kits, and mobile phone messages, would influence intermediate and proximal determinants of breastfeeding, and consequently lead to early breastfeeding

initiation. However, for such an intervention to be effective, it should be targeted at the key decision makers and actors concerning early breastfeeding initiation and exclusive breastfeeding. In the passage above, the conceptual framework is used as a tool to highlight the various levels in the early breastfeeding initiation pathway, addressed by this thesis.

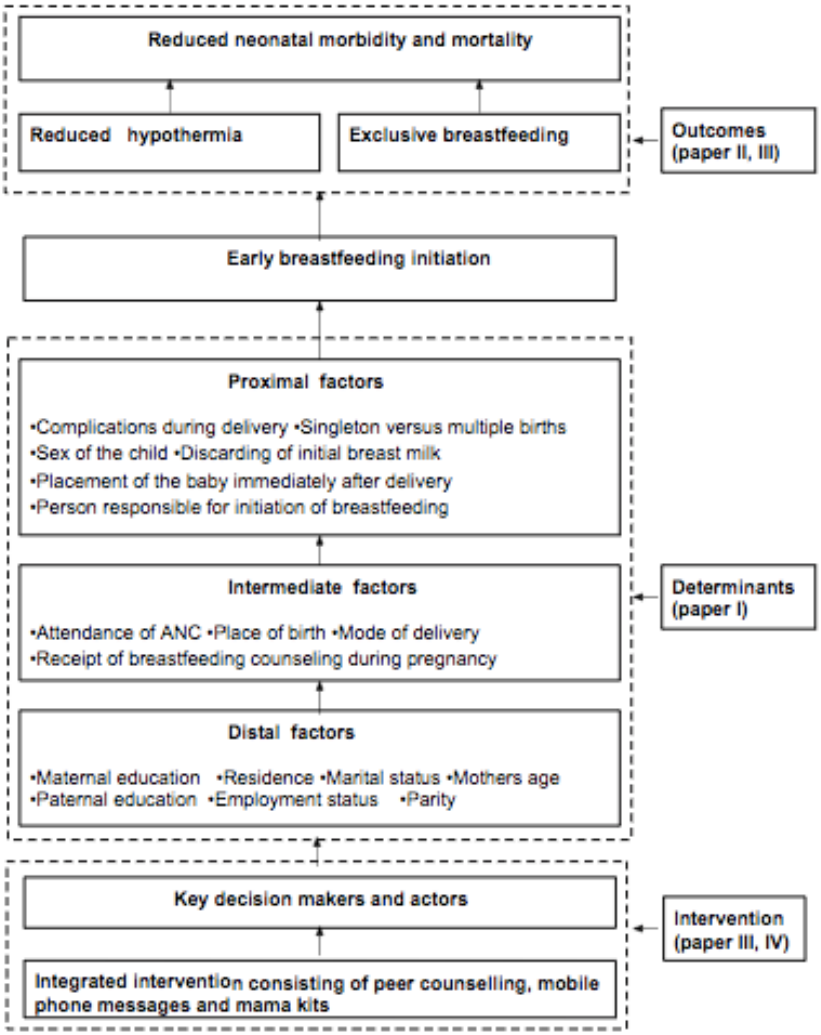

Figure 6: Conceptual framework of topics studied in this thesis adapted from UNICEF conceptual framework of under nutrition

Justification for the studies

As we have seen in the previous sections, optimal breastfeeding could prevent up to 800,000 newborn deaths annually. However, the prevalence of early initiation of breastfeeding and exclusive breastfeeding are still low and need to be scaled up [12]. The proportion of mothers in Uganda who practice exclusive breastfeeding has remained stagnant in the past decade [62]. On the contrary, the proportion of mothers in Uganda who practice early breastfeeding initiation has increased gradually in the last decade. However, this increase was not observed in Northern Uganda [62]. In order to design interventions that promote optimal breastfeeding, the magnitude and context specific factors associated with sub-optimal breastfeeding need to be studied.

It is generally believed that provision of information concerning optimal breastfeeding to mothers improves breastfeeding practices. Peer counseling is an attractive and cost effective means of delivering breastfeeding information [79, 97, 98]. However, the effectiveness of peer counseling in promoting early breastfeeding initiation is unknown.

One of the benefits of early breastfeeding initiation and continued breastfeeding is the reduction in the incidence of hypothermia [99], a major contributor to neonatal morbidity and mortality [43, 44, 47]. However, community estimates of hypothermia in sub-Saharan Africa are unavailable [53]. Knowledge of the incidence and risk factors of hypothermia will highlight the burden and priority groups for targeted interventions to prevent neonatal hypothermia. In addition, this information will enable better estimates of the lives saved by promoting early breastfeeding initiation.

In order to target the right persons when promoting newborn care practices, key decision makers and actors need to be known [88, 89]. Whereas knowledge obtained from qualitative methods has provided insight into the decision makers and actors in newborn care, there is limited data obtained from quantitative methods in this field. Knowledge obtained from quantitative methods could offer a sense of magnitude and generalizability to the key actors and decision makers in newborn care.

Aim and objectives

Aim

The aim of this thesis work was to study newborn care practices in Northern Uganda in order to facilitate implementation efforts

Specific objectives

1. To assess the prevalence and determinants of delayed breastfeeding initiation among mothers in Lira District, Northern Uganda
2. To determine the incidence and predictors of hypothermia among newborns in a community cohort in Northern Uganda.
3. To determine the effect of peer counseling, mobile phone messages, and mama kits on early and exclusive breastfeeding in Northern Uganda
4. To determine key decision makers and actors in selected newborn care practices in Northern Uganda

Study subjects, material and methods

We conducted two formative studies (paper I and IV), one intervention study (paper III) and one follow up study (paper II). The methods used in these studies are described in detail in each paper. However, a summary of the methods is provided in this section.

Table 1: Summary of study methods

Paper	Study design	Sample size	Exposure(s)	Outcome(s)
I	Cross-sectional study	930	Socio-demographic and economic characteristics, determinants of delayed breastfeeding initiation from literature	Delayed breastfeeding initiation
II	Prospective cohort study	1330	Socio-demographic and economic characteristics, determinants of neonatal hypothermia from literature	Neonatal hypothermia
III	Cluster randomized controlled trial	1877	Integrated intervention consisting of peer counseling, mobile phone messages, and mama-kits	Early breastfeeding initiation Exclusive breastfeeding
IV	Cross-sectional study	930	Socio-demographic and economic characteristics, determinants of maternal decision making from literature	Key decision makers and actors

Study area

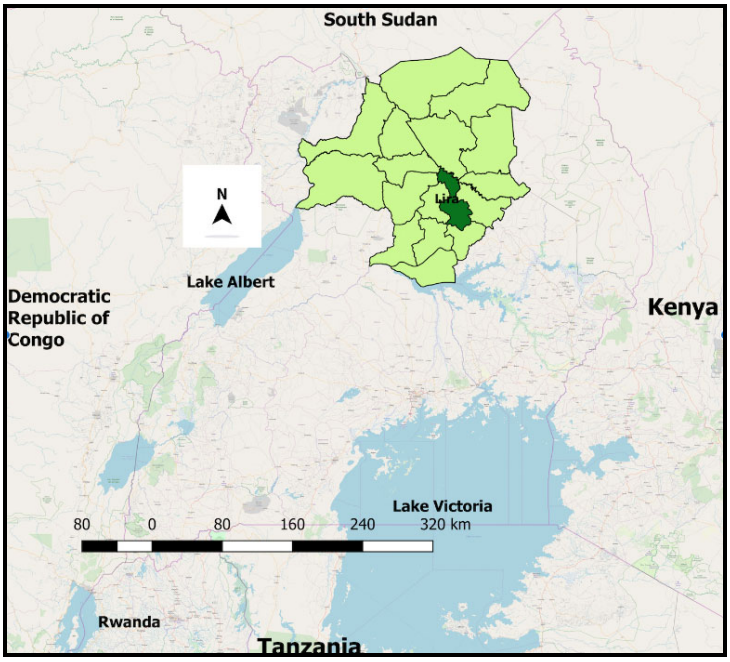

Figure 7:Map of Uganda showing the location of Lira District (dark green) and Northern Uganda (light green)

The studies were conducted in Lira District, located in Northern Uganda (fig 7). Lira District is approximately 350 km north of the capital city, Kampala. It has 13 sub-counties, 1 municipality, and 751 villages. The majority of the population is of *Langi* ethnicity, and the main language spoken is *Lango*. Lira district had approximately 400,000 people in the 2014 census [100]. The baseline studies were conducted between August and November 2016, in three sub-counties: Aromo, Agali, and Lira Municipality (fig 8). Aromo and Agali were chosen because they had the poorest maternal and child health indicators, based on the District Health Officer's report of the previous year. Lira Municipality was chosen because it was the largest urban centre hence could increase the generalizability of the results. Based on the results of the baseline studies, we conducted a cluster randomized controlled trial between January 2018 and March 2019. The study took place in Aromo and Agweng sub-counties in the northern part of the district (fig 9).

They were chosen because Aromo sub-county had the lowest prevalence of facility births and early breastfeeding initiation in the baseline survey. The baseline study had indicated that only 51.8% of mothers with infants less than two years initiated breastfeeding within the first hour after birth [101]. We included Agweng sub-county and one parish in neighbouring Ogur sub-county (fig 9), which are neighbouring areas, to achieve the needed number of clusters. Aromo and Agweng sub-counties are home to about 72,000 people. The average population of a sub-county, parish and village are about 30,000; 2,000; and 300 people respectively. The cluster randomized controlled trial was nested within a larger trial which was using the same intervention to promote health facility births.

Figure 8: Map of Lira District showing location of the baseline survey (green area)

Figure 9: Map of Lira District showing location of the Survival Pluss Intervention (green area)

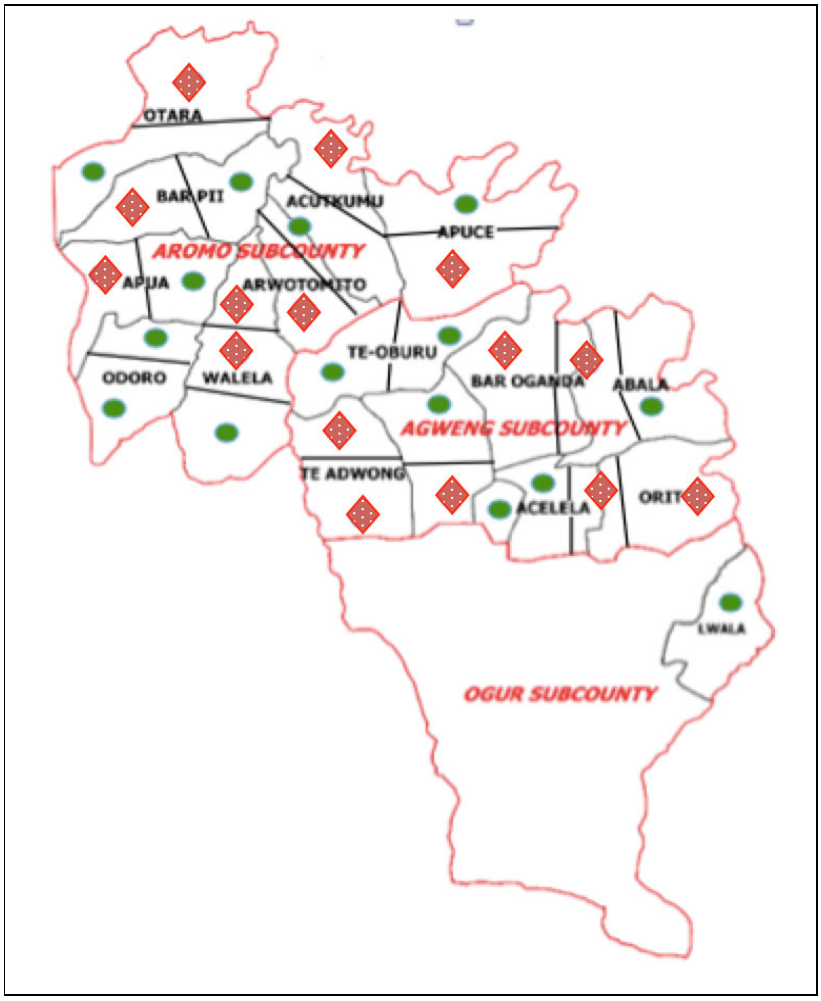

Figure 10: Map of Aromo Agweng and Agali showing intervention (green dots) and control (red diamonds) clusters

Study design and procedure

Paper I and IV

These were cross-sectional studies conducted among mothers with children aged two years or less. A two-stage sampling modification of the WHO EPI method [102, 103] was

used. All villages in the three selected sub-counties and the household populations were listed and 30 villages were chosen by probability proportionate to size. In each village, a sampling frame of all households was used to select a random index household. After identifying the index household, the next household was chosen by selecting the nearest household to the first (the one whose door was closest to the prior household). Only one mother-child pair would be chosen from each household. This process continued until 31 mother-child pairs had been interviewed in each village.

Paper III

Paper III was a community-based cluster randomized controlled trial, designed to evaluate the effect of an intervention consisting of peer counseling, mobile phone messaging and mama kits on the proportion of mothers who practiced early initiation of breastfeeding and exclusive of breastfeeding. The unit of randomization was a cluster: made up of 5 to 10 villages with a population of at least 1,000 people. A total of 30 clusters were randomized (fig 10). We conducted a cluster randomized controlled trial because the nature of the intervention was both individual and family directed, and there was a high risk of contamination had the randomization been individualised. We also wanted to avoid conflict, since it would appear discriminatory for peer counsellors to visit some women giving them mama kits and yet not visiting their neighbours. The study participants comprised of pregnant women living in the study area. Women, who were 28 or more weeks pregnant or visibly pregnant and who were resident in the selected clusters were included in the study. The women gave informed consent before enrolment into the study. Women were excluded if they intended to move away from the study area within 6 months of enrolment. Mothers who had overt mental disorders or had experienced a miscarriage, or stillbirth were also excluded. All clusters within the study area were randomized.

Intervention

The intervention was an integrated package, consisting of peer support by pregnancy buddies, provision of mama kits and mobile phone messaging, administered at the individual and family level but not at the cluster level.

Co-intervention

The study was nested within a larger study designed to evaluate the effect of an intervention consisting of peer counseling, mobile phone messaging and mama kits on the proportion of mothers who gave birth at health facilities. The participants in the trial concurrently received messages encouraging health facility births and postnatal hospital visits. The trial was registered at http://clinicaltrial.gov/ as NCT02605369.

Support by peer counsellors

Each village elected their peer counselor during the sensitization meeting. These were literate women of reproductive age (18-45 years), who were trained for 3-days plus a monthly 1-day refresher training and feedback session for the entire period of the trial. Training materials used to promote breastfeeding practices were adapted from a similar study in Uganda [79] conducted by the same principal investigators. Counseling skills were taught by demonstrations and role-plays. In total, 114 peer counsellors were trained. Each peer buddy counselled 5-15 mothers, and each visit would last between 20-60 minutes. After obtaining consent from the participant, at least four peer buddy visits were scheduled. The first visit would take place immediately after recruitment while the next two visits were scheduled to take place at the mother's convenience before delivery. The last visit would take place within the first three days post-partum. Topics discussed in the first three visits included: encouraging health facility births, developing a birth preparedness plan, counseling the mother on danger signs in pregnancy, benefits of initiating breastfeeding within the first hour, benefits of exclusive breastfeeding, advantages of colostrum, skin-to-skin care, and the dangers of pre-lacteal feeding. The

fourth visit mainly encouraged the mother to go to the health facility for postnatal care within the first week of life. Counseling took place at the mothers' homes and involved the mother, husband, mother-in-law, and any significant others (fig 11).

Figure 11: A peer counselor performing a home visit

Mobile phone messaging

Peer buddy counseling was supplemented by mobile phone messaging to the study participant or any other family member, in case the participant did not have a mobile phone. The mobile phone messages contained the same messages discussed in the counseling sessions: encouraging health facility births, birth preparedness, early initiation of breastfeeding, and skin-to-skin care. The text messaging system was automated with messages being sent weekly until birth. A message was also sent after birth to encourage postnatal health facility visits. The messages were validated and translated into *Lango*,

the local language. The role of mobile phone messages in this study was to reinforce the information offered by peer counsellors and to remind mothers.

Mama kits

Figure 12: A research participant sited with her newly obtained mama kit

All participants in the intervention clusters were given mama kits. Mama kits (fig 12) are clean delivery kits, which contain; gauze, cotton wool, a razor blade, umbilical cord ties, soap, 2 pairs of sterile gloves, a polythene sheet and a child growth monitoring and immunization card [104]. These were given to the women during the third trimester. The distribution of mama kits was meant to motivate women to give birth at a health facility [105]. However, it was also envisioned that the distribution of mama kits could avoid unnecessary delays in the birth process, which result in delayed initiation of breastfeeding. Additionally, since we distributed mama Kits to mothers during

pregnancy, we hoped that their benefits could also benefit mothers who failed to give birth at a health facility. Mama kits are supposed to be given free of charge, to mothers during childbirth, at all government owned health centres, but frequent stock outs have resulted in mother having to buy their own kits prior to going to health facilities for child birth [105].

Comparator

Participants in the control area received the standard of care, which involved occasional radio health promotional messages by the Ministry of Health, as well as information obtained during the antenatal, natal, and postnatal health facility visits. This information was often delivered to pregnant women during each visit, in-group sessions, and often in a didactic format. Topics covered majorly included malaria, HIV, immunisation, with less emphasis on newborn care [106]. Exclusive breastfeeding was the main focus whenever breastfeeding information was given.

Paper II

This was a prospective cohort study which included newborns born alive to mothers in the control arm of a cluster randomized controlled trial promoting newborn care practices and health facility births, described above. A team of 42 research assistants collected data and conducted the measurements on the day of birth, or as soon as possible after birth. Most (87%) of the neonates were visited within the first 3 days after birth. A high axillary temperature was taken during a home visit. We used a lithium battery-operated digital thermometer: Model TM01 (manufactured by Cotronic Manufacturing, Shenzhen). The research assistants were trained on how to measure temperature and were supervised by a team consisting of three paediatricians, one obstetrician, two general practitioners, one nurse and one data analyst. Temperature measurements were mostly conducted before taking the baby's anthropometric measurements; with emphasis being placed on minimizing the time the babies were exposed to the cold. Measurements were conducted either in the caretaker's arms or on a cloth placed on the floor (fig 13). Measurements

involved putting the tip of the thermometer high up in the middle of the axilla and holding the arm in place until an automatic audible beep was heard (fig 13). Two measurement readings in degrees Celsius were taken and the mean of these used.

Figure 13: A research assistant measuring the temperature of a newborn

Variables

Paper I: The dependent variable was initiation of breastfeeding. Women were asked how long after birth the baby was put to the breast for the first time. Responses were recorded in minutes and/or hours. The dependent variable was categorized as early initiation if breastfeeding was initiated within the first hour after birth and late initiation if breastfeeding was initiated later than 1 hour after birth. Exposure variables included mother's age at last birthday, collected as a continuous variable but categorized into <19, 20-24, 25-29, 30-34, and ≥35. Maternal and paternal education was categorized as none, primary (up to 7 years of school), secondary (between 8 and 13 years of school) and

tertiary education (between 1 and 3 years of school after secondary school). Mother's employment (activity outside the home) was categorized as yes or no, marital status was categorized as single if the mother was not living with a partner (single, divorced, widowed, separated) and married if the mother was living with a partner (married, cohabiting). Residence was categorized as (rural / urban). Other variables included: parity (1, 2 or 3, 4, >5), place of delivery (facility / home), mode of delivery (vaginal / caesarean delivery), any complications during delivery such as; vaginal bleeding, obstructed labour, sepsis, birth asphyxia, cord prolapse, small baby, breathing/crying problem at birth (yes / no), prematurity at birth (yes / no), singleton versus multiple births, sex of the child (male / female), placement of baby immediately after delivery (side of mother, abdomen or chest of mother, other), receipt of breastfeeding counseling during pregnancy (yes / no), person responsible for initiation of breastfeeding (mother / person other than mother) and discard (throwing away) of initial breast milk (yes / no).

Paper II: The outcome variable in this study was hypothermia, which was defined as an axillary temperature less than 36.5°C. This was categorized into mild, moderate and severe based on the WHO definitions [45]. Hypothermia was categorised as mild hypothermia if the axillary temperature was between 36.0°C and 36.5°C, moderate if the temperature was between 32.0°C and 36.0°C, and severe hypothermia if the temperature was less than 32.0°C. Data were collected on several risk factors during pregnancy and immediately after birth. These included: maternal age, parity, maternal education, paternal education, wealth, singleton or multiple birth, sex of the newborn, place of birth, birth weight, early breastfeeding initiation, bathing of the newborn, and the place the newborn was placed immediately after birth. We classified a season as wet if the average monthly precipitation was 60 mm or more (Koppen-Geiger climate classification) [107]. The average monthly precipitation and temperature for the study period were obtained from Ngeta weather station, in Lira district. Wealth quintiles were calculated from an asset-based index using principal component analysis [108, 109]. The following assets and house characteristics were considered: cupboard, bicycle, radio, mobile phone,

motorcycle, cement floor, iron sheets, burnt bricks, and land ownership. We defined early breastfeeding initiation as the initiation of breastfeeding within one hour of birth.

Paper III: The primary outcomes of this sub-study were early initiation of breastfeeding and exclusive breastfeeding during the first 28 days of life. Early initiation of breastfeeding was defined as initiating breastfeeding within the first hour after birth. Research assistants approached participants within 24 hours after birth, and asked them whether they had initiated breastfeeding, and if yes, after how long in minutes and hours (when applicable) they initiated breastfeeding. If the mother had not initiated breastfeeding by the time the research assistant came for the visit, the research assistant returned on day 7, and 28 to obtain the information. Exclusive breastfeeding was defined as not giving the baby anything else apart from breast milk, medicines (including vaccines and vitamins), and oral rehydration salts for the first 28 days of life. Mothers were asked if they fed their babies anything apart from breast milk in the preceding 24 hours and since birth apart from medicines and vitamins. Data were collected on potential confounders during pregnancy and immediately after birth. These included: maternal age, parity, maternal education, occupation, antenatal care attendance, maternal morbidity, wealth, household size, singleton or multiple birth, sex of the infant, birth weight, gestational age, place of birth, and marital status.

Paper IV: To determine the key decision makers and actors in newborn care, mothers were asked the following questions regarding their most recent birth experience: Who mainly decided where you should give birth? Who dried your baby immediately after birth? Who first bathed your baby? Who mainly decided when you initiated breastfeeding? Who mainly decided what you did with the initial breast milk? Who mainly decided whether or not you practiced bottle-feeding? Who applied substances to the umbilical cord of your child immediately after birth? Who mainly decided whether or not to seek care for your sick newborn? (Addressed to only those who reported having had a sick newborn). We defined key decision makers and actors as the most frequently

cited decision maker or actor, and common decision makers and actors as the two most frequently cited decision makers and actors. The newborn care practices studied were obtained from lists of recommended newborn care practices [110-113]. Socioeconomic status quintiles were calculated from an asset-based wealth index using principal component analysis. Other variables collected included: maternal age, maternal education, paternal education, marital status, parity, residence, maternal employment, and place of birth. These were collected to offer a general description of the study participants, and to act as explanatory variables or confounders in the multivariable analysis. We classified place of birth as a newborn care practice with an understanding that newborn care begins during birth, and therefore, the choice of the place of childbirth is a distal newborn care decision.

Sample size estimation

Paper I and Paper IV

A total of 930 mother-child pairs were enrolled in the study. This was calculated by Open-Epi *(http://www.openepi.com)* [114], assuming a prevalence of 51%, of those who practice early initiation of breastfeeding, a prevalence obtained in a community study done in Eastern Uganda [110]. We assumed a precision of 5%, and a design effect of 2. This gave us a sample size of 768 participants. Assuming a non-response of 15%, we came up with a sample size of 904. To achieve a self-weighted sample, we decided to enrol 31 children from each of the 30 villages. Concerning factors associated with delayed initiation of breastfeeding, we calculated sample sizes of various exposures and finally used 'place of delivery' which gave us the largest sample size. We calculated this using Open-Epi [114] sample size calculation for detecting differences between proportions of two groups (Fleiss with CC) assuming that 60% of mothers delivered in health facility while 40% delivered from home, and assuming the proportion of mothers who practiced delayed initiation of breastfeeding was 70% among those who gave birth

at home and 58% among those who gave birth at a health facility [115]. This yielded a sample size of 551. Therefore, the sample size calculated for the prevalence objective was sufficient to study the factors associated with delayed breastfeeding initiation.

Paper II

We enrolled 1330 neonates in paper II. The participants were initially enrolled in a cluster randomized controlled study which had a neonatal hypothermia intra cluster correlation coefficient of 0.044 an average cluster sample size of 65, giving us a design effect of 3.8, and effective sample size of 350. This sample size results in absolute precision of 1.5% to 5.2%, i.e. the difference between the point estimate and the 95% confidence interval (CI) for incidence values ranging from 2% to 50%. Since we were studying a very common outcome, we deemed this precision adequate.

Paper III

We used Stata IC version 14 (StataCorp, College Station, Tx, USA) to calculate the sample size [116], with 95% CIs and 90% power. We assumed that 50% of mothers would initiate breastfeeding within the first hour after birth, a finding we obtained from the baseline survey. We also assumed an average cluster size of 50 pregnant women; and an intra-cluster correlation coefficient (ICC) of 0.09. To detect a 20% increase in the proportion of mothers initiating breastfeeding within the first hour in the intervention clusters; we needed 15 clusters per arm and a minimum sample size of 750 participants per arm or a total of 1,500. The sample size we calculated was less than 1800 that had been calculated for the primary objective of the parent study, and hence this study population exceeds our calculated sample size.

Data analysis

Data were collected on mobile phones using Open Data Kit software (https://opendatakit.org) (fig 14) and analysed using Stata version 14.0 (StataCorp; College Station, TX, USA). Continuous descriptive variables were presented as means

and standard deviations. Categorical variables were presented as proportions. We used chi-squared tests to tests for comparison of categorical variables and reported the resultant *p* values. We performed bi-variable and multivariable logistic regression to determine the association between the independent factors and the dependent variables. Factors known to be predictors of the dependent variables from the literature and those with a bi-variable *p*-value <0.25 (as long as they were not in the casual pathway and they were not strongly collinear with other independent variables) were considered for multivariable analyses. Collinearity was assessed for all variables considered in the multivariable analyses and factors were considered to be strongly collinear if their variance inflation factor (VIF) was greater than 10. In case of collinearity, the factor with a stronger measure of association with the outcome variable was retained and the other dropped.

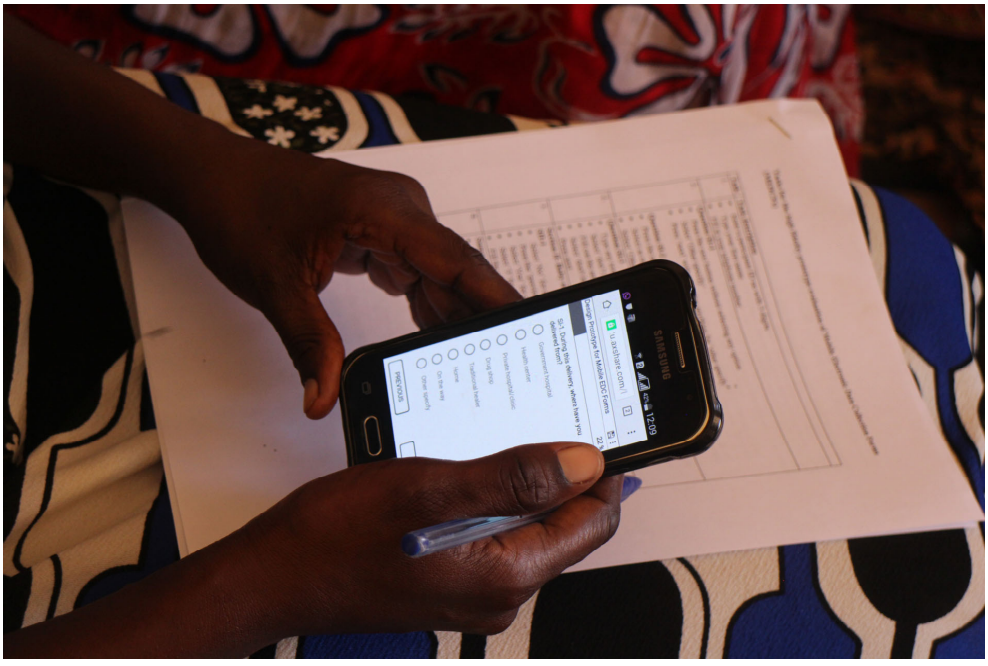

Figure 14: A smart phone displaying an Open Data Kit platform

Paper I and Paper IV

We performed bi-variable and multivariable logistic regression to determine the association between the independent factors and the dependent variables.

Paper II

Hypothermia was categorized using both the WHO classification [45], and a classification suggested by Mullany et al [117], and presented as proportions with corresponding 95% Confidence Intervals adjusted for clustering. Factors associated with moderate to severe hypothermia were determined using a generalized estimating equation model for the Poisson family, with a log link, taking into account the clustering, and assuming an exchangeable correlation.

Paper III

We compared baseline characteristics of the mother, household and new-borns between the intervention and the control groups to check for group comparability and identify potential confounders. Analysis of the main outcome was based on intention-to-treat. The primary analysis compared the prevalence of mothers who initiated breastfeeding within the first hour, and who exclusively breastfed in the first 28 days of life, in the intervention and control group. We calculated prevalence ratios for early initiation of breastfeeding, and exclusive breastfeeding using a generalized estimating equation model for the Poisson family, with a log link, taking into account the clustering, and assuming an exchangeable correlation. This was done by a) trial arm and b) by cohort design; factors different across the two arms were entered into a multivariable generalized estimating equation model. Prevalence differences were calculated as above but using an identity link instead of a log link. We also calculated socioeconomic inequality using the STATA DASP package and we report Concentration Indexes.

Ethics

For all studies, we obtained ethical approval from the following bodies: 1) Research and Ethics committee School of Medicine, Makerere University 2) Uganda National Council of Science and Technology 3) Regional Committees for Medical and Health Research Ethics (REK VEST 2017/2079). The trial was registered at ClinicalTrial.gov as NCT02605369. We also obtained permission from the Ministry of Health and Lira Local Government before conducting the studies. Written informed consent was obtained from the respondents in the study. Research assistants were trained on the importance of confidentiality of the information and the right of the respondent to withdraw their participation at any time during the study. Infants found to be ill, or having any health related challenge during the study, were referred to the health centers. In case mothers had financial or transport related challenges accessing the health services, the study would facilitate them.

Summary of results

Paper I

Study participants

A total of 930 mother-child pairs were enrolled. The mean (standard deviation, SD) maternal age was 25.8 (5.9) years and the mean child age was 11.2 (7.7) months. The majority (78.4%, 729) of the mothers had only a primary level education. Forty four percent (405) of the mothers had four or more children.

Prevalence of delayed breastfeeding initiation

Almost half [448/930: 48.2% (95% Confidence Interval (CI) 44.3,52.1)] of mothers delayed initiation of breastfeeding. The prevalence of delayed breastfeeding initiation was similar in Lira municipality 46.3% [95%CI 39.9, 52.9] and Agali sub-county [46.4% 95% CI 40.2,52.7] but higher in Aromo Sub-county 51.3% [95% CI 42.7, 59.8]. When we restricted the analysis to mothers with children aged three months or less (n=172), 50.6% of the mothers delayed initiation of breastfeeding, 95% CI (42.9-58.2).

Factors associated with delayed breastfeeding initiation

Factors associated with delayed breastfeeding initiation at multivariable analysis included caesarean section delivery [Adjusted Odds Ratio (AOR) 11.1: (95% CI 3.7, 33.0), discarding initial breast milk [AOR 2.0: (95% CI 1.4, 2.9)], home births [AOR 1.4: (95%CI 1.0, 2.0)], and mother solely deciding when to initiate breastfeeding [AOR 1.7 (95% CI 1.3, 2.3)]. Having a secondary school education was protective against delayed initiation of breastfeeding compared to no education [AOR 0.54: (95% CI 0.30,0.96)].

Paper II

Participant characteristics

We recruited 1,330 participants in this study. The mean age of mothers in the study was 24.6 years (SD 6.8) and their median education was 5 years (Inter Quartile Range (IQR 3-6). The mean weight of children in the study was 3.2 (SD 0.5).

Hypothermia

The mean temperature was 36.4°C (SD 0.7), and the median temperature recorded was 36.4°C (IQR 36.1°C -36.8°C). The minimum temperature recorded was 32.0°C, and the maximum temperature recorded was 39.4 °C. The incidence of hypothermia (temperature less than 36.5°C) was 678/1330 [51.0%: 95% CI (46.9-55.1)]. Thirty two percent (429/1330), 95%CI (29.5-35.2)] had mild hypothermia (temperature 36.0°C - <36.5°C), while 18.7% (249/1330), 95% CI (15.8-22.0) had moderate hypothermia (temperature 32.0°C - <36.0°C). No child had severe hypothermia (temperature less than 32.0°C).

Mortality

The risk of death among newborns with moderate hypothermia was 3/249 (1.2%, 95%CI 0.38-3.7) compared to 6/1023 (0.59%, 95% CI 0.28-1.2) among newborn with normal temperature resulting in a crude risk ratio of 2.0 (95% CI 0.60-6.9).

Factors associated with hypothermia

At multivariable analysis, the factors associated with neonatal hypothermia included: home birth [Adjusted Risk Ratio, ARR, 1.9, 95% CI (1.4-2.6)], low birth weight [ARR 1.7, 95%CI (1.3-2.3)], and delayed breastfeeding initiation [ARR 1.2, 95%CI (1.0-1.5].

Paper III

Participant characteristics

We identified 2,345 pregnant women but recruited 1,877 into the study from January 2018 to February 2019 (figure 15). Nine hundred ninety-five (995) were randomized to the intervention arm while 882 were randomized to the control arm. Breastfeeding initiation status was assessed for 926 participants (93%) mothers in the intervention and for 829 (94%) in the control (figure 15). A few baseline differences were noted among the participants. Almost 16 % (155/995) of the participants in the intervention arm had electricity in their homes compared to 6.2% (55/882) in the control arm. Mothers in the intervention arm were more likely to give birth at a health facility, and to have mobile phones in their homesteads. Overall, only 55% (n=1024) of participants owned a mobile phone in their household.

Effect of the intervention on early and exclusive breastfeeding

Sixty-four percent (337/511) of participants in the intervention arm, initiated breastfeeding within the first hour after birth compared to 60% (255/423) in the control arm. Participants in the intervention arm were almost as likely to initiate breastfeeding early compared to participants in the control arm [PR 1.08 (0.97-1.21)]. Eighty-nine percent (804/904) of participants in the intervention arm exclusively breastfed their infants in the first month of life compared to 81% (656/813) in the control arm. Participants in the intervention arm were 10% more likely to have exclusively breastfed in the preceding 24 hours compared to participants in the control arm [PR 1.10, 95% CI (1.04-1.17)], and 16% more likely to have exclusively breastfed since birth compared to mothers in the control arm [PR 1.16, 95% CI (1.03-1.30)].

Adjusting for baseline characteristics and equity analysis

When we adjusted for presence of electricity and presence of a mobile phone in the household, mothers in the intervention arm were as likely to have initiated breastfeeding early, and as likely to have exclusively breastfed as before adjustment. Forty percent

(n=683) of mothers reported that health workers were responsible for the timing of the first breastfeeding session. When we restricted the analysis to only mothers who decided on when to breastfeed, there was some evidence of intervention effectiveness [PR 1.20, 95%CI (0.99-1.5)] (fig 16). Early breastfeeding initiation was pro-rich [Concentration Index 0.045, 95% CI (0.011-0.079)] but the intervention did not decrease this inequality. There was almost no inequality with regards to exclusive breastfeeding (fig 17). The intra-cluster correlation for early initiation of breastfeeding was 0.03, 95% CI (0.01-0.07), whereas the intra-cluster correlation for exclusive breastfeeding was 0.07, 95% CI (0.03-0.15).

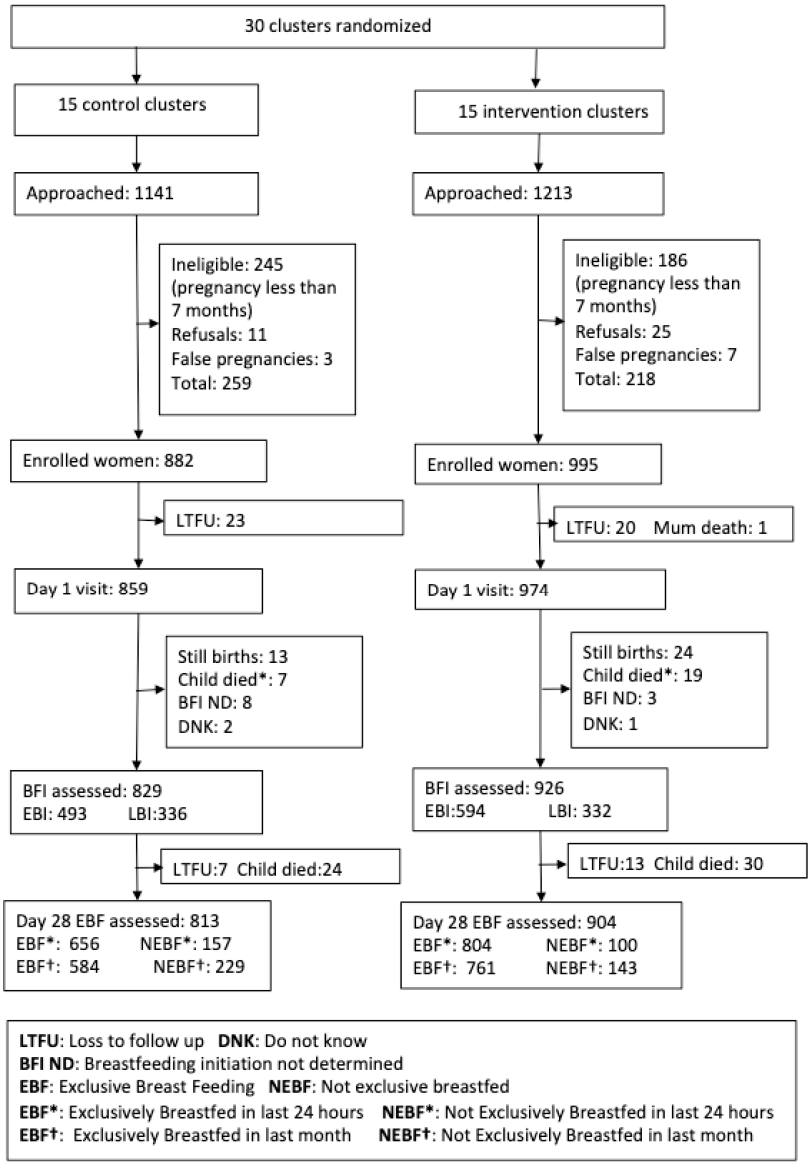

Figure 15: Flow chart of participant recruitment in a cluster randomized controlled trial promoting optimal breastfeeding in Lira district, Northern Uganda

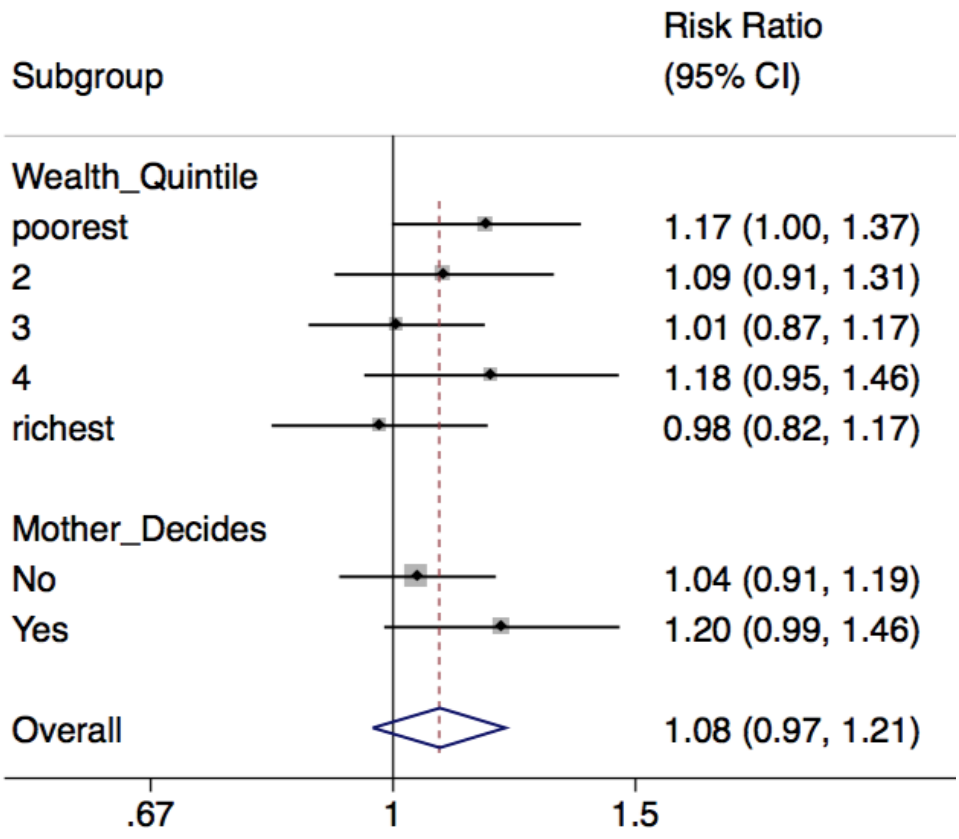

Figure 16: Sub group analysis showing the effect of the intervention on early initiation of breastfeeding by wealth index and mother's decision regarding early initiation of breastfeeding in Northern Uganda

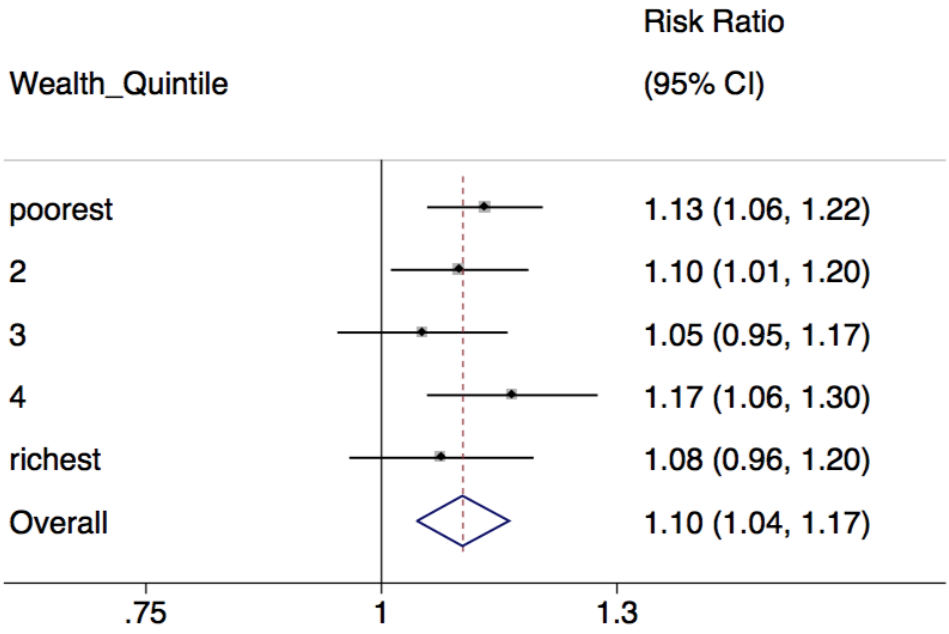

Figure 17: Sub group analysis showing the effect of the intervention on exclusive breastfeeding (measured by 24-hour recall) by wealth index

Paper IV

Study characteristics

We enrolled 930 mother infant pairs in this study. The mean (standard deviation, SD) maternal age was 25.8 (5.9) years, and the mean child age was 11.2 (7.7) months. Majority (78.4%) of the 930 mothers had only a primary level education. Forty four percent (405) of the mothers had four or more children.

Key decision makers and actors in newborn care

Fathers most commonly decided on where a mother gave birth (54.3%, *n* = 505), but the mothers (31.1%, *n* = 289) were also common decision makers. Fathers also most commonly decided on whether to seek care for a sick newborn child (47.7%, *n* = 92). Grandmothers most commonly bathed the baby immediately after birth (55.5%, *n* = 516), whereas mothers most commonly decided on when to initiate breastfeeding (53.7%, *n* = 499) and on whether to bottle-feed (73.6%, *n* = 684). Health workers were also commonly cited in the decision to initiate breastfeeding and to practice bottle-feeding. Traditional birth attendants were most implicated in applying substances to the umbilical cords of newborns immediately after birth. The distribution of key decision makers in the subgroup analysis (rural residence, first-time mothers, and home births) was similar to that of the overall population. A notable difference in the subgroup analysis was that grandmothers were more involved with first-time mothers.

Factors associated with the mother being the key decision maker

At multivariable analysis, factors associated with the mother being the key decision maker for where she gave birth included: mother having a secondary education compared to no education (adjusted odds ratio, AOR 1.9: (95% CI 1.0, 3.6)), mother having parity of 4 or more compared to one (AOR 2.1: (95% CI 1.2, 3.8)), and mother being employed (AOR 2.0: (95% 1.5, 2.9)). Mothers from households that belonged to the wealthiest quintile were less likely to be mainly responsible for where they gave birth from as compared to mothers from households in the poorest quintile (AOR 0.44: (95% CI 0.25, 0.76)). Regarding the decision to initiate breastfeeding, older mothers were more likely to decide on when to initiate breastfeeding (AOR 1.3: (95% 0.58, 3.1)), while mothers in rural areas were less likely to make this decision (AOR 0.72: (95% CI 0.52, 0.99)).

Discussion

Discussion of the main findings

In the community-based survey conducted in post conflict Northern Uganda, almost half of all mothers initiated breastfeeding later than an hour post-partum. Factors associated with delay included caesarean delivery, discarding initial breast milk and the mother being solely responsible for initiating breastfeeding. Half of newborns developed hypothermia; 33% developed mild hypothermia, while 19% developed moderate hypothermia. Early breastfeeding initiation was protective against hypothermia. Other factors associated with neonatal hypothermia included low birth weight, and home birth. An intervention consisting of peer counseling, mobile phone messages and mama kits delivered to both the mother and significant others increased the proportion of mothers who exclusively breastfed at one-month postpartum, but did not increase the proportion of women who initiated breastfeeding within the first hour after birth. Health workers were the key decision makers regarding initiation of breastfeeding in the trial. Mother, fathers, grandmothers, health workers, and traditional birth attendants were the key decision makers and actors in newborn care, albeit for different practices.

Prevalence and determinant of delayed breastfeeding initiation

Almost half of the mothers we surveyed delayed to initiate breastfeeding. This is in agreement with the global estimates from the Lancet Breastfeeding Series [12]. Countries like Uganda with a huge burden of diarrhea and pneumonia related morbidity benefit most from the scale up of early breastfeeding initiation [13]. Scale up of early breastfeeding initiation is therefore of utmost importance. The World Health Organization categorizes a 52% prevalence early initiation of breastfeeding as good [118]. I argue that countries like Uganda with a huge burden of infectious disease related morbidity and mortality, and with limited resources to scale up other interventions should

set more ambitious individual targets of early breastfeeding initiation. A target of 70% would be more adequately termed as good.

One of the factors associated with delay in initiating breastfeeding was the practice of discarding the initial milk (colostrum). This practice has been observed in many other societies in sub-Saharan Africa such as South Sudan, Ethiopia, and Guinea-Bissau [71, 119, 120]. The practice of discarding colostrum is often due to a misconception that the initial milk is dirty and hence harmful to the neonate [71, 121]. Mothers with this perception wait for the milk to clear before they initiate breastfeeding and hence the delay [122]. Another factor associated with delayed breastfeeding initiation was giving birth at home. Mothers who gave birth at home were more likely to delay initiating breastfeeding compared to mothers who gave birth from health facilities. Similar findings were reported in Nigeria [115]. This could be related to the existing policies and assistance offered in some health facilities, which encourage early initiation of breastfeeding [123]. To support the hypothesis that mothers need assistance to initiate breastfeeding, mothers who were solely responsible for initiating breastfeeding delayed in comparison to the mothers who reported receiving assistance from health workers or relatives. The importance of persons other than the mother in decisions related to breastfeeding practice, and the need to train them for this role is one of the tenets affirmed by the academy of breastfeeding medicine [123].

Among those that delivered at a health facility, caesarean section delivery was the main factor associated with delayed initiation of breastfeeding. This association has also been observed in other studies in Uganda, Nigeria and Vietnam [31, 115, 124]. The practice of separating the newborn from the mother immediately after caesarean delivery could partly explain this delay [125]. In addition, often, mothers are not supported to initiate breastfeeding early after caesarean section [31, 125, 126]. Mothers often feel fatigued and experience pain after caesarean section, which may also contribute to this delay [31]. Specific support for early initiation of breastfeeding is needed for mothers who deliver by caesarean section in order to reduce the delay in this group of women [126]. This is

feasible because majority of caesarean sections in Uganda and other countries in sub-Saharan Africa are done under spinal anaesthesia.

Lastly, education was another factor associated with delayed initiation of breastfeeding. Mothers with a secondary education were less likely to delay initiating breastfeeding. This pattern was also observed in a similar study in Nepal [38], which showed that educated mothers were less likely to delay initiation of breastfeeding. Educated mothers have been shown to feed their children with more attention, discipline, purpose, and intentionality, and this could explain the association observed [127].

The findings from our baseline survey indicated that an intervention promoting health facility births was needed in this area, especially in the northern part of the area as it had the highest prevalence. The findings also suggested that the intervention should also be able to target mothers who give birth at home, mothers with low education, and other important persons in the household. Cultural practices like discarding colostrum should also be addressed in the intervention. In the event that a health facility intervention is possible, mothers who have had a caesarean section should be targeted.

Incidence and predictors of hypothermia

The incidence of hypothermia in this study population was high. About half of the newborns developed hypothermia. Similar findings were observed in other community-based studies in Nepal and India [128] [129]. There have been no previous documented community-based studies from sub-Saharan Africa that have followed up women from pregnancy and determined the incidence of neonatal hypothermia in the first hours after birth [53, 117]. This makes this work crucial and an eye opener in this setting.

One of the main challenges faced by researchers studying hypothermia is the various definitions of hypothermia used and their potential limitations [45, 117, 130]. This could partly explain the difference between the incidence obtained in our study and that from similar studies conducted in India [131, 132]. We defined hypothermia as a temperature

less than 36.5°C in accordance with recommendations from the World Health Organization [45], whereas the Indian studies defined hypothermia as temperature less than 35°C to 35.6°C.

Mothers who practiced early breastfeeding initiation were less likely to have hypothermic babies. This finding was also observed in the community-based study in Nepal [99]. Newborns who are breastfed within the first hour after birth receive warmth through skin-to-skin contact with their mothers [117, 133] and this could explain the observed phenomenon. This finding is further justification of the need to promote early breastfeeding initiation among mothers in the study community and other similar communities.

Newborns who had low birth weight were more likely to be hypothermic compared to newborns with normal birth weight. This is not surprising since low birth weight infants have less capacity to conserve and generate heat mainly as a result a reduced amount of brown fat and a poor shivering reflex [52, 130]. Similar findings have been observed in Nepal [99] and in many other hospital based studies in Uganda, Ethiopia [134, 135], and other countries [136, 137].

Babies born at home were more likely to be hypothermic compared to babies born in health facilities. This finding has also been reported in other settings [130]. A study conducted in Uganda found that mothers who gave birth at home were more likely to practice sub-optimal thermal care practices [113], such as bathing their babies soon after birth [138, 139], which could explain the increased risk of hypothermia observed in these babies. The main reason for bathing newborns early is the belief that newborns are dirty, having come into contact with maternal fluids and vernix caseosa [55, 57-59]. Bathing newborns is also perceived as a prerequisite to good neonatal rest and sleep after birth [57]. As a result, interventions that prevent neonatal hypothermia such as skin-to-skin care, and early breastfeeding initiation are urgently needed.

The effect of peer counseling, mobile phone messages and mama kits on early initiation of breastfeeding and exclusive breastfeeding

Provision of peer counseling, mobile phone messages and mama kits did not increase the proportion of mothers who practiced early initiation of breastfeeding. This was disappointing given the hypothesised intervention theory that anticipated a strong change in behaviour and agency following the peer counseling process. One possible explanation for this surprising result could be the non-inclusion of birth attendants (both health workers and traditional birth attendants) from the intervention. Our study was strictly community based and involved only pregnant mothers and their families. However, the most effective intervention that promotes early breastfeeding initiation is the baby friendly hospital initiative, which is mainly a health facility intervention [76]. The intervention was provided in the antenatal period and therefore, by design; the mothers were not supported to initiate breastfeeding. Involvement of health workers could have bridged this critical gap.

In a review of interventions that improve breastfeeding outcomes, it was noted that breastfeeding interventions that combine health systems, home, family and community settings have the greatest impact [14, 140, 141].

Another possible explanation could be the lack of maternal decision-making power in the immediate postpartum period [142]. We had hypothesized that mothers that received the intervention would demand that their babies be put on the breast immediately after birth. However, health care providers are often the key decision-makers in the immediate postpartum period, and little may be done without their cooperation [143, 144]. Approximately 40% of mothers in our study stated that it was the health workers who decided when they initiated breastfeeding. This suggests that it's crucial to involve health service providers when designing interventions that promote early initiation of breastfeeding [140, 141]. Mothers often experience anxiety in the immediate postpartum period and may not be able to recall the breastfeeding instructions given to them during the antenatal period. To address this, our intervention had also involved significant others

like husbands and co-wives. However, in Uganda, like most other low-income countries, husbands and other relatives do not have access to the labour ward and are often absent during the birthing process [145, 146].

Studies in other settings have observed similar findings to ours [81, 82, 147, 148]. However, other investigators have observed an improvement in the prevalence of early breastfeeding initiation with peer counsellors [70, 149]. A study conducted in Uganda, Burkina Faso, and South Africa and showed that peer counseling improved the early initiation of breastfeeding in Uganda, but not in Burkina Faso or South Africa. These trials were solely conducted to promote breastfeeding practices and did not have any other interventions, and this might have ensured better trial fidelity. However, in low and middle-income settings, packaging groups of interventions is an efficient and effective way to deliver care [11]. We had hoped that utilising peer counsellors to encourage both health facility births, and newborn feeding practices would be more pragmatic and cost-effective.

Whereas the proportion of mothers who practiced early breastfeeding initiation did not change, our intervention increased the proportion of mothers who exclusively breastfed their newborns. Studies done in Eastern Uganda [79], and elsewhere in the world [80, 150, 151] have shown a similar effect. The effectiveness of our intervention to promote exclusive breastfeeding but not early initiation of breastfeeding could be caused by the greater control a mother has over what she can do with her baby in the later postnatal periods, compared to immediate postnatal periods [89]. In order to design better interventions, researchers and implementers need to target the right persons responsible for particular practices. A study on key decision makers and actors in newborn care is therefore essential for future implementation endeavours.

Key decision makers and actors in newborn care

Fathers were key decision makers concerning where the mother gave birth from and whether care was sought for sick a newborn. Similar findings have been observed in other settings [55, 152]. This study adds a quantitative dimension to these findings,

showing that husbands make these decisions in approximately half of all cases. This can be explained by the fact that husbands often provide transport, money, and other instrumental support needed in seeking care for pregnant women and their newborns [153-155].

Grandmothers most commonly performed the first neonatal bath. In the period immediately after birth, mothers are (perceived to be) exhausted [89], and the care of newborns is often delegated to older female relatives who are perceived to be knowledgeable and experienced [59, 156]. This could explain why these older women were most commonly the ones who first bathed the baby. This finding was also observed in other African countries [89]. As expected we found that grandmothers and traditional birth attendants were more involved in the postnatal care of first-time mothers. First-time mothers often lack the knowledge or confidence to care for newborns [89] and delegate these activities to older female relatives who have both experience and necessary knowledge [157]. Sometimes, the younger mothers have differing opinions to those of the older female relatives but forsake them to avoid conflict [157].

Mothers were the key decision makers regarding early breastfeeding initiation. Mothers claimed responsibility for half of the decisions but stated that health workers were responsible for a quarter of the decisions regarding early breastfeeding initiation. Since mothers spend the most time with the babies in the post-immediate period after birth, they are most likely to be the key decision makers concerning practices related to infant feeding. However, health workers were also common key decision makers in breastfeeding practices. Similar findings were seen in Malawi, where mothers were the most often-cited decision makers in breastfeeding, but grandmothers were also involved [94]. These findings from Uganda are in broad agreement with similar literature from Ethiopia, Tanzania, and Nigeria [89] and this suggests that the findings might be cross-cultural in sub-Saharan Africa.

Regarding the decision on the place of birth, more educated mothers and mothers earning money were more likely to decide on the place of birth. Regarding the decision to practice early breastfeeding initiation, older mothers and mothers in urban areas were more likely to decide on when to initiate breastfeeding. This implies that when designing interventions in rural areas, other people key in deciding on breastfeeding initiation like health workers need to be involved.

Discussion of the methods used in the thesis

Factors affecting internal validity

Measurement bias

A major limitation of the cross-sectional study was measurement of the main outcome with a two-year recall window. The long recall period of the time to initiating breastfeeding might have introduced a misclassification bias [139, 158, 159]. The effect of this misclassification could either have under or overestimated the prevalence and the effect of the co-variables [160, 161]. We used this long recall window mainly to enable us obtain a sufficient number of mothers necessary to study breastfeeding initiation in the community using a multistage sampling technique. To gauge the magnitude of the potential misclassification, we conducted sub-group prevalence estimates for mothers who had children under 1 month, 3 months and under 2 years. We found these estimates to be 55%, 50% and 48%, respectively. A validation study done in Eastern Uganda showed high consistency between infant feeding questions asked at birth and those asked at 3 months [162], further research is needed to assess the consistency after 1 year or more. That said, a two year recall period is the recommended standard by the World Health Organization [163] and is also the standard used by the Demographic and Health Surveys which makes it a meaningful period to use for comparative purposes. There is some evidence that suggests that maternal recall is a good estimate for initiation and duration of breastfeeding [164] but a poor estimate for exclusive breastfeeding [164-166].

We improved upon the limitation of outcome assessment in the cluster randomized controlled trial by ascertainment of the outcome as soon as possible after birth.

Two other potential challenges have been noted regarding the measurement of early breastfeeding initiation [159]. The first challenge regards mothers' perception of time. Time to initiation was captured in minutes and hours. However, some participants do not estimate or recall time with that precision and could offer answers like "immediately" or "soon". Our solution to this challenge was probing for a rough estimate. In cases where the mother did not recall, we used the "Do not know" answer option. We believe that the errors in estimating time to breastfeeding increase with delay in breastfeeding. In other words we believe the first few hours (probably two hours) can be estimated accurately after which errors increase exponentially. To counter this, we categorized the main outcome into early versus late initiation. The most ideal way to measure time to breastfeeding initiation would be either to video record or have observers recording the birthing process and the early post-partum period. We were unable to do any of the two.

The second challenge regards the mothers' interpretation of time to breastfeeding initiation. Strictly speaking, time to breastfeeding initiation aims to capture the time to the first attempt to breastfeed [163]. This means that mothers who placed the baby on the breast but did not have breast milk at that time should be considered to have practiced early breastfeeding initiation. Some mothers however interpret the question as time to successful breastfeeding, thus introducing a measurement error. To reduce on the potential for this error, we asked the mothers; "How long after birth did you first put the baby on the breast?".

We could also have underestimated hypothermia by using a digital thermometer, placed in the axilla. Digital thermometers might slightly over or underestimate temperature readings as compared to mercury thermometers [167-169]. We used these because they are inexpensive, locally available, and easy to use by community workers [128]. In addition, digital thermometers are easier to use in poorly lit rural home [128]. We used axillary measurements because they were easier to do, safer, and more acceptable than

rectal measurements [128]. In a systematic review studying differences between rectal and axillary temperatures, the pooled mean difference of rectal minus axillary temperature was estimated to be 0.17°C ranging from -0.15°C to 0.5°C [170].

Regarding the assessment of key decision makers and actors, we acknowledge that decision-making is a complex process involving multiple parties at different levels, and the utilization of a more detailed framework in data collection would have been ideal. Such a framework would have enabled us to address joint decision making, power dynamics, willingness or unwillingness of mothers to make decisions, changing trends of decision making over time, and influence of urbanization/globalization on decision making.

Selection bias

1) Selection of participants into the study

In the baseline survey (Paper I, IV) we used local leaders and village health team members to identify mothers with children under the age of two years in their areas. These leaders were very knowledgeable about the area and often had updated lists of community members in the area. Our response rate was over 90% and we believe the potential of selection bias was low in this study. We did not capture women who had lost their children and did not have children under the age of two years by the time of the survey. Loss of a newborn is regarded, as a very secretive issue in the area and mothers may not open up to strangers about it. Since early breastfeeding initiation is associated with lower mortality [29, 36], exclusion of mothers who had lost a child may have led to an under estimation of the prevalence of delayed breastfeeding initiation. However, since mortality is a rare outcome, we suspect that this bias was very small.

In the intervention study, we hired recruiters and village health team members, who generated independent lists of all pregnant women in their areas. Our response rate was also very high. We therefore believe that selection bias regarding participant selection into the study was negligible.

2) Loss to follow-up

The intervention study had a follow-up rate of over 90% and therefore we believe that the selection bias resulting from loss to follow-up was negligible. However, selection bias is a potential challenge in paper II, where we did not get outcome data for 25% of the potential study participants. Some of these participants had measurements done after 72 hours after birth, and others were not measured at all. We compared baseline characteristics of the missed participants and conducted some sensitivity analyses, which suggested that our estimates of hypothermia were biased downwards; meaning that we might have underestimated the incidence of hypothermia. This is because it was mainly the very sick children who did not get temperature readings in the first 72 hours after birth. This is shown by the fact that neonatal mortality was much higher in the unmeasured group.

Confounding

We used multivariable regression analysis as the main method to control for cofounding in Paper 1, II, and IV. We mainly relied on the literature to select the confounders we included in the models. Multivariable regression analysis cannot control for unmeasured confounders creating the possibility of residual confounding in these studies. In paper III, we used randomization to control for confounding, and this controls for both known and unknown confounders.

Chance

We enrolled a large sample in the survey, which enabled us to get estimates with relatively high precision. The intervention also enrolled a large sample size and this enabled us to get precise estimates. Our sample size was however not sufficient for some secondary outcomes. We report absence of association between the dependant variables and many independent variables. It is possible that associations could have been observed with the use of a larger sample size.

Consistency: Reliability and dependability

Reliability and dependability were major concerns in the measurement of weight and temperature. Regarding the weight measurements, we adequately trained the research assistants and used tared weighing to reduce errors. We also took two measurements from each participant and considered the average. In the event that the first and second readings were greater than 100 grams we took a third weight reading. All scales were calibrated daily with standardized weights. We gave frequent refresher trainings to the research assistants. Regarding temperature measurements, we adequately trained the research assistants and used digital thermometers with audible beeps to reduce on errors. We also took two readings and averaged them.

Intervention fidelity

Delivering the intervention in a package could have compromised trial fidelity. It is possible that peer counsellors prioritized health facility birth messages over the breastfeeding messages. However, when we re-interviewed participants in the intervention group to assess study fidelity and quality, 766/805 (95.2%) of the participants in the intervention arm reported that a peer counsellor visited them. Of the participants that were visited by a peer counsellor, 707/766 [92.3%: (95%CI 89.0-94.6)] reported that they had been counselled on early breastfeeding initiation. When asked after how long a baby should ideally be put to the breast 747/766 [97.3%: (95% CI 95.3-98.4)] gave an answer within an hour suggesting sufficient knowledge. These findings make intervention infidelity less likely. Delivering interventions in community-based packages has been shown to be effective and more feasible for implementation and policy development [171]. Another possible cause of trial infidelity was the absence of mobile phones in the homes. Only half of the participants had a mobile phone in their homesteads and less than 10% of mothers had personal mobile phones. This means that most of the mobile phone messages did not reach the intended parties and the trial lost out on the benefit of mobile phone messages reinforcing the peer counseling.

External validity (generalizability)

The studies in this thesis were conducted in Lira district, which is a post conflict area, and therefore results from this thesis may potentially be generalized to similar settings. The survey (Paper I, IV) was conducted in both rural and urban areas thus can be generalized to the entire district, and similar regions. However, the trial (Paper III) and follow up (Paper IV) were conducted in a rural setting and can only be generalized to rural areas. Over 80% of Ugandans live in rural areas [100]. The findings from these studies are therefore potentially generalizable to a large proportion of the population. However, newborn care practices vary across different cultures and there is a possibility that our results may differ in different cultural groups. Some of the key findings were largely similar to findings from other settings in sub-Saharan Africa and we therefore expect our findings to be externally valid to areas in sub-Saharan Africa with similar settings and cultures.

Potential for bias in the cluster randomized controlled study

Below, we have used a cluster randomized controlled trial extension of the Cochrane risk of bias tool (RoB 2.0) [172] to evaluate our cluster randomized controlled trial. This tool suggests key sources of bias that should be assessed in cluster randomized control trials. These sources of bias include bias arising from: the randomization process, the timing of identification and recruitment of participants in relation to timing of randomization, deviations from intended intervention, missing outcome data, measurement of the outcome and selection of the reported result. We summarize the bias assessment below:

Domain 1: Risk of bias arising from the randomization process

Signalling questions	Comments	Response options
1.1 Was the allocation sequence random?	An independent researcher used computer generated random numbers to assign clusters to intervention or control.	Yes
1.2 Is it likely that the allocation sequence was subverted?	No, because the allocation was done by an independent researcher who was based in a different country and had never visited the study area	No
1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?	There were a few baseline differences, but most of the participant characteristics were balanced	No
Risk-of-bias judgement	There was low risk of bias because the randomization was random, independent and concealed	Low

Domain 2: Risk of bias arising from the timing of identification and recruitment of participants in a cluster randomized trial

Signalling questions	Comments	Response options
2.1 Were all individual participants identified before randomization of clusters (and if the trial specifically recruited patients were they all recruited before randomization of clusters)?	No. Participants were recruited after randomization and therefore recruitment bias is possible	No
2.1b Is it likely that selection of individual participants was affected by knowledge of the intervention?	I don't think so. The recruiters and research assistants were not told of the intervention. The non-response and loss to follow up is the same in both intervention and control clusters. However there is a possibility that selection of participants was affected by knowledge of intervention since the intervention sites recruited many more participants than the control sites. Additionally, participants were not blinded	Probably yes
2.2 Were there baseline imbalances that suggest differential identification or recruitment of individual participants before arms?	There are a few baseline differences but these are compatible with chance	No
Risk-of-bias judgement	We tried all we could to minimize bias in this domain. However, the much higher recruitment in the intervention arm raises some concerns.	Some concerns

Domain 3: Risk of bias due to deviations from the intended interventions (*effect of assignment to intervention*)

Signalling questions	Comments	Response options
3.1 Were participants aware that they were in a trial	No. Participants were informed that they were in a program designed to promote maternal and child health. However, they were not aware that they were in "an experiment". This was done to prevent conflicts and discouragement among participants in the control arm.	No
3.2 Were participants aware of their assigned intervention during the trial?	Yes. The participants in the intervention clusters were aware since the intervention was delivered to the participant. However, in the control clusters, participants were unaware	Yes
3.3 Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?	Yes. The intervention was also administered to carers. However the data collectors were not aware.	Yes
3.4 If Y/PY/NI to 3.1 or 3.2: Were there deviations from the intended intervention beyond what would be expected in usual practice?		No
3.5 If Y/PY to 3.4: Were these deviations likely to have affected the outcome?		Not Applicable since there were no deviations

3.6 Were any clusters analysed in a group different from the one, which they were assigned?	No. Analysis was by intention to treat.	No
3.7 Were any participants analysed in a group different from the one, which they were assigned?	No. Analysis was by intention to treat.	No
3.8. If Y/PY/NI to 3.7: Was there potential for a substantial impact (the estimated effect of intervention) of analysing participants in the wrong group?		Not applicable since analysis was by intention to treat
Risk-of-bias judgement		Low

Domain 4: Bias due to missing outcome data

Signalling questions	Comments	Response options
4.1 Were data for this outcome available for all, or nearly all, clusters randomized?	Yes. We did not loose any clusters.	Yes
4.2 Were data for this outcome available for all, or nearly all, participants within clusters randomized?	We obtained outcome data for over 90% of all participants	Yes
4.3 If N/PN/NI to 4.1 and 4.2: Are the proportions of missing outcome data and reasons for missing outcome data similar across intervention groups?	Yes, the proportion of missing outcome data and reasons for missing outcome data are similar between intervention and control groups	Yes

4.4 If N/PN to 4.1 and 4.2: Is there evidence that results were robust to the presence of missing outcome data?		Not applicable since proportions of missing data and reasons are similar between groups
Risk-of-bias judgement	Our risk of bias is low because we had a very high follow up proportion.	Low

Domain 5: Risk of bias in measurement of the outcome in a cluster-randomized trial

Signalling questions	Comments	Response options
5.1 Were outcome assessors aware that a trial was taking place?	We tried as much as possible to mask our research assistants, but we cannot be certain of this. We did not inform them that a trial was taking place. We told them that they were involved in a program monitoring maternal and child health in the study area.	Probably No
5.2 If N/PN/NI to 4.1: Were outcome assessors aware of the intervention received by study participants?	We tried as much as possible to mask our research assistants, but we cannot be certain of this. We did not inform them that a trial was taking place. We told them that other organizations affiliated with our institutions were carrying out a parallel program in the area counseling mothers and distributing mama kits.	Probably No
5.3 If N/PN/NI to 4.1 and 4.2: Was the assessment of the outcome likely to be influenced by knowledge of intervention received?	We do not think so, since the main outcome was noted as told by the participant.	No

Risk-of-bias judgement		Low

Domain 6: Risk of bias in selection of the reported result

Signalling questions	**Comments**	**Response options**
6.1 Was reported data selected on the basis of the results, from multiple outcome measurements?	We report data on two outcomes as envisioned in the protocol.	No
6.2 Was reported data selected on the basis of the results, from multiple analyses of the data?	We report all analyses done.	No
Risk-of-bias judgement		Low
Optional: What is the predicted direction of bias due to selection of the reported result?		Not applicable since the risk of bias is low

Overall risk of bias

Risk-of-bias judgement	Since the risk of bias is low in 5 of the 6 domains, our judgement is that the overall risk of bias in this study was low	Low
Optional: What is the overall predicted direction of bias for this outcome?		Not applicable since the risk of bias is low

Ethical issues relating to the cluster randomized controlled study

Cluster randomized controlled trials face unique ethical challenges resulting from different units of randomization, intervention, and outcome assessment [173]. For a cluster randomized controlled trial to stand on a firm ethical foundation, Weijer et al [174] suggest that the six questions below must be answered.

1) Who is a research subject?

The question is relevant to our study. Was it the peer counsellors, pregnant women, or newborns that were the study participants in our study? We considered pregnant women, and newborns as our study participants since they fulfilled the four requirements of being a study participant: they were directly intervened upon, they interacted with investigators, their environment was manipulated, and their private information was used to generate the study data [175].

2) From whom, how, and when must informed consent be obtained?

Our study intervention was delivered at the individual level and hence informed consent for participation was obtained. However, we did not obtain individual informed consent for randomization. We obtained permission to randomize from village, parish, and district leaders; and from community members that attended the sensitization meeting. Obtaining informed consent after randomization has both methodological, and ethical disadvantages. Methodological, it is a risk to the internal validity of a study, as randomized clusters can refuse to participate after randomization, leading to a selection bias (recruitment bias). Ethically, it can be rightly argued that it is unethical to randomize uninformed individuals to an intervention, since interventions could have both direct, and indirect unwanted effects. For example, an intervention promoting health facility births could result in congestion at the health facility, which could affect health care of the entire village. In our study, we judged such indirect effects as minimal risks. We did not obtain informed consent prior to randomization for logistical reasons.

3) Does clinical equipoise apply to cluster randomized controlled studies?

In our study, this question is better answered by reflecting on whether we had a convincing argument for withholding the intervention in the control clusters. Since this was a combined intervention, the ethical challenges are more complex. Generally, we had equipoise for using peer counseling for early breastfeeding initiation, and sending mobile phone messages for promotion of early breastfeeding initiation. As stated earlier, we had genuine uncertainty about the use of peer counsellors for promotion of early breastfeeding initiation. This was also true for the use of mobile phone messages and mama kits to promote early breastfeeding initiation.

4) How do we determine if the benefits outweigh the risks of cluster randomized controlled studies?

We offered 2 bars of soap to participants in both the intervention and control arms, as a benefit to participating in the trial. This was done for two reasons. Firstly, it was done to mask participants in the control clusters of the intervention in the neighbouring clusters. Secondly, it was culturally inappropriate to visit new-borns empty handed. As a result, all participants in our study had some modest benefit of participating in our study.

5) How do we protect vulnerable groups in cluster randomized controlled studies?

The study primarily involved a vulnerable group (s). Our intervention involved pregnant women, and their newborn babies. Since the results of the intervention are meant to benefit these same groups, it was justifiable to include them in the study. In addition, the intervention posed low risk to both the pregnant mothers and their children.

6) Who are the gate keepers and what are their responsibilities

Researchers have a moral duty to consider the community wide effects of their study [176]. As such, the role of gatekeepers (persons entrusted with the wellbeing of a community) is very important when doing research. In our study, we engaged with various gatekeepers at village, parish, and district level. I believe the role of gatekeepers

is even more important in communities that have high levels of poverty, and low levels of education. These communities can easily be manipulated, and should probably be treated as vulnerable communities.

Conclusions

About half of mothers delayed initiation of breastfeeding until after one hour after birth. Programs to promote, protect and support breastfeeding in this post conflict region are urgently needed. We recommend that attention should be paid to caesarean section births.

The incidence of neonatal hypothermia was very high demonstrating that communities in tropical climates should not ignore neonatal hypothermia. Interventions designed to address neonatal hypothermia should consider ways of reaching newborns born at home as these are at a greater risk of hypothermia. Low birth weight newborns, and those born to mothers in the poorest socioeconomic status need to be prioritized. Early breastfeeding initiation is protective against neonatal hypothermia and should be highlighted in interventions addressing neonatal hypothermia alongside other interventions like skin-to-skin care.

An intervention consisting of peer counseling, mobile phone messages, and mama kits delivered to both the mother and significant others increased the proportion of mothers who exclusively breastfed at one-month postpartum, but did not increase the proportion of women who initiated breastfeeding within the first hour after birth. Interventions that promote early breastfeeding initiation should consider involvement of persons who conduct the deliveries if they are to be successful.

Fathers, grandmothers, health-workers, and traditional birth attendants were influential in newborn care. Programs that aim to promote newborn care, especially programs that encourage facility births and immediate newborn care, need to involve persons other than the mother; particularly husbands and grandmothers. Health workers should be involved in programs that promote timely initiation of breastfeeding.

Recommendations

Based on our findings, we came up with the following recommendations.

A. Policy implications

1. There is a large burden of neonatal hypothermia and available low-cost interventions need to be prioritized.
2. There is a large burden of delayed breastfeeding initiation and this may contribute to neonatal hypothermia, morbidity and mortality. Interventions aimed at promoting early breastfeeding initiation need to be prioritized
3. Interventions that aim to promote neonatal care practices should target the key decision makers who vary across practices and settings.

B. Further research questions

1. Does a combined intervention consisting of peer counseling in the perinatal period and the baby friendly hospital initiative: a) increase the proportion of women who practice early breastfeeding initiation b) reduce the proportion of neonates with hypothermia?
2. What is the effect of hypothermia on growth outcomes at 1 year of age?
3. Does an intervention consisting of peer counseling on kangaroo mother care, supplemented by demonstration sessions immediately after birth by health workers, reduce the incidence of neonatal hypothermia in the first week of life?

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Errata

Page	**Now reads**	***Previously/Action***
Page 6	I dedicate this work to my mum, **Mrs Edith Mukunya,** and dad, **Eng PJK Mukunya**, who showed me sacrifice.	*Bold words were missing*
Page 7	...without whom I would never **have** managed.	*Bold word was missing*
Page 13	Only half of the mothers practice**d** early breastfeeding initiation.	*Bold 'd' was missing*
Page 21	… incorporate axillary temperature **measurements taken** with standard inexpensive digital thermometers …	*Bold words were missing*
Page 29	Conceptual framework	*Heading moved to the correct place*
Page 29	… which in turn influence proximal **determinants** that directly...	*Bold word was missing*
Page 40	the same messages discussed in the counseling sessions ~~included~~	*The strikeout word has been removed*
Page 42	On the ~~first~~ day of birth	*The strikeout word has been removed*
Page 61	One of **the** main challenges	*Bold word was missing*
Page 68	Exclusion **of** mothers who had lost a child	*Bold word was missing*

Papers

Paper I

Paper II

Paper III

Paper IV

Appendices (on request from the author)

Appendix I:	**Survey Questionnaire**
Appendix II:	**Intervention Questionnaire**
Appendix III:	**School of Medicine ethical clearance form**
Appendix IV:	**REK ethical clearance form**
Appendix V:	**UNCST ethical clearance form**

Paper I

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Factors associated with delayed initiation of breastfeeding: a survey in Northern Uganda

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ABSTRACT

Background: Initiation of breastfeeding later than 1 hour after birth is associated with increased neonatal morbidity and mortality.

Objective: To determine the prevalence and factors associated with delayed initiation of breastfeeding.

Methods: We conducted a survey in 2016 of 930 children under the age of 2 years in Lira district, northern Uganda. Mothers of the children were interviewed and data was collected on mobile phones using Open Data Kit software (https://opendatakit.org). Multivariable logistic regression was used to determine factors associated with delayed initiation of breastfeeding.

Results: Almost half [48.2%, 95% confidence interval (CI) (44.3–52.1)] of the mothers delayed initiation of breastfeeding. Factors significantly associated with delayed initiation of breastfeeding in multivariable analysis included caesarean delivery [Adjusted Odds Ratio (AOR) 11.10 95% CI (3.73–33.04)], discarding initial breast milk [AOR 2.02 95% CI (1.41–2.88)], home delivery [AOR 1.43 95% CI (1.04–1.97)] and mother being responsible for initiating breastfeeding as compared to a health worker or relative [AOR 1.73 95% CI (1.33–2.26)]. Mothers having a secondary education were less likely [AOR 0.54 95% CI (0.30–0.96)] to delay initiation of breastfeeding as compared to those with no education.

Conclusion: About half the mothers delayed initiation of breastfeeding until after 1 hour after birth. Programs to promote, protect and support breastfeeding in this post conflict region are urgently needed.

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Background

Reduction of neonatal mortality to 12/1000 live births by the year 2030 is one of the targets of the third sustainable development goal (SDG) [1,2]. Sub-Saharan Africa has one of the highest neonatal mortality rates in the world at 28/1000 live births [3,4] with Uganda at 27/1000 live births [5]. Over 800,000 neonatal deaths annually could be prevented if breastfeeding practices were scaled up [6]. One of the important practices in scaling up breastfeeding is initiating breastfeeding within the first hour after birth, failure of which is termed delayed initiation of breastfeeding.

Delayed initiation of breastfeeding has been shown to increase the risk of neonatal morbidity and mortality [7–10]. The morbidity and mortality risk associated with delayed initiation of breastfeeding is due to a number of factors. Delayed initiation of breastfeeding increases the use of pre lacteal feeds, which are often contaminated, and also lack the mucosa protective effect of breast milk [7]. Newborns who are delayed breastfed are also deprived of an opportunity to fully benefit from the immunological protection offered by colostrum [7,9]. Another benefit that is lost when initiation of breastfeeding is delayed, is the body heat offered to the baby by the mother in the initial moments after birth [9]. Finally, mothers who delay the initiation of breastfeeding are more likely to use alternative or additional foods during the first 6 months of life [7,9]. Due to all the risks caused by delayed initiation, interventions that promote early initiation of breastfeeding are listed as priority intervention to improve neonatal health and survival [11].

The prevalence of mothers who delay initiation of breastfeeding is high both in Uganda [12] and the world at large [6] with only about half of mothers worldwide practicing early initiation of breastfeeding

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[6]. Factors associated with delayed initiation of breastfeeding include maternal-infant factors (such as absence of breast milk, HIV status of the parent and perinatal morbidity), cultural factors (such as colostrum discarding), and social factors (such as rural residence and place of delivery) among others [12–14]. However, breastfeeding initiation practices have been found to vary across ethnic lines and geographical locations [15]. This study was undertaken in post conflict Northern Uganda. Negative public health effects have been observed in post conflict areas lasting for so many years after the conflict [16]. The negative public health trends in post conflict areas are a result of poor health-seeking behaviors and distrust of health care systems among other reasons [17]. As such, public health interventions designed for post conflict areas might be of significant value.

To design interventions to scale up early initiation of breastfeeding, we need increased knowledge of associated factors. Therefore, in this community study, we aimed to determine the prevalence of delayed initiation of breastfeeding in Lira district, located in post conflict Northern Uganda and to determine factors associated with the delay.

Methods

Study design

This was a comparative cross-sectional study carried out among women with a child below the age of 2 years.

Study setting

The study was conducted between August and November 2016 in Lira district, located in post conflict Northern Uganda. Lira district is home to about 400,000 people with the majority living in rural areas [18,19]. Most of the population is ethnic Langi and the predominant language spoken is Luo. Lira district has 3 Counties and 13 sub-counties, 1 municipality and 751 villages. Three sub counties of Aromo, Agali and Lira municipality were surveyed because they had been chosen as the sites for a randomized controlled trial designed to promote facility births and recommended breastfeeding practices. Aromo and Agali were chosen because they had the poorest maternal and child health indicators. Lira municipality was chosen because it was the largest urban center.

Sampling

This study was a two-stage sampling modification of the WHO EPI method [20,21].

All villages in the three selected sub-counties and the household populations were listed (add range) and 30 villages were selected by probability proportional to size. In each village, a sampling frame of all households was then used to select a random index household. After identifying the first household, the next household was chosen by selecting the nearest household to the first (the one whose door was closest to the prior household). Only one mother-child pair would be chosen from each household. This process would continue until 31 mother-child pairs had been interviewed in each village.

Study participants

We recruited mother-child pairs where the child was aged 2 years or less. Children were recruited only if they were residents in the village and were identifiable by the village leadership and were mentally and physically able to complete the interview. If the mother had more than 1 child born within the last 2 years, the youngest child was selected. If the mother had twins, she would answer child-related questions basing on the younger twin. Children with no mothers were excluded from the study.

Study procedure

Thirty trained research assistants who were knowledgeable about the area and were fluent in both written and spoken forms of the local language collected data. Village health team members and local area leaders acted as community guides. Interviews were carried out at the mothers' homesteads and where possible in a private location away from distraction within those homesteads. Thirty-one participants were recruited from each of the 31 villages. Missing households would be revisited later the same day before the research assistants left the village. Those that were not found at home were revisited the following day and if not found declared missing and replaced. Replacement was based on proximity to the missing household; the household with the nearest door to the missing household was visited and this process repeated until a replacement was got. Data were collected on mobile phones using ODK software (https://opendatakit.org).

Data quality

We used a validated structured coded questionnaire, which was pretested during the piloting. The validated questionnaire was developed from two questionnaires; the first was a locally validated questionnaire from a breastfeeding promotion trial conducted in Eastern Uganda [22] and the second was an infant feeding assessment questionnaire developed by the World Health Organization [23]. A language expert translated the questionnaires to the local language and back translated them to ensure proper

translation. The mobile data collection tool ensured completeness of the questionnaire using its checks, by preventing progression if a question had been left unanswered. Completed questionnaires were saved onto the mobile phone and uploaded onto a server at the end of each day. A data manager was available when needed to deal with any issues related to the mobile phone data collection process. To reduce the potential of a measurement bias, mothers were first asked about events surrounding the most recent pregnancy to refresh their memory. They were subsequently asked questions about the most recent delivery in the last 2 years as an effort to ease recall.

Variables

The dependent variable was initiation of breastfeeding. Women were asked how long after birth the baby was put to the breast for the first time. Responses were recorded in minutes and/or hours. The dependent variable was categorized as early initiation if breastfeeding was initiated within the first hour after birth and late initiation if breastfeeding was initiated later than 1 hour after birth. Exposure variables (Tables 1–3) included mother's age at last birthday collected as a continuous variable but categorized into <19, 20–24, 25–29, 30–34, and ≥35. Maternal and paternal education was categorized as none, primary, secondary and tertiary education. Mother's employment (activity outside the home) was categorized as yes or no, Marital status was categorized as single if the mother was not living with a partner (single, divorced, widowed, separated) and married if the mother was living with a partner (married, cohabiting). Residence was categorized as (rural/urban). Other variables included; parity (1, 2 or 3, 4, >5), place of delivery (facility/home), mode of delivery (vaginal/caesarean delivery), any complications during delivery such as; vaginal bleeding, obstructed labor, postpartum hemorrhage, sepsis, birth asphyxia, cord prolapse, small baby, premature baby (yes/no), breathing/crying problem at birth (yes/no), prematurity at birth (yes/no), singleton versus multiple births, sex of the child (male/female), placement of baby immediately after delivery (side of mother, abdomen or chest of mother, other), receipt of breastfeeding counseling during pregnancy (yes/no), person responsible for initiation of breastfeeding (mother/person other than mother) and discard (throwing away) of initial breast milk (yes/no).

Table 1. Baseline characteristics of mother-infant pairs surveyed in Northern Uganda.

Variable	All participants N = 930 n (%)	Delayed initiation of breastfeeding N = 448 n (%)
Sex of the child		
Male	465 (50.0)	231 (51.6)
Female	465 (50.0)	217 (48.4)
Mother age		
≤19	157 (16.9)	84 (18.8)
20–24	303 (32.6)	138 (30.8)
25–29	218 (23.4)	97 (21.7)
30–34	145 (15.6)	70 (15.6)
≥35	107 (11.5)	59 (13.2)
Mothers education		
None	102 (11.0)	56 (12.5)
Primary	729 (78.4)	355 (79.2)
Secondary	83 (08.9)	29 (06.5)
Tertiary	16 (01.7)	8 (01.8)
Paternal education		
None	24 (02.8)	11 (02.7)
Primary	524 (61.4)	261 (63.5)
Secondary	228 (26.7)	107 (26.0)
Tertiary	77 (09.0)	32 (07.8)
Marital status		
Single	77 (8.3)	37 (08.3)
Married	853 (91.7)	411 (91.7)
Maternal employment		
No	537 (62.0)	266 (63.9)
Yes	329 (38.0)	156 (36.1)
Parity		
1	227 (24.4)	114 (25.5)
2–3	298 (32.0)	139 (31.0)
4>	405 (43.6)	195 (43.5)
Residence		
Rural	589 (63.3)	290 (64.7)
Urban	341 (36.7)	158 (35.3)

Table 2. Delivery characteristics of mother-infant pairs surveyed in northern Uganda.

Variable	All participants N = 930 n (%)	Delayed initiators of breastfeeding N = 448 n (%)
Mode of delivery		
Vaginal	894 (96.1)	416 (92.9)
Caesarean	36 (03.9)	32 (07.1)
Place of delivery		
Facility	622 (66.9)	284 (63.4)
Home	308 (33.1)	164 (36.6)
Breathing/crying problem		
No	816 (87.7)	384 (85.7)
Yes	114 (12.3)	64 (14.3)
Discarded initial milk		
No	675 (72.6)	296 (66.1)
Yes	255 (27.4)	152 (33.9)
Advised on breastfeeding during pregnancy		
No	379 (40.8)	193 (43.1)
Yes	551 (59.3)	255 (56.9)
Complications during birth		
No	820 (88.2)	380 (84.8)
Yes	110 (11.8)	68 (15.2)
Place baby initially put		
Other	82 (08.8)	51 (11.4)
Stomach/chest of mother	563 (60.5)	255 (31.0)
Side of mother	285 (30.7)	142 (31.7)
Baby born at term		
No	49 (05.3)	23 (05.1)
Yes	881 (94.7)	425 (94.9)
Who was responsible for initiation		
Other	431 (46.3)	188 (42.0)
Mother	499 (53.7)	260 (58.0)

Sample size estimation

A total of 930 mother-child pairs were enrolled in the study. This was calculated by Open-Epi

Table 3. Factors associated with delayed initiation of breastfeeding at bi-variable and multivariable analysis among mother-infant pairs in Northern Uganda.

	Bi-variable N = 930		Multivariable N = 930	**Multivariable N = 866
Variable	OR (95% CI)	p value	AOR (95% CI)	AOR (95% CI)
Sex of the child				
Male n (%)	1	0.342	-	-
Female n (%)	0.89 (0.69–1.14)			
Mothers education				
None	1	0.281	0.87 (0.53–1.43)	0.87 (0.54–1.40)
Primary	0.78 (0.49–1.24)	0.007	0.54 (0.30–0.96)	0.50 (0.29–0.85)
Secondary	0.44 (0.25–0.79)	0.758	0.80 (0.18–3.56)	0.83 (0.19–3.57)
Tertiary	0.82 (0.23–2.99)			
Marital status (living with partner)				
Single	1	0.983	-	-
Married	1.00 (0.61–1.65)			
Parity				
1	1	0.424	-	-
2–3	0.87 (0.60–1.24)	0.645		
4>	0.92 (0.64–1.33)			
Residence				
Urban	1	0.449	-	-
Rural	1.12 (0.82–1.53)			
Mode of delivery				
Vaginal	1	0.001	11.10 (3.73–33.04)	10.09 (3.35–30.43)
Caesarean	9.19 (2.76–30.66)			
Place of delivery				
Facility	1	0.051	1.43 (1.04–1.97)	1.49 (1.09–2.03)
Home	1.36 (1.00–1.84)			
Breathing/crying problem at birth				
No	1	0.089	1.42 (0.92–2.20)	1.41 (0.91–2.17)
Yes	1.44 (0.94–2.20)			
Discarded initial milk				
No	1	0.001	2.02 (1.41–2.88)	-
Yes	1.89 (1.35–2.65)			
Advised on breastfeeding				
No	1	0.243	-	-
Yes	0.83 (0.60–1.14)			
Complication during birth				
No	1	0.004	1.30 (0.79–2.12)	1.29 (0.79–2.12)
Yes	1.87 (1.24–2.84)			
Place baby initially put				
Stomach/chest of mother	1	0.226	-	-
Side of mother	1.20 (0.89–1.62)	0.021		
Other place	1.99 (1.12–3.53)			
Baby born at term				
No	1	0.869	-	-
Yes	1.05 (0.55–2.00)			
Who was responsible for initiation of breastfeeding?				
Person other than mother	1	0.008	1.73 (1.33–2.26)	1.61 (1.25–2.07)
Mother	1.41 (1.10–1.79)			

**Multivariable: Model without 'discarding of initial milk variable' -: Excluded from multivariable model

(*http://www.openepi.com*) assuming a prevalence of 51% who practice early initiation of breastfeeding, a prevalence obtained in a community study done in eastern Uganda [24]. We assumed a precision of 5%, and a design effect of 2. This gave us a sample size of 768 participants. Assuming a non-response of 15% we came up with a sample size of 904. To achieve a self-weighted sample, we decided to enroll 31 children from each of the 30 villages.

About factors associated with delayed initiation of breastfeeding, we calculated sample sizes of various exposures and finally used 'place of delivery' which gave us the largest sample size. We calculated a sample size needed to detect differences in the proportion of delayed initiation of breastfeeding between mothers who delivered at home and those who delivered from the facility (place of delivery resulted in the largest sample size among the factors associated with delayed initiation of breastfeeding). We calculated this using Open-Epi [25] sample size calculation for detecting differences between proportions of two groups (Fleiss with CC) assuming that 60% of mothers delivered in health facility whereas 40% delivered from home, and assuming the proportion of delayed initiation being 70% for those who delivered at home and 58% for those who delivered at a health facility [26]. This yielded a sample size of 551, which was covered by the sample size calculated for the prevalence estimate.

Data analysis

We used Stata version 14 (*http://www.stata.com/stata14/*) with survey set command adjusting for the multistage sampling in the analysis. Continuous

descriptive variables were presented as means and standard deviations. Categorical variables were presented as proportions. We used chi square tests to tests for comparison of categorical variables and reported the resultant p values. We performed bi variable and multivariable logistic regression to determine the association between the independent factors and delayed initiation of breastfeeding. Factors known to be predictors of delayed initiation of breastfeeding from the literature and those with a bi-variable p-value <0.25 (as long as they were not in the casual pathway and they were not strongly collinear with other independent variables) were considered for the initial multivariable model [27]. Collinearity was assessed and factors were considered to be strongly collinear if their variance inflation factor was greater than 10. In case of collinearity, the factor with a stronger measure of association with the outcome variable was retained and the other dropped. Variables considered for the initial multivariable model were entered in a backward stepwise logistic model, and the variables that were dropped were assessed for their confounding effect on a model that only had the factors retained in the stepwise model. A variable was called a confounder if it changed the unadjusted measure of association by 10% or more. The final model included all confounders and was tested for goodness of fit using the Hosmer and Lemeshow goodness of fit test [28]. The process of multivariable modeling was repeated without the variable 'discarding of initial milk'.

Results

Baseline characteristics

A total of 930 mother-child pairs were included in the analysis. The response rate was 93%. The majority (>95%) of non-respondents were mothers who were absent from their homestead. The mean (standard deviation, SD) child age was 11.2 (7.7) months. The mean (SD) maternal age was 25.8 (5.9) years. Most mothers and fathers had only primary education. The majority of the women had no employment and 44% had so far given birth to 4 or more children (Tables 1 and 2).

Bivariable analysis

Almost a half [48.2%, 95% Confidence Interval (CI) (44.3–52.1)] of mothers delayed initiation of breastfeeding. When analysis was restricted to only those with children aged 1 month or less (n = 87), the proportion of mothers who delayed initiation of breastfeeding was 55.2%, 95% CI (44.3–65.6). Among mothers with children aged 3 months or less (n = 172), 50.6% of the mothers delayed initiation of breastfeeding, 95% CI (42.9–58.2). The factors associated with delayed initiation of breastfeeding in bi-variable analysis were; placing the baby away from the mother, having a caesarean section, discarding of initial milk, complications during delivery, and mother being solely responsible for initiation of breastfeeding (Table 3). Of the women who delivered from home, the mother was solely responsible for initiating breastfeeding 55% (n = 171) of the time. Mothers who delivered by caesarean section were significantly more likely to receive help from other persons to initiate breastfeeding compared to those who delivered vaginally [78% (n = 28) versus 45% (n = 403) respectively].

Multivariable analysis

The factors significantly associated with delayed breastfeeding initiation at multivariable analysis included caesarean delivery Adjusted Odds Ratio (AOR) 11.10 95% CI (3.73–33.04), discarding initial breast milk AOR 2.02 95% CI (1.41–2.88), home delivery AOR 1.43 95% CI (1.04–1.97) and mother being solely responsible for initiating breastfeeding AOR 1.73 95% CI (1.33–2.26). Having a secondary education was protective against delayed initiation of breastfeeding when compared to no education [AOR 0.54 95%CI (0.30–0.96)] (Table 3).

In a model without discarding initial milk, the same factors above were associated with delayed initiation of breastfeeding and the measures of association were similar.

Discussion

In this community-based survey conducted in post conflict northern Uganda, almost half of all mothers initiated breastfeeding later than an hour post-partum. Factors associated with this delay included caesarean delivery, discarding initial breast milk and the mother being responsible for initiating breastfeeding. Mothers who had a secondary education were less likely to initiate breastfeeding after 1 hour.

The proportion of mothers who delayed initiation is similar to findings from other African countries [6]. Analysis of the demographic health survey data showed almost half of women in Uganda delay to initiate breastfeeding [6]. Another community survey done in Eastern Uganda showed that only 51% of mothers initiated breastfeeding immediately after birth [24]. This proportion is, however, different from another study done at the national referral hospital, which found a much higher proportion of almost 70%, of mothers initiating breastfeeding early [12]. The difference could be explained by the policies at the national referral hospital or differences in the populations studied.

One of the major factors associated with delay in initiating breastfeeding was the practice of discarding the initial milk (colostrum). This practice has also been observed in Ethiopia [29] and Guatemala [30]. Another study conducted in Guinea-Bissau also noted that negative cultural ideas about colostrum were associated with delayed initiation of breastfeeding [31]. The practice of discarding colostrum is often due to a misconception that the initial milk is dirty and hence harmful to the neonate [31]. Mothers with this practice will probably wait for the milk to clear before they initiate breastfeeding and hence the delay. However, there is also a reverse causation possibility; that the practice of discarding initial milk was a result of delayed breastfeeding initiation linked to other factors like neonatal morbidity. The mother might be left with no other option but to express and discard the initial milk to alleviate the discomfort caused by engorged breasts. In such a scenario, discarding initial milk would be a consequence and not a cause of delayed initiation of breastfeeding. To control for this scenario, we repeated the multivariable modeling without the variable of 'discarding initial milk' but we found similar results.

In addition to discarding initial milk, delivering from home was also associated with delayed breastfeeding initiation. Mothers who delivered at home were more likely to delay initiating breastfeeding compared to mothers who delivered from health facilities. Similar findings have been reported in Nigeria [26]. This could be related to the existing policies and assistance offered in some health facilities, which encourage early initiation of breastfeeding [32]. To further support the hypothesis that mothers needed assistance to initiate breastfeeding, mothers who were solely responsible for initiating breastfeeding delayed in comparison to the mothers who reported receiving assistance from health workers or relatives. The importance of persons other than the mother in decisions related to breastfeeding practice, and the need to train them for this role is one of the tenets affirmed by the academy of breastfeeding medicine [32]. In addition, breastfeeding consultants at facilities medicine also advocates for a special position of a breastfeeding expert who among other roles assists caregivers and other health workers make decisions concerning breastfeeding [32–34].

Among those that delivered from health facilities, caesarean section delivery was the main factor associated with delayed initiation of breastfeeding. This association has also been observed in other studies done in Uganda, Nigeria and Vietnam [12,26,35]. The practice of separating the newborn from the mother immediately after caesarean delivery could partly explain this delay [36]. In addition, encouraging women to initiate breastfeeding early after caesarean section is uncommon [12,36,37]. Fatigue and post caesarean pain may also contribute to this delay [12]. Specific support for early initiation of breastfeeding is needed for mothers who deliver by caesarean section in order to reduce the delay in this group of women [37]. In this population, only 4% of women delivered by caesarean section, and this makes the relative contribution of this variable appear small. However, the caesarean section rate in this area is much lower than the minimum rate needed for optimal maternal and child health [38]. This suggests that the low cesarean rate is probably a result of poor health systems and therefore will become higher as the health systems in the area recover.

Lastly, education was another factor associated with delayed initiation of breastfeeding. Mothers with a secondary education were less likely to delay initiating breastfeeding. This pattern was also observed in a similar study done in Nepal [39], which showed that educated mothers were less likely to delay initiation of breastfeeding. Educated mothers have been shown to feed their children with more attention, discipline, purpose, and intentionality, and this could explain the association observed [40].

Strengths and limitations

Our study assessed breastfeeding patterns from the community and is therefore more generalizable than prior hospital-based studies. Conducting a community-based study enabled us to capture and comment about home deliveries, which are common in this setting. In addition, the study looked at a unique setting, which is post conflict northern Uganda. A major limitation of our study was measurement of the main outcome with a 2-year recall window. The long recall periods of the time to initiating breastfeeding might have introduced a misclassification bias [41–43]. We used this long recall window mainly to enable us obtain sufficient mothers to study breastfeeding initiation in the community using multistage sampling. To gauge the magnitude of the potential misclassification we conducted sub group prevalence estimates for mothers who had children under 1 month, 3 months and under 2 years. We found these estimates to be 55%, 50% and 48%, respectively. From these estimates, we note that there was no major difference in recall for this variable based on time. A validation study done in Eastern Uganda showed high consistency between infant feeding questions asked at birth and those asked at 3 months [44], further research is needed to assess the consistency after 1 year or more. That said, a 2-year recall period is the recommended standard by the World Health Organization [23] and is also the standard used by the demographic and Health surveys which makes it a meaningful period to use for comparative purposes.

Conclusion

About half of the mothers delayed initiation of breastfeeding until after 1 hour after birth. Programs to promote, protect and support breastfeeding in this post conflict region are urgently needed. We recommend that attention should be paid to caesarean section deliveries, and special policies concerning breastfeeding initiation in this group be considered. Persons other than the mother should be involved in programs promoting breastfeeding initiation.

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Author contributions

DM, JKT, VN, GN, TT conceived, designed, supervised the study, analyzed the data and wrote the first draft of manuscript. IO, JT, JBT, AN, VA, BO, were instrumental in the design and supervision of the study, and drafting of the manuscript. SK contributed in the analysis of the data and critical revision of the manuscript. All authors read and approved the final version to be published.

Disclosure statement

No potential conflict of interest was reported by the authors.

Ethics and consent

We obtained ethical approval from the School of Medicine Research and Ethics committee and from the Uganda National Council of Science and Technology. Written informed consent was obtained from the participants prior to participation in the study. For participants who could not write, a thumbprint was obtained. No compensation was given to the participants. Participant's questions regarding health-related issues were addressed at the end of the interview.

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Paper context

Breastfeeding initiation patterns vary across different contexts. This study was done in Lira district, situated in post conflict northern Uganda, to inform the conduct of a randomized controlled study. Our study showed that delayed initiation is common in this region associated with factors such as caesarean delivery, home delivery, lack of education and discarding of initial milk. This study also showed that importance of persons other than the mother in initiating breastfeeding.

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Paper IV

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Article

Key Decision Makers and Actors in Selected Newborn Care Practices: A Community-Based Survey in Northern Uganda

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Abstract: Knowledge of key decision makers and actors in newborn care is necessary to ensure that health interventions are targeted at the right people. This was a cross-sectional study carried out in Lira district, Northern Uganda. Multivariable logistic regression was used to determine factors associated with mothers being the key decision maker regarding where to give birth from and when to initiate breastfeeding. Fathers were the key decision makers on the place of birth (54.3%, n = 505) and on whether to seek care for a sick newborn child (47.7%, n = 92). Grandmothers most commonly bathed the baby immediately after birth (55.5%, n = 516), whereas mothers and health workers were common decision makers regarding breastfeeding initiation. Predictors for a mother being the key decision maker on the place of birth included: Mother having a secondary education (AOR 1.9: 95% C.I (1.0–3.6)) and mother being formally employed (AOR 2.0: 95% (1.5–2.9)). Mothers, fathers, grandmothers, health-workers, and traditional birth attendants were the most influential in the selected newborn care practices. Programs that aim to promote newborn care need to involve husbands, grandmothers, and health workers in addition to mothers.

Keywords: newborn; neonatal; implementation; influencers; actors; decision-making; Uganda; post-conflict; behavior

1. Introduction

Uganda has unacceptably high under-5-year child mortality; 62.4 deaths per 1000 live births compared to the worldwide estimate of 38.4 deaths per 1000 live births [1]. A large proportion of deaths under the age of 5 years occur in the newborn/neonatal period (first 28 days of life), with 22.3 newborn deaths per 1000 live births occurring in Uganda compared to the global estimate of 16.7 deaths per 1000 [1]. Most of these deaths are preventable, and low-cost interventions that can significantly reduce

them exist [2–4]. It is estimated that existing low-cost interventions can reduce newborn deaths by 72% [3]. Nonetheless, the scale-up of these low-cost interventions in sub-Saharan Africa has been both poor and inequitable [5]. One of the main challenges to scaling up these interventions has been the under-recognition of the behavioral and sociocultural aspects of newborn care practices [4].

One under-recognized sociocultural aspect of newborn care is the primary caretakers of newborns in the perinatal period [4]. Traditionally, it has been thought that mothers are the key decision makers in the perinatal period [6,7]. However, since mothers are often (or perceived to be) exhausted in the immediate post-partum period, and may be inexperienced in newborn care (especially first-time mothers), older relatives often take over the role of caring for mothers and newborns [8]. Antenatal education usually promotes recommended care practices like newborn care, timely health care seeking, optimal breastfeeding, and also educates mothers on danger signs in pregnancy [9]. The education is usually provided by health workers, at health facilities, and mainly targets the pregnant women, and not the significant others [10]. As a result, the persons who take care of newborns seldom receive antenatal education concerning recommended practices in newborn care [11]. To design effective interventions that promote behavioral change in newborn care, it is important to identify the key decision makers and actors in newborn care [4]. Whereas multiple players could be responsible for various actions in the newborn period, our experience with the study population showed that there was often a key decision maker or an actor, who was ultimately responsible for the action. Previous research has highlighted some decision makers and actors, but these have largely been obtained in qualitative studies [8,12] and hence cannot estimate the magnitude, the relative contribution of different players, and the generalizability to wider populations.

In this study, we aimed to quantitatively determine key decision makers and actors in newborn care among mothers with children under the age of 2 years in the Lira district, Northern Uganda.

2. Materials and Methods

2.1. Study Design

This was a cross-sectional study that involved mothers who had a child below the age of 2 years.

2.1.1. Study Setting

The study was carried out between August and November 2016 in the Lira district, Northern Uganda. The district has 13 subcounties, 1 municipality, and 751 villages [13,14]. The majority of the population is ethnic Langi, and the predominant language spoken is Lango. The study was carried out in 3 subcounties in Northern Uganda: Aromo, Agali, and the Lira municipality. These subcounties were chosen because they had poor maternal and child health indicators and were ideal for an interventional study designed to increase facility-based births, and to improve breastfeeding practices.

2.1.2. Sampling

All villages in the 3 selected subcounties were listed, and 30 villages were selected by probability proportional to size. A sampling frame of all households in the village obtained from the village leaders was used to randomly select a household to begin with in each village. After identifying the first household, the next household was chosen based on proximity to the first. The nearest household was defined as one whose door was closest to the prior household. Only one mother–child pair would be chosen from each household. This process would continue until 31 mother–child pairs had been interviewed in each village. If the mother had more than one child born within the previous 2 years, questions were addressed to the most recent pregnancy and therefore the youngest child. If the mother had twins, questions were aimed at the younger twin.

2.1.3. Study Participants

We recruited mothers with children born within the last 2 years. Mothers were recruited only if they were residents in the respective village as determined by the village leadership and were mentally and physically able to complete the interview.

2.1.4. Study Procedures

Data collection was carried out with the help of 30 research assistants who were recruited from Lira district and were well conversant with the local languages. Data were collected using Open Data Kit (ODK, https://opendatakit.org/) software installed on mobile phones. The questionnaires were translated to the local language and back-translated to English for accuracy. Village health team members and local area leaders acted as our guides. Households whose members were absent at the time of the visit were revisited later on the same day, prior to exiting the village. Those that were still absent were revisited the following day and, if not found, were declared missing and replaced. Interviews were carried out at the mothers' homesteads, preferably at a private place away from distraction, e.g., under a tree at the periphery of the compound. The interviews lasted between 45 and 60 min. The questions asked were close-ended questions.

2.2. Variables

To determine the key decision makers and actors in newborn care, mothers were asked the following questions regarding their most recent birth experience: Who mainly decided where you should give birth? Who dried your baby immediately after birth? Who first bathed your baby? Who mainly decided when you initiated breastfeeding? Who mainly decided what you did with the initial breast milk? Who mainly decided whether or not you practiced bottle-feeding? Who applied substances to the umbilical cord of your child immediately after birth? Who mainly decided whether or not to seek care for your sick newborn? (Addressed to only those who reported having had a sick newborn). We defined key decision makers and actors as the most frequently cited decision maker or actor, and common decision makers and actors as the two most frequently cited decision makers and actors. The newborn care practices studied were obtained from lists of recommended newborn care practices [15–18]. Mothers were classified as formally employed if they personally earned money through some activities. Socioeconomic status quintiles were calculated from an asset-based wealth index using principal component analysis. Other variables collected included: maternal age, maternal education, paternal education, marital status, parity, residence, maternal employment, and place of birth. These were collected to offer a general description of the study participants, and to act as explanatory variables or confounders in the multivariable analysis. We classified place of birth as a newborn care practice with an understanding that newborn care begins during birth, and therefore, the choice of the place of childbirth is a distal newborn care decision.

2.3. Sample Size Estimation

The sample size was calculated for the primary objective of this study. A total of 930 mothers were enrolled in the study. This was calculated by Open-epi software (www.openepi.com), assuming that a proportion of 50% of women decide where they should give birth. We also assumed precision of 5% and a design effect of 2. This gave us a sample size of 768 participants. Assuming a nonresponse of 15%, we came up with a minimum sample size of 904 mothers. To achieve an equal enumeration in all the 30 villages, we purposed to enroll at least 31 mothers from each village. The sample size calculated was sufficient to determine the different proportions of decision makers, influencers, and actors, assuming that 50% of mothers were the key decision makers concerning all practices.

2.4. Data Analysis

The analysis strategy considered the fact that we used multistage sampling. Descriptive variables were presented as means and proportions for continuous and categorical variables, respectively. Factors with a p-value <0.25 at bi-variable analysis were considered for the multivariable model. Collinearity was assessed, and factors were considered to be strongly collinear if their variance inflation factor was greater than ten. In cases where factors were found to be collinear, the factor with a stronger scientific plausibility was retained in the model. Our final multivariable models consisted of factors with strong scientific plausibility, factors with significant associations at bi-variable analysis, and factors which changed the measure of association of any covariate in the intermediate models by greater than 10%. As stated before, this study was primarily designed to determine the prevalence of health facility births, and breastfeeding practices in the study area in order to inform the design and interpretation of a cluster randomized controlled study in the area. We, therefore, present the multivariable analysis of only the key decision makers regarding health facility births and breastfeeding initiation, as these were of primary interest to the interpretation of the intervention study. We stratified our results by place of residence (rural versus urban), place of birth (health facility versus home), and parity. We used these strata because qualitative literature suggested there could be differences in key decision makers in these strata [8,12,19–22].

2.5. Ethics

We obtained ethical approval from the Makerere University School of Medicine Research and Ethics committee (SOMREC number: 2015-121) and from the Uganda National Council of Science and Technology. District and local area leaders gave us permission to perform the study. Written informed consent was obtained from the participants prior to participation in the study. For participants who could not write, a thumbprint was obtained.

3. Results

3.1. Descriptive Characteristics

A total of 930 mother–child pairs were considered for the analysis. The response rate was 93%. The majority (>95%) of non-respondents were mothers who were absent from their homestead. The mean child age was 11.2 months, with a standard deviation of 7.7 months. The mean maternal age was 25.8, with a standard deviation of 5.9 years. The majority of mothers (729, 78.4%) and fathers (524, 61.4%) had less than 7 years of formal education. The rest of the participant characteristics are presented in Table 1.

Table 1. Baseline characteristics of mothers surveyed in the Lira district, Northern Uganda.

	Participants (n = 930) n (%)
Mother age	
≤19	157 (16.9)
20–35	686 (73.8)
>35	87 (09.4)
Mothers education	
None	102 (11.0)
Primary	729 (78.4)
Secondary	83 (08.9)
Tertiary	16 (01.7)
Paternal education	
None	24 (02.8)
Primary	524 (61.4)
Secondary	228 (26.7)
Tertiary	77 (09.0)
Marital status	
Single	77 (08.3)
Married	853 (91.7)
Mother formally employed	
No	601 (64.6)
Yes	329 (35.4)
Parity	
1	227 (24.4)
2–3	298 (32.0)
>4	405 (43.6)
Residence	
Rural	589 (63.3)
Urban	341 (36.7)
Place of birth	
Health facility	622 (66.9)
Home	308 (33.1)

3.2. Decision Makers and Actors in Newborn Care

Fathers most commonly decided on where a mother gave birth (54.3%, n = 505), but the mothers (31.1%, n = 289) were also common decision makers. Fathers also most commonly decided on whether to seek care for a sick newborn child (47.7%, n = 92). Grandmothers most commonly bathed the baby immediately after birth (55.5%, n = 516), whereas mothers most commonly decided on when to initiate breastfeeding (53.7%, n = 499) and on whether to bottle-feed (73.6%, n = 684) (Table 2). Health workers were also commonly cited in the decision to initiate breastfeeding and to practice bottle-feeding. Traditional birth attendants were most implicated in applying substances to the umbilical cords of newborns immediately after birth (Table 2). The distribution of key decision makers in the subgroup analysis (rural residence, first-time mothers, and home births) was similar to that of the overall population. A notable difference in the subgroup analysis was that grandmothers were more involved with first-time mothers (Table 3). Table A1 in the Appendix A provides a detailed breakdown of the main practices and actors studied.

Table 2. Table showing key decision makers and actors in newborn care in the Lira district, Northern Uganda.

Variable	All Births n = 930		Home Births n = 308	Health Facility Births n = 622	p-Value * (X^2) †
	n (%)	95%CI of %	n (%)	n (%)	
Decide birthplace					
Father	505 (54.3)	49.4–59.2	148 (48.1)	357 (57.4)	0.022 (3.933)
Mother	289 (31.1)	27.5–34.9	121 (39.3)	168 (27.0)	
Grandmother	94 (10.1)	8.2–12.4	27 (8.8)	67 (10.8)	
Others	42 (4.5)	3.4–6.0	12 (3.9)	30 (4.8)	
Dried baby immediately after birth					
Health worker	561 (63.8)	55.7–71.1	4 (1.4)	557 (95.1)	<0.001 (407.3)
TBA	238 (27.1)	20.5–34.8	235 (79.9)	3 (0.5)	
Others	81 (9.2)	7.2–11.7	55 (18.7)	26 (4.4)	
Conducted first bath					
Grandmother	516 (55.5)	51.9–59.1	142 (46.1)	374 (60.1)	<0.001 (8.906)
Mother	165 (17.7)	15.4–20.3	54 (17.5)	111 (17.9)	
Others	249 (26.8)	23.2–30.7	112 (36.4)	137 (22.0)	
Decide breastfeeding initiation					
Mother	499 (53.7)	49.8–57.5	171 (55.5)	328 (52.7)	<0.001 (57.87)
Health worker	239 (25.7)	22.1–29.7	9 (2.9)	230 (37.0)	
Grandmother	92 (9.9)	8.4–11.6	42 (13.6)	50 (8.0)	
TBA	77 (2.5)	5.8–11.7	77 (25.0)	0 (0.0)	
Others	23 (2.5)	1.6–3.7	9 (2.9)	14 (2.3)	
Decide what to do with initial breast milk					
Mother	534 (57.4)	54.5–60.3	175 (56.8)	359 (57.7)	<0.001 (70.28)
Health worker	207 (22.3)	19.8–24.9	12 (3.9)	195 (31.4)	
Grandmother	93 (10.0)	8.2–12.1	35 (11.4)	58 (9.3)	
Others	96 (10.3)	7.6–13.9	86 (27.9)	10 (1.6)	
Decide whether or not to practice bottle-feeding					
Mother	684 (73.6)	70.3–76.5	241(78.3)	443 (71.2)	<0.001 (8.184)
Health worker	90 (9.7)	7.5–12.3	10 (3.3)	80 (12.9)	
Grandmother	57 (6.1)	4.6–8.2	19 (6.2)	38 (6.1)	
Others	99 (10.7)	8.8–12.8	38 (12.3)	61 (9.8)	
Applied substances to the umbilical cord					
TBA	17 (28.8)	19.4–40.5	17 (53.1)	0 (0)	<0.001 (12.00)
Health Worker	16 (27.1)	16.0–42.1	0 (0)	16 (59.3)	
Mother	15 (25.4)	16.9–36.4	9 (28.1)	6 (22.2)	
Others	11 (18.6)	10.5–31.0	6 (18.8)	5 (18.5)	
Decide care seeking for sick newborn					
Father	92 (47.7)	41.8–53.7	27(42.9)	65 (50.0)	0.688 (0.370)
Mother	88 (45.6)	39.0–52.4	31(49.2)	57 (43.9)	
Others	13 (6.7)	3.9–11.5	5(7.9)	8 (6.2)	

TBA: Traditional birth attendants; p-value *: Pearson's chi-squared test; (X^2) †: Chi-squared test statistic.

Table 3. Table showing key decision makers and actors in newborn care in Lira district, Northern Uganda.

	Rural Births ***n*** **= 589** ***n*** **(%)**	**Urban Births** ***n*** **= 341** ***n*** **(%)**	***p*-Value * (X^2) †**	**First-Time Mothers** ***n*** **= 227** ***n*** **(%)**	**Mothers with Previous Birth** ***n*** **= 703** ***n*** **(%)**	***p*-Value * (X^2) †**
Decide birthplace						
Father	311 (52.8)	194 (56.9)		114 (50.2)	391 (55.6)	
Mother	194 (32.9)	95 (27.9)	0.498 (0.766)	51 (22.5)	238 (33.9)	<0.001(21.03)
Grandmother	59 (10.0)	35 (10.3)		48 (21.2)	46 (6.5)	
Others	25 (4.2)	17 (5.0)		14 (6.2)	28 (4.0)	
Dried baby immediately after birth						
Health worker	302 (53.6)	259 (81.7)	<0.001 (23.16)	160 (74.8)	401 (60.2)	<0.001(10.62)
TBA	199 (35.4)	39 (12.3)		44 (20.6)	194 (29.1)	
Others	62 (11.0)	19 (6.0)		10 (4.7)	71 (10.7)	
Conducted first bath						
Grandmother	344 (58.4)	172 (50.4)	0.090 (2.591)	175 (77.1)	341 (48.5)	<0.001(32.21)
Mother	100 (17.0)	65 (19.1)		9 (4.0)	156 (22.2)	
Others	145 (24.6)	104 (30.5)		43 (18.9)	206 (29.3)	
Decide breastfeeding initiation						
Mother	303 (51.4)	196 (57.5)		91 (40.1)	408 (58.0)	
Health worker	144 (24.5)	95 (27.9)	<0.001 (5.813)	75 (33.0)	164 (23.3)	<0.001(8.116)
Grandmother	61 (10.4)	31 (9.1)		39 (17.2)	53 (75.4)	
TBA	68 (11.5)	9 (2.6)		16 (7.1)	61 (8.7)	
Others	13 (2.2)	10 (2.9)		6 (2.6)	17 (2.4)	
Decided what to do with initial breast milk						
Mother	321 (54.5)	213 (62.5)	<0.001 (7.54)	87 (38.3)	447 (63.6)	<0.001(9.027)
Health worker	125 (21.2)	82 (24.1)		66 (29.1)	141 (20.1)	
Grandmother	67 (11.4)	26 (7.6)		44 (19.4)	49 (7.0)	
Others	76 (12.9)	20 (5.9)		30 (13.2)	66 (9.4)	
Decide whether or not to practice bottle-feeding						
Mother	441 (74.9)	243 (71.3)	0.318 (1.189)	150 (66.1)	534 (76.0)	<0.001(10.27)
Health worker	49 (8.3)	41 (12.0)		22 (9.7)	68 (9.7)	
Grandmother	36 (6.1)	21 (6.2)		31 (13.7)	26 (3.7)	
Others	63 (10.7)	36 (10.6)		24 (10.6)	75 (10.7)	
Applied substances to the umbilical cord						
TBA	15 (37.5)	2 (10.5)	0.112 (2.099)	9 (40.9)	8 (21.6)	0.179(1.708)
Health Worker	8 (20.0)	8 (42.1)		7 (31.8)	9 (24.3)	
Mother	10 (25.0)	5 (26.3)		2 (9.1)	13 (35.1)	
Others	7 (17.5)	4 (21.1)		4 (18.2)	7 (18.9)	
Decide care seeking for sick newborn						
Father	58 (43.6)	34 (56.7)	0.240 (1.468)	29 (53.7)	63 (45.3)	0.003 (6.543)
Mother	66 (49.6)	22 (36.7)		16 (29.6)	72 (51.8)	
Others	9 (6.8)	4 (6.7)		9 (16.7)	4 (2.9)	

p-value *: Pearson's chi-squared test; (X^2) †: Chi-squared test statistic.

3.3. Factors Associated with the Mother Being the Key Decision Maker

At multivariable analysis, the factors associated with the mother being the key decision maker for where she gave birth included: Mother having a secondary education compared to no education (adjusted odds ratio, AOR 1.9: (95% CI 1.0, 3.6)), mother having parity of 4 or more compared to one (AOR 2.1: (95% CI 1.2, 3.8)), and mother being employed (AOR 2.0: (95% 1.5, 2.9)) (Table 4). Mothers from households that belonged to the wealthiest quintile were less likely to be mainly responsible for where they gave birth from as compared to mothers from households in the poorest quintile (AOR 0.44: (95% CI 0.25, 0.76)) (Table 4).

Table 4. Factors associated with mothers being key decision makers on place of birth in the Lira district, Northern Uganda.

	Bi-Variable $n = 930$ **OR (95% CI)**	***p*-Value**	**Multivariable** $n = 930$ **AOR (95% CI)**
Mother age			
≤19	1		1
20–35	1.6 (1.1, 2.4)	0.018	1.1 (0.60, 2.0)
>35	1.3 (1.3, 4.3)	0.008	1.3 (0.58, 3.1)
Mother's Wealth index			
Lowest	1		1
2	0.89 (0.58, 1.4)	0.590	0.81 (0.51, 1.3)
3	0.90 (0.57, 1.4)	0.639	0.74 (0.47, 1.2)
4	0.95 (0.64, 1.4)	0.809	0.77 (0.50, 1.2)
Highest	0.59 (0.38, 0.93)	0.024	0.45 (0.26, 0.75)
Mothers education			
None	1		1
Primary	0.84 (0.52, 1.34)	0.451	1.2 (0.73, 1.9)
Secondary	1.0 (0.57, 1.86)	0.925	1.9 (1.0, 3.6)
Tertiary	0.44 (0.12, 1.6)	0.200	0.84 (0.21, 3.4)
Fathers education			
None	1		
Primary	0.39 (0.19, 0.80)	0.012	-
Secondary	0.46 (0.22, 0.97)	0.042	
Tertiary	0.33 (0.13, 0.85)	0.023	
Marital status (living with partner)			-
Single	1		
Married	0.38 (0.23, 0.63)	0.001	
Parity			
1	1		1
2–3	1.4 (0.94, 2.0)	0.101	1.3 (0.85, 2.1)
>4	2.1 (1.5, 3.0)	<0.001	2.1 (1.2, 3.8)
Residence			
Urban	1		-
Rural	1.3 (0.90, 1.8)	0.167	
Mother formally employed			
No	1		1
Yes	1.9 (1.4, 2.7)	<0.001	2.0 (1.5, 2.9)

Regarding the decision to initiate breastfeeding, older mothers were more likely to decide on when to initiate breastfeeding (AOR 1.3: (95% 0.58,3.1)), whereas mothers in rural areas were less likely to make this decision (AOR 0.72: (95% CI 0.52, 0.99)) (Table 5).

Table 5. Factors associated with mothers being the key decision makers on when to initiate breastfeeding in the Lira district, Northern Uganda.

	Bi-Variable $n = 930$ OR (95% CI)	*p*-Value	Multivariable $n = 930$ AOR (95% CI)
Mother age			
≤19	1		1
20–24	2.0 (1.3–3.2)	0.003	1.8 (1.1–3.0)
25–29	2.5 (1.6–3.9)	0.000	1.9 (1.1–3.4)
30–34	3.5 (2.1–6.0)	0.000	2.8 (1.3–6.1)
≥35	3.9 (2.3–6.8)	0.000	3.1 (1.5–6.4)
Mother's Wealth index			
1 (Lowest)	1		
2	1.1 (0.72–1.6)	0.777	–
3	1.3 (0.89–1.8)	0.171	
4	1.0 (0.68–1.5)	0.999	
5 (Highest)	1.2 (0.82–1.9)	0.289	
Mothers education			
None	1		1
Primary	0.90 (0.65–1.2)	0.493	1.3 (0.87–1.9)
Secondary	0.93 (0.46–1.9)	0.848	1.3 (0.63–2.7)
Tertiary	1.0 (0.35–2.9)	0.977	1.4 (0.40–4.7)
Fathers education			
None	1		
Primary	1.2 (0.48–2.9)	0.704	–
Secondary	1.3 (0.49–3.4)	0.606	
Tertiary	1.1 (0.44–3.0)	0.783	
Marital status (living with partner)			
Single	1		1
Married	1.5 (0.82–2.8)	0.176	1.2 (0.67–2.1)
Parity			
1	1	1	1
2–3	1.6 (1.2–2.2)	0.002	1.2 (0.79–1.7)
>4	2.5 (1.8–3.4)	<0.001	1.3 (0.76–2.4)
Residence			
Urban	1	1	1
Rural	0.78 (0.59–1.1)	0.095	0.72 (0.52–0.99)
Mother formally employed			
No	1		1
Yes	1.1 (0.87–1.5)	0.349	1.1 (0.85–1.4)
Place of Birth			
Home	1		1
Health facility	0.89 (0.68–1.2)	0.414	0.86 (0.64–1.2)

4. Discussion

This study showed that mothers, fathers, grandmothers, health workers, and traditional birth attendants were the key decision makers and actors in newborn care, albeit for different practices. This finding is not surprising and has been reported by qualitative findings in other African countries [4,8,23]. This study contributes to the existing literature by adding a quantitative dimension to those findings.

We found that in the majority of cases, fathers were the key decision makers concerning where the mother gave birth from and whether care was sought for sick newborns. Similar findings were

observed in a study in Eastern Uganda [19] and in Zambia [24]. We think this could be related to the financial implications of the decision to seek care outside the home [25]. Indeed, previous research has highlighted the role of husbands in acquiring transport, money, and other instrumental support needed in seeking care for pregnant women and their newborns [26–28]. Our findings differ from studies in Ethiopia and Ghana, which found that grandmothers played a key role in deciding where a woman should give birth [26,29,30]. Decision makers vary across different places, since decision making is socially and culturally constructed, and this could explain this difference [21]. The difference could result from differences in the respect given to grandmothers in different countries, or the ability of grandmothers to pay for the health care services of their daughters/daughters-in-law. In addition, the difference could be explained by the difference in study design and sampling methods used in these studies. The studies in Ethiopia and Ghana used a qualitative design, with nonrandom sampling (purposeful sampling), whereas we used a quantitative design with random sampling.

Grandmothers most commonly performed the first neonatal bath, whereas traditional birth attendants most commonly applied substances to the umbilical cord of the child in the period immediately after birth. In the period immediately after birth, mothers are (or perceived to be) exhausted [8], and the care of newborns is often delegated to older female relatives who are perceived to be knowledgeable and experienced [20,22]. This could explain why these older women were most commonly the ones who first bathed the baby, a finding that was also observed in communities in Nigeria, Tanzania, and Ethiopia [8]. As suspected, we found that grandmothers and traditional birth attendants were more involved in the postnatal care of first-time mothers, compared to mothers who had given birth before. First-time mothers are perceived to be least knowledgeable as regards newborn care [8]. Another reason that could explain greater grandmother involvement in the postnatal care of first-time mothers relates to the young age at which girls in Africa get pregnant [21]. Since the mothers are very young, societies have derived ways of training them in childcare, and central to this plan are the grandparents [21]. Young women often have to accept whatever decisions are made to avoid conflict [21].

Mothers were key decision makers relating to practices concerning breastfeeding. Since mothers spend the most time with the babies in the post-immediate period after birth, they are most likely to be the key decision makers concerning practices related to infant feeding. However, health workers were also common key decision makers in breastfeeding practices. Similar findings were seen in Malawi, where mothers were the most often-cited decision makers in breastfeeding, but grandmothers were also involved [11]. A study conducted in the same area showed that involvement of significant others in breastfeeding decisions was a predictor of early initiation of breastfeeding [31]. These findings from Uganda are in broad agreement with similar literature from Ethiopia, Tanzania, and Nigeria [8], and this suggests that the findings might be cross-cultural.

Regarding the decision on place of birth, mothers earning money and more educated mothers were more likely to decide on the place of birth. Similar findings have been observed in Ghana [32], and this suggests that decision-making could be a good measure of women empowerment [33]. Regarding the decision to practice timely breastfeeding initiation, older mothers and mothers in urban areas were more likely to decide on when to initiate breastfeeding. This implies that when designing interventions in rural areas, other people key in deciding on breastfeeding initiation like health workers need to be involved. Interventions that seek to promote health facility births need to involve husbands, and interventions to promote delayed bathing of the newborn need to involve grandparents.

In this study, we observed that men were not commonly involved in the selected newborn care practices, apart from deciding the place of birth and seeking care for sick newborns. Prior research has shown that improved male involvement is associated with improved maternal and newborn health through the promotion of skilled birth attendance, postpartum care, complications preparedness, and maternal nutrition [34]. As such, men need to be encouraged to have more involvement in newborn care, especially in being direct actors in newborn care practices. It has been reported that cultural perceptions hinder men from participating in the immediate care of newborns, as this period

is gendered as feminine [25]. This could explain the absence of male involvement in this period, and campaigns aimed at encouraging male involvement need to address that issue.

This study had some limitations; the long recall period (11 months on average) could have introduced a measurement/information bias. We used this long recall window to enable us to obtain sufficient mothers using multistage sampling [35]. To minimize the recall limitation, we asked questions relating to only the most recent pregnancy and childbirth. We acknowledge that decision-making is a complex process involving multiple parties at different levels, and the utilization of a more detailed framework in data collection would have been ideal. Such a framework would enable us to address joint decision making, power dynamics, willingness or unwillingness of mothers to make decisions, changing trends of decision making over time, and influence of urbanization/globalization on decision making. It can, therefore, be argued that we oversimplified a very complex process. The role of different actors in childcare is rooted in larger sociocultural constructs [21] and is expected to vary from one place to another. This study was carried out in the Lira district, located in post-conflict Northern Uganda, and the findings reported can only be generalized to similar settings. We did not explore various aspects of the decision-making process.

5. Conclusions

Fathers, grandmothers, health-workers, and traditional birth attendants were influential in newborn care. Programs that aim to promote newborn care, especially programs that encourage facility births, and immediate newborn care, need to involve persons other than the mother; particularly husbands and grandmothers. Health workers should be involved in programs that promote timely initiation of breastfeeding, especially in rural areas. This study also highlights the importance of context-specific formative research prior to interventional studies being rolled out, to ensure that interventions are directed at the right people.

Author Contributions: D.M., V.N., G.N., T.T., and J.K.T. conceived, designed, supervised the study, analyzed the data, and wrote the first draft of manuscript. I.O., J.T., J.B.T., A.N., V.A., B.O., and A.A.A. were instrumental in the design and supervision of the study, and in drafting of the manuscript. S.K. contributed in the analysis of the data and critical revision of the manuscript. All authors read and approved the final version to be published.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Table showing a detailed list of key decision makers and actors in newborn care in the Lira district, Northern Uganda.

Variable	*n* (%)	95% CI of %
Decide birthplace		
Mother of baby	289 (31.08)	27.53–34.86
Father of baby	505 (54.30)	49.35–59.17
* Mother-in-law	57 (6.13)	4.77–7.85
Sister	6 (0.65)	0.26–1.59
* Grandmother	37 (3.98)	2.79–5.64
Friend	2 (0.22)	–
TBA	4 (0.43)	0.16–1.13
Health worker	6 (0.65)	0.03–1.38
Other	24 (2.58)	1.73–3.82
Cut and tied the umbilical cord		
Mother of baby	13 (1.40)	0.78–2.50
Father of baby	2 (0.22)	–
Mother-in-law	16 (1.72)	1.03–2.86
Sister	3 (0.32)	–
Grandmother	12 (1.29)	0.76–2.18
Friend	1 (0.11)	–
TBA	257 (27.63)	20.89–35.58
Health worker	617 (66.34)	58.02–73.77
Other	9 (0.97)	0.46–2.02
Applied substances to the umbilical cord		
Mother of baby	15 (25.42)	16.88–36.40
Father of baby	1 (1.69)	0.20–12.68
Mother-in-law	4 (6.78)	2.81–15.45
Sister	1 (1.69)	0.2–12.68
Grandmother	5 (8.47)	2.97–21.85
TBA	17 (28.81)	19.39–40.51
Health worker	16 (27.12)	15.99–42.12
First bathed the baby immediately after birth		
Mother of baby	165 (17.74)	15.43–20.32
Father of baby	7 (0.75)	0.38–1.49
Mother-in-law	340 (36.56)	33.58–39.65
Sister	46 (4.95)	3.50–6.95
Grandmother	176 (18.92)	15.97–22.29
Friend	24 (2.58)	1.50–4.41
TBA	76 (8.17)	5.20–12.62
Health worker	13 (1.40)	0.78–2.50
Other	83 (8.92)	6.90–11.48
Decide breastfeeding initiation		
Mother of baby	499 (53.66)	49.79–57.48
Mother-in-law	57 (6.13)	4.91–7.63
Sister	5 (0.54)	0.19–1.50
Grandmother	35 (3.76)	2.58–5.47
Friend	1 (0.11)	–
TBA	77 (8.28)	5.78–11.72
Health worker	239 (25.70)	22.08–29.68
Other	17 (1.83)	1.21–2.76
Decide what to do with initial breast milk		
Mother of baby	534 (57.4)	54.49–60.30
Mother in Law	59 (6.34)	5.00–8.02
Sister	4 (0.43)	-
Grandmother	34 (3.66)	2.56-5.19
Friend	2 (0.22)	-
TBA	83 (8.92)	6.24–12.61
Health Worker	207 (22.26)	19.84–24.88
Other	7 (0.75)	0.38–1.49
Decide whether or not to practice bottle-feeding		
Mother of baby	684 (73.55)	70.33–76.54
Father of baby	3 (0.32)	–
Mother-in-law	37 (3.98)	2.90–5.44
Sister	2 (0.22)	–
Grandmother	20 (2.15)	1.31–3.52
TBA	15 (1.61)	0.9–2.87
Health worker	90 (9.68)	7.54–12.34
Other	79 (8.49)	6.81–10.55
Decide care seeking for ill newborn (For those who had sick newborns and sought care)		
Mother of baby	88 (45.60)	38.97–52.38
Father of baby	92 (47.67)	41.76–53.65
Mother-in-law	2 (1.04)	0.26–4.02
Grandmother	7 (3.63)	1.76–7.33
Other	4 (2.07)	0.78–5.41

* Grandmother refers to the mother of the mother of the baby. * Mother-in-law refers to the mother of the father of the baby.

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