THE DELIVERY OF POST NATAL CARE AND ITS ASSOCIATION WITH NEWBORN SURVIVAL AND FEEDING: A FOCUS ON AFRICA

Shane M. Khan

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Maternal and Child Health in the Gillings School of Global Public Health.

Chapel Hill
2015

Approved by:

Ilene Speizer

Kavita Singh

Gustavo Angeles

Nana A. Y. Twum-Danso

Pierre Barker

ABSTRACT

Shane M. Khan: The Delivery of Post Natal Care and its Association with Newborn Survival and Feeding: A focus on Africa
(Under the direction of Ilene Speizer)

The goal of this dissertation is to understand how postnatal care (PNC), a relatively new intervention, functions in the context of sub-Saharan Africa with respect to improving neonatal survival and newborn feeding. Further, this dissertation also evaluates if a quality improvement intervention is able to improve PNC.

Paper one examines if PNC is associated with neonatal mortality in 17 countries in sub-Saharan Africa. Findings show that PNC coverage is low, often lower than skilled delivery, and that newborns from wealthier households are more likely to receive PNC. Using multi-level modelling, we find that PNC is associated with saving newborn lives and that PNC provided at home and facilities show about the same level of neonatal mortality reductions. Finally, the association of PNC with neonatal mortality is different in East and Southern Africa compared with the West and Central African countries we studied.

In paper two, we examine if PNC is associated with improved newborn feeding practices. The results indicate that PNC is associated with early breastfeeding though not with PLFs (which refer to liquids other than breastmilk that are given to newborns before breastfeeding is established). These findings may indicate that the implementation of PNC must better be tailored to promote the reduction of PLFs.

Paper 3 examines if a quality improvement (QI) intervention in Ghana can improve PNC for the mother and newborn. Using three waves of household survey data, results show that PNC is associated with improvements in PNC for the mother though not for the newborn. The intervention was associated with significant reductions in PNC within one week for either the newborn or mother. These findings suggest that the program may have emphasized maternal health but not newborn health improvements.

Overall, these results show that national implementation of PNC can save lives and improve newborn feeding though additional work is needed to supplement existing approaches to newborn feeding. Then, QI interventions may be a useful mechanism to improve PNC coverage. These findings are useful to monitor national outcomes as well as examine small-scale studies which contribute to the overall knowledge base on PNC implementation.

ACKNOWLEDGEMENTS

Over these short years, many have provided support towards completion of this work. I take this opportunity to thank all of them. To Ilene, my advisor, heartfelt thanks for supporting me technically and personally and providing the space to pursue my ideas. Kavita, many thanks for all of the technical knowledge you bring to my work and for seeing much of my potential. Gustavo, Nana and Pierre, the feedback I received have made much of this possible. To my entire committee, I look forward to working with you as part of my professional life. I also acknowledge the vital contribution that the MNR program, the Bill and Melinda Gates Foundation, the MICS and the DHS programs have made in providing data to make this dissertation possible. My gratitude goes to the MCH department and the Bill and Melinda Gates Foundation which provided funding for my studies. Finally, I acknowledge the contributions of my doctoral cohort and other MCHers who grew with me and worked closely with me through this process.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANC	antenatal care
BMGF	Bill and Melinda Gates foundation
CHW	community health worker
DHS	Demographic and Health Surveys
GDP	gross domestic product
ICN	Improvement Collaborative Network
MICS	Multiple Indicator Cluster Surveys
MLM	multilevel model
MNR	Maternal and Newborn Referrals Project
NNM	neonatal mortality
PLF	prelacteal feed
PNC	postnatal care
QI	quality improvement
TBA	traditional birth attendant
UNICEF	United Nations Children's Fund
WHO	World Health Organization

CHAPTER 1: POSTNATAL CARE TO IMPROVE NEONATAL OUTCOMES

Introduction

Neonatal deaths are a significant global problem; annually, close to 2.9 million children die within the first 28 days of life, accounting for about 44% of all under-five deaths in developing countries[1]. Two-thirds of neonatal deaths are caused by preterm birth, intrapartum-related conditions (previously referred to as birth asphyxia) and severe post-birth infection, much of which is preventable[2]. Neonatal deaths can be prevented through a range of interventions which can include the use of resuscitation, case management of infections, and kangaroo care[3]. A recent joint statement by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) recommends that developing countries promote the use of post-natal care (PNC) for mothers and children, in addition to antenatal care and skilled birth attendance, to help prevent neonatal deaths and maternal morbidity and mortality[4]. PNC should include the promotion of immediate and exclusive breastfeeding (for children less than 6 months of age), hand-washing, and examination of mother and child for danger signs and appropriate referral for medical care[5]. This recommendation is based on the results of studies in Bangladesh, Pakistan and India where PNC was associated with neonatal mortality declines of 30-61%[6-9] and with the improvement of maternal identification of newborn health risks[10]. Additional studies indicate that PNC in trials and small-scale interventions can improve rates of early initiation of breastfeeding and exclusive breastfeeding[11,12] and thereby improve newborn feeding. Despite the association between PNC and early initiation of breastfeeding in trials and intervention settings, it is not currently known if PNC can affect other feeding practices such as prelacteal feeds (PLFs).

Under-five mortality is highest in sub-Saharan African countries (98 deaths per 1000 live births)[13] with approximately a third of these deaths occurring during the neonatal period. Since the release of the WHO-UNICEF PNC recommendation, progress has been made on national monitoring of PNC. However, the population effects of PNC in national samples on outcomes for newborns are currently unknown. This study aims to address this gap in knowledge by describing use of PNC and then examining the association of PNC with neonatal mortality and newborn feeding practices using nationally representative data from the UNICEF-supported Multiple Indicator Cluster Surveys (MICS) and USAID-supported Demographic and Health Surveys (DHS) in 19 sub-Saharan African countries. To examine the association between PNC and neonatal mortality, we propose a hierarchical linear model, which accounts for clustering of women in countries. We use the same approach to study the association of PNC on early initiation of breastfeeding and PLFs using separate multi-level models, using the same set of sub-Saharan African countries. While previous studies have examined the association between PNC and various outcomes in trials and small-scale interventions, this study is one of the first to examine these relations at the national level in multiple African countries. Results can impact policy recommendations for promoting PNC to improve newborn survival and feeding practices. Quality improvement (QI) interventions are one approach that can be used to improve coverage of PNC. QI interventions have been used in developed countries for a number of years, and more recently, in developing settings. QI within the African health system has focused on organizing teams of health care providers who test and implement changes in health care processes based on locally identified problems[14]. A number of studies in sub-Saharan Africa show that QI interventions are effective in improving maternal and child health. In Malawi, a QI initiative improved quality of pneumonia care for children and reduced case fatality[15]. In Ghana, QI was effective in scaling up of post natal care (PNC) coverage[16] and can increase visits to health facilities by underweight infants and skilled delivery coverage[17]. However, no study has examined the short and long-term effects of a QI intervention on improving coverage of PNC in a subnational sample of urban and rural areas in Ghana.

Despite the potential of PNC to improve maternal and child health outcomes[6,8-12,18], relatively few developing countries collect detailed data on PNC[19]. Currently, the two major global sources of data on PNC are the UNICEF-supported Multiple Indicator Cluster Surveys (MICS) and the USAID-supported Demographic and Health Surveys (DHS). Recently, UNICEF developed and tested a standard module on PNC which collects data for all births in the two years before the survey on the timing, provider and location of PNC for both the mother and the newborn with detailed probes to assist respondent recall of the sequence of events following birth. PNC indicators in the DHS cover similar topics but lack these probes and in some surveys, PNC is only collected for non-facility births, though in more recent surveys, more detailed and harmonized indicators are collected by the DHS, as per UNICEF recommendations. Neither survey program currently provides indicators on the content of PNC, as is routinely done for antenatal care. PNC content refers to care behaviors and practices for newborns such as checking the newborn's temperature, weight and if the cord was checked. Recently, global agreement on indicators for content of PNC for newborns was reached and will be measured in the coming years in the MICS. This study implements this new set of content questions on PNC in Ghana using an existing program evaluation that examines QI effectiveness in improving access to maternal and child health services.

The Maternal and Newborns Referral Project (MNR) in Ghana is an ongoing QI intervention funded by the Bill & Melinda Gates Foundation. This proposed study will determine the short and long-term program effects of this QI intervention on PNC coverage and examine if the intervention is associated with greater use of specific PNC practices and behaviors and the variation in use and content of PNC. This study is quasi-experimental and will use data from three consecutive household surveys collected from the same districts for intervention and non-randomly assigned comparison districts to answer the research questions. The first two waves of data were collected in 2012 and 2013, and the endline data will be collected in 2015. All three waves contain data on PNC coverage though only the final wave will contain indicators on the content of PNC.

SPECIFIC AIMS

This dissertation is divided into 3 papers with the following specific aims:

<u>Paper 1: Postnatal care: an overview and its association with neonatal mortality</u>

<u>Aim #1</u>: Describe the variation in the receipt of PNC by newborns in sub-Saharan African countries.

Hypothesis 1: Newborns from wealthier households are more likely to receive PNC than newborns from poorer households.

<u>Aim #2</u>: Examine the association between PNC exposure and neonatal mortality in sub-Saharan African countries.

Hypothesis 1: PNC is associated with lower neonatal mortality rates.

Hypothesis 2: PNC given in facilities is associated with lower neonatal mortality rates that PNC given at home visits.

Hypothesis 3: The association of PNC on neonatal mortality differs by sub-regions of sub-Saharan Africa.

<u>Paper 2: Postnatal care and newborn feeding practices in 15 sub-Saharan African countries</u>

<u>Aim #1</u>: Examine the association between PNC and newborn feeding practices in sub-Saharan African countries, such as early initiation of breastfeeding and prelacteal feeds.

Hypothesis 1: PNC is associated with higher levels of early initiation of breastfeeding and lower levels of prelacteal feeds.

Paper 3: Can a quality improvement intervention improve Post Natal Care coverage and content?

Aim #1: Determine the short and long-term effects of the QI intervention on PNC coverage.

Hypothesis 1: Women in the intervention areas are more likely to use PNC compared with women in the comparison areas 1 year after program implementation (short-term) and 2+ years after initial implementation (long-term).

Aim #2: Examine if the QI intervention is associated with specific post-natal care behaviors and practices such as weight and temperature measurement and breastfeeding counseling (PNC content).

Hypothesis 1: At endline, women and newborns in the intervention areas are more likely to have their weight and temperature measured and to be counseled on breastfeeding compared with women in comparison areas.

BACKGROUND AND SIGNIFICANCE

The global problem of neonatal deaths – magnitude, locations, causes, and timing

Neonatal deaths (deaths in the first 28 days of life) are a global problem. Approximately 2.9 million neonatal deaths occur annually, accounting for close to half of under-five deaths globally (44%) [20]. Neonatal deaths are not distributed equally across the globe. Rather, there are large variations in deaths across countries and regions. Sub-Saharan Africa has the highest neonatal mortality rates (32 deaths per 1000 births) and accounts for close to 40% of global neonatal deaths (2012 data), while developed regions such as Europe and the Americas accounts for less than 2% of global neonatal deaths[1]. In 2012, nine countries had high neonatal mortality rates (NNM) (i.e. rates $\geq$ 40), 8 of which are in sub-Saharan Africa [21]. While global neonatal mortality rates have declined since 1990 from 33 to 21 deaths per 1000 live births, this 37% reduction is much less than the 50% reduction seen in deaths among children age 1-5 years[20]. In general, NNM rates in sub-Saharan Africa and south Asia were the highest in 1990 and have had the least reductions [21]. These figures underscore the need to focus on neonatal mortality.

The major causes of neonatal death (in 2012) are complications from preterm birth (36%), intrapartum-related conditions (previously referred to as "birth asphyxia", 23%), and infections (mostly sepsis, meningitis, and pneumonia; 23%) [21]. Another 18% are caused by congenital diseases (10%) and other causes (8%). In the early neonatal period (0-6 days), the majority of deaths are caused by preterm births and intrapartum-related conditions, while in the later neonatal period, infections such as sepsis and pneumonia were most common [21]. In high NNM countries, infections and intrapartum-related conditions are the main causes of death.

The neonatal period is critical as the daily risk of dying in this time frame is estimated to be more than 30 times that of the post-neonatal period[22]. Even within the neonatal period, the risk of death varies considerably. For live births, the risk of death is highest on the day of birth[21]. Globally, 36% of neonatal deaths occur on the first day of life while 73% of deaths occurred during the first week of life [23].

Interventions to address neonatal deaths – cost, effectiveness, coverage

Though the number of potential interventions to reduce neonatal deaths is relatively large, a review by Darmstadt *et al.* of the effectiveness, efficacy and cost of evidence-based interventions recommends 16 interventions for low and middle-income countries[24]. These interventions serve to first, maximize reductions in neonatal deaths and then to minimize intervention cost. Darmstadt and colleagues also recognize that single interventions are less effective than bundles of interventions and therefore recommend various packages of interventions that occur across the lifecycle of women. These packages of interventions are positioned as preconception, antenatal, intrapartum or postnatal. Overall, it is estimated that universal coverage (99%) of the 16 interventions can reduce 42-71% of neonatal deaths[24].

The proposed interventions show a range of effects on neonatal mortality reduction. For example, folic acid supplementation during preconception is estimated to reduce NNM by 42-87%, while clean delivery practices during the intrapartum period yields an estimated reduction of 58-78%. The postnatal care package of interventions recommended during the postnatal period by Darmstadt et al. consists of five interventions: resuscitation of the newborn, breastfeeding, prevention and management of hypothermia, kangaroo mother care, and community-based pneumonia case management. Resuscitation of the newborn is estimated to yield a 6-42% reduction in NNM, while breastfeeding has a 55-87% effect on reducing NNM through the reduction of pathogen ingestion and stimulation of the immune system[25-27]. Prevention and management of hypothermia produces a reduction of 18-42%, while kangaroo mother care and community-based management of pneumonia produces reductions of 51% (7-75%) and 27% (18-35%) respectively[24]. Finally, it has been recommended that these postnatal interventions be implemented through different service delivery modes such as through facilities, outreach (such as home visits) or part of the family-community care (which supports self-care and improves treatment seeking and includes community-based illness management and behavior change communications).

Postnatal care (PNC) to reduce neonatal mortality

After the recommendations by Darmstadt et al., the WHO and UNICEF recommended PNC as a means to reduce neonatal mortality and highlighted the need to supplement facility-based PNC with home visits for non-institutional births. This recommendation is based primarily on four studies in south Asia which conclude that home visits can reduce neonatal mortality from 30-61% [6-9] through the management and treatment of infections such as sepsis, identification of disease and appropriate referrals, prevention of hypothermia and promotion of thermal care and appropriate cord-care. Additionally, PNC can be used to promote neonatal resuscitation which reduces neonatal deaths[28]. In a later randomized trial in Ghana, authors find that home visits have similar effect levels as the other randomized trials[29]. Three additional studies examined the effect of PNC on neonatal mortality within program settings. These studies in Bangladesh[30], Pakistan[31] and India[32] showed a reduction of 13%, 15% and 9%, respectively. These results are substantially lower than those seen in trials done outside of program settings, suggesting that effects in trials are difficult to replicate in customary or program conditions.

Postnatal care (PNC) – the intervention and effects on other health outcomes

The general focus of PNC is to prevent health complications to the woman and newborn through counseling the woman on key health information, assessment of the woman and newborn for various health problems and referrals for the woman and newborn if problems are detected. The WHO-UNICEF recommendation for PNC considers that facility care be complemented by home visits, as part of PNC. Facility care entails a facility birth following which women and the newborn are assessed for health problems, and asked to return to the facility at a specific time for further care even if there are no apparent problems or to return immediately if there are danger signs such as bleeding and infection[33]. For non-institutional births, skilled health workers should make home visits. There is no evidence when these visits should be made. However, as newborns are most likely to die within the first few days after birth, the recommendation is for two mandatory visits, the first within 24 hours of birth, the second on day 3 and one optional visit on day 7 for non-institutional births[4]. Institutional births should have the first visit as soon as possible after the baby and mother return home, and follow the same schedule of non-institutional visits for the second and third visits[4].

During a home visit, WHO-UNICEF recommends the promotion of early initiation of breastfeeding and exclusive breastfeeding, kangaroo care, and improved hygiene such as hand-washing and hygienic cord and skin care. Home visits in developed countries have been shown to improve breastfeeding rates and parenting skills, while in developing countries, home visits can improve coverage interventions for newborns including breastfeeding (especially early initiation of breastfeeding and exclusive breastfeeding) thermal care (including skin-to-skin contact and delayed bathing) and improved hygiene[6-9,12,34]. Mothers should be counselled to identify danger signs and also both the mother and the newborn should be examined for danger signs during visits. Danger signs include not feeding well, difficulty breathing, fever, colds, fits or convulsions. Finally, birth registration, immunization and identifying newborns with special needs such as low birth weight newborns should be done during home visits.

Sub-Saharan Africa: health context

Sub-Saharan Africa has some of the world's worst health problems compared to other geographic regions. The latest estimates of under-five mortality points out that under-five deaths are becoming more concentrated in this region (along with southern Asia) while the opposite occurs in other regions[1]. In sub-Saharan Africa, the risk of death in the first month of life is the highest and has also shown the least progress[1]. Maternal mortality estimates for sub-Saharan Africa stand at 510 deaths per 100 000 live births, more than twice that of south Asia at 190 deaths per 100 000 live births[35]. Another striking fact about sub-Saharan Africa is that the use of skilled birth attendants is low; only 1 in 2 children are born using a skilled professional, compared with 9 in 10 in Latin America and the Caribbean. Figures also reveal disparities in coverage within sub-Saharan Africa. For example, women in rural areas are about half as likely to use skilled birth attendance than urban women in this region[36]. Children in sub-Saharan Africa fare worse than children in other regions. Pneumonia is a leading health problem in sub-Saharan Africa while diarrheal diseases have the highest burden in the Sahel and care-seeking for these conditions is low[37].

Paper 1: Postnatal care: an overview and its association with neonatal mortality

Paper 1 is guided by the Proximate Determinants of Child Survival model[38]. The model proposes that proximate determinants act directly to alter a child's health, from wellness to illness which influences mortality. The five proximate determinants are maternal factors (such as age, parity, birth intervals), environmental contamination, nutrient deficiency, injury and personal illness control. The proximate determinants framework also recognizes that socio-economic determinants play a role in the illness and death of children. Factors such as wealth and gender are typical socio-economic determinants and exert an effect on illness and mortality though these effects are mediated by the proximate determinants. This model is widely used and is recognized as the conceptual basis for many studies on mortality[39].

Aim #1: Describe the variation in the receipt of PNC by newborns in sub-Saharan African countries.

Few studies have explored the variation in the use of PNC. One study explores postnatal coverage in Egypt and Bangladesh between 2004 and 2008 using data from the Demographic and

Health Surveys [40]. The author finds that the majority of postnatal care occurs within 24 hours of birth and for the countries in their study, trends show little improvement in coverage over time. Another study in India examined socio-economic inequalities in PNC coverage, compared with antenatal care and delivery care[41]. The results indicated that PNC coverage was much lower than care during pregnancy and birth, and that mothers with home births were much less likely to receive PNC. The results also underscore the rich-poor gap in use of PNC among women with complications during birth, with richer women more likely to use PNC than poorer women. A descriptive study of postpartum care (defined as care received from 1 hour after delivery of the placenta to 42 days) in 30 countries showed that in 7 out of 10 countries, women received no postnatal care, and that the average timing of postnatal care is about 2 days following birth. Postpartum care was associated with higher household wealth, education above the primary level, urban residence and exposure to mass media[42]. Results were similar in Nepal, where the rich and more educated were more likely to use PNC[43]. This proposed study will be one of the first to provide analysis of the use of PNC in a number of sub-Saharan countries, detailing which newborns are most likely to receive PNC. Such information is useful to identify underserved groups for programmatic targeting.

Aim #2: Examine the association between PNC exposure and neonatal mortality in sub-Saharan African countries.

Based on evidence from trials, PNC was proposed as an intervention to reduce neonatal mortality [6-9]. However, few studies have examined the population-effects of PNC. In the literature, two population-based studies examine the association of PNC on neonatal mortality, controlling for key characteristic such as place of delivery and use of antenatal care. In a district-level study in India, authors find that PNC within 24 hours of birth does not reduce mortality, though Kangaroo care, which should be promoted by PNC, is significant in reducing neonatal mortality rates[44]. In

Indonesia, using data from the Demographic and Health Surveys, authors also find that postnatal care does not reduce neonatal mortality, though supplementation with folic acid does[45]. One of the weaknesses of these studies is that they did not control for a number of known confounders which can bias estimates such as birth weight, or size at birth, and birth intervals in the case of the India study, and neither of these studies addressed hand washing, which can prevent deaths due to diarrhea and pneumonia, important causes of death especially in the late neonatal period[21]. A recent 10 country study on PNC and neonatal mortality using DHS data finds that PNC is protective against neonatal death and that unskilled providers can be effective to deliver PNC[46]. Our proposed study expands the number of countries to 17, including data from DHS as well as MICS surveys. While our paper also addresses the issue of PNC and neonatal mortality, we also examine if facility-based PNC has a greater association with NNM than PNC from home visits and further, if there are regional variations in the relationship between PNC and neonatal mortality. Finally, we also introduce covariates of neonatal mortality such as birth spacing that were not included in the previous multi-country study[46].

The current WHO-UNICEF recommendation on PNC includes the use of home visits for PNC given that a large proportion of births occur outside of health facilities and that many women who have unskilled births are unable to seek PNC as recommended[33]. While several studies have shown that under controlled programmatic conditions, home visits can reduce neonatal mortality, there is currently no evidence that compares the associations of facility-based PNC and home-based PNC with NNM. This question is addressed in this dissertation by identifying the type of PNC (facility-based or home-based) and comparing the associations of these on neonatal mortality (hypothesis #2).

In sub-Saharan Africa, health systems and the availability of health professionals vary widely. For example, sub-Saharan Africa has the lowest distribution of medical doctors and nurses globally and from country to country, there is wide variation in the numbers of health professionals[47]. As PNC, in part, depends on the use of available health professionals and others such as traditional birth attendants, given the variation in the availability of these, we would expect that the effect of PNC on neonatal mortality to vary by region within sub-Saharan Africa.

Paper 2: Postnatal care and newborn feeding practices in 15 sub-Saharan African countries

Aim #1: Examine the association between PNC exposure and newborn feeding practices in sub-Saharan African countries, such as early initiation of breastfeeding and prelacteal feeds.

Breastfeeding is recognized as a key intervention to improve the health and survival of children. The WHO and UNICEF recommend early initiation of breastfeeding[48]. Early initiation of breastfeeding refers to breastfeeding within an hour of birth. However, global monitoring efforts by UNICEF also include initiation of breastfeeding within one day of birth, which can provide more detailed information on the feeding patterns of newborns. Early initiation of breastfeeding has a number of health benefits, one of which is to reduce neonatal mortality[49,50]. Additionally, newborns who are breastfed immediately are more likely to receive colostrum which can improve the newborn's immune system and theoretically, reduce infection and mortality. Breastfeeding is especially important in the few hours and days of life as it exposes newborns to skin-to-skin contact with the mother[51], a form of thermal care which is a recommended means to reduce neonatal mortality[24].

Prelacteal feeds (PLFs) refer to foods other than breast milk that is given to the newborn before breastfeeding is established between the mother and newborn. PLFs usually occur within the first few days of life and are associated with a number of negative health outcomes for the newborn and mother. These include insufficient milk production, diarrhea and reduced length of breastfeeding duration[52]. Another study showed that early initiation of breastfeeding within an hour of birth was negatively associated with PLFs[53]. WHO and UNICEF outlines that PLFs should not be encouraged unless medically indicated, and outlines that for successful breastfeeding, PLFs should be prohibited[54]. Part of the intervention of PNC is to educate the mother on newborn feeding practices, counseling her on breastfeeding. We would therefore expect that a newborn who has received PNC would be more likely to initiate breastfeeding early and less likely to have a prelacteal feed.

Paper 3: Can a quality improvement intervention improve Post Natal Care coverage and content?

Quality improvement interventions – definitions, introduction

Quality improvement (QI) interventions broadly refer to a class of interventions which seek to improve health-care processes and thereby affect health outcomes. QI interventions in Africa are rapidly expanding[14] though a number of QI approaches in Africa show limited results. Clinical training and supervision which has long been part of quality improvement, has shown only a limited impact on quality [55-57], while audit and feedback approaches show none to limited impact [58]. However, a study in 12 developing countries shows that testing and implementing changes can improve quality and performance of health facilities[59]. In Ghana, developing, testing and implementing facility and community-based change ideas was significantly associated with increased skilled delivery and post-natal care during the scale up of a national policy on PNC[16] and increased percentages of underweight infants attending wellness clinics and skilled attendance during birth [17].

Ghana: health context and PNC policy

Ghana, like other West African countries, has seen slower declines in under-five mortality than other developing countries. Child mortality remains high at 72 deaths per 1000 live births (2012) in Ghana despite improvements over the past 2 decades[13]. Strikingly, neonatal mortality accounts for close to 40% of all under-five deaths in the country[13]. Progress in reducing under-nutrition remains a serious public health issue. Among children less than 5 years of age, 13% are underweight (low weight for age) in Ghana is 13%, with rural rates 5 percentage points higher than urban rates[60]. Levels of exclusive breastfeeding are about 45% in Ghana and are similar to other countries in west Africa (Sierra Leone: 32% and Benin 43%)[61]. In Ghana, about 1 in 5 newborns receive a prelacteal feed, 46 percent are breastfed within an hour and 84 percent are breastfed within a day[60].

Ghana's initial policies on PNC promoted two contacts of health workers with newborns. The first policy promoted first contact during the second week of life and second contact at 6 weeks. The second policy amended the timing of the first contact only, to contact within 3 days of life. Neither of these policies mentions that the majority of mortality occurs within the first 48 hours of life. However, the 2008 policy proposes two visits within the first week of life to encourage healthy behaviors and detect early warning signs of illness for the mother and newborn.

Paper 3 is divided into two aims:

Aim #1: Determine the short and long-term effects of the QI intervention on PNC coverage.

A QI intervention in Ghana – the Maternal and Newborn Referrals project

The Maternal and Newborn Referrals project (MNR), a sub-project of the Project Fives Alive!, funded by the Bill and Melinda Gates Foundation (BMGF), is a QI intervention in Ghana. The objective of MNR is to increase the use of maternal and newborn health services by using QI processes to improve referrals to health providers. Ultimately, this project aims to contribute to reducing neonatal mortality. MNR relies on an existing platform called the Improvement Collaborative Network (ICN) developed by the Institute for Healthcare Improvement and used in *Project Fives Alive!*. Every 4-6 weeks, health staff from different health facilities meet in learning sessions which facilitate sharing of experiences and learning about change ideas, data analysis and learning improvement. The intervention occurs in two stages using QI teams which are comprised of members of the facility and of the community, hence operating a "facility-community" approach. In the first stage, a subset of health facilities is used essentially as a testing ground for change ideas, and in the second stage, successful ideas are scaled up to more facilities. By involving community members such as pregnant women, their families and community leaders, MNR can further identify problems and barriers to using health services. The intervention was not randomly assigned to the two districts where the MNR program operates. However, there was no special selection of these districts based on selected characteristics such as poverty and intervention coverage rates.

Aim #2: Examine if the QI intervention is associated with specific post-natal care behaviors and practices such as weight and temperature measurement and breastfeeding counseling (PNC content).

Measurement of Content of PNC

At the global level, data on PNC is relatively scarce; only 25 countries have data on PNC and less than 5 have detailed data on PNC[19]. This is in part due to the fact that only recently was a consensus developed by experts on what should be measured as PNC. Guidelines now recommend that PNC measurement should include the timing, location, and type of provider of PNC. The DHS historically collected PNC data only for non-facility births based on the assumption that mothers who give birth in facilities will not know if PNC occurred or not. However, a recent study refutes this assumption and globally, the agreement is to measure PNC for all births[19]. These recommendations were recently used to develop a standard module on PNC for mothers and newborns by the UNICEF MICS surveys. This module was launched and implemented in a number of developing countries and is now harmonized across the MICS and DHS.

One of the main global recommendations for PNC measurement, especially for programs which work on neonatal survival, is to measure PNC and the content of such care. The interagency newborn Technical Working Group (which has representation from UNICEF, USAID, Save the

Children, among other groups) recommends the measurement of five signal functions which are considered feasible for reporting by women on their newborns. These are checking the newborn's cord, assessing the mother's temperature, counseling and observing breastfeeding, information on newborn danger signs and weighing the newborn[19]. Thus far, only one country has used these indicators (Nigeria DHS 2013). As the MNR is a program dedicated to improving neonatal mortality outcomes, the MNR is an ideal program to collect data on the PNC content. These data can provide greater depth and understanding of PNC in the program areas and further, these data can assist programmatically in showing which components of care are provided and which need improvement.

Innovations of the papers

Globally, there is a dearth of comparable country data on PNC across the developing world[42]. The analysis from this proposed dissertation is one of the first to present cross-country analysis of PNC and examine the association of PNC on neonatal mortality and newborn feeding practices, for which PNC was recommended. The impact of this study is potentially high. First, results can indicate gaps in coverage and provide contextual information on which newborns do not receive PNC. Second, PNC is supposed to reduce NNM and a null result can indicate that existing services are not performing optimally. Finally, as we examine two indicators on newborn feeding, we are able to deepen our knowledge of newborn feeding in a sample of sub-Saharan African countries and examine if PNC is able to influence either of these practices.

This is also one of the few studies to examine PNC within the context of customary care as implemented by national health care systems. The majority of previous studies have examined PNC within the context of trials and smaller program settings that reflect medical attention and care that adheres rigorously to guidelines. This kind of care may contrast sharply with customary care practices seen in developing country settings. Additionally, the majority of studies on PNC use samples that were drawn from districts and within program settings. These results are usually not generalizable to the national population due to the samples used. As this proposed study is based on nationally representative samples of households in countries in sub-Saharan Africa, inferences on the effects of the main predictor can be made for the group of countries included. Another strength of this study is that we include a large number of sub-Saharan African countries in the analysis and further, examine if there are sub-regional differences in the relationship between PNC and neonatal mortality which previous studies could not show. We also examine if the association of facility-based PNC on NNM is different to home-based PNC on NNM, which no study has previously examined.

Further, this study is one of the few to provide additional evidence on how PNC coverage can be improved through programmatic effort. QI interventions have been used successfully in improving maternal and child outcomes though limited work has been done to examine if QI interventions can be used to improve PNC coverage. The results of this study can influence the development and implementation of other programs that seek to improve maternal and newborn care services.

We also provide data on five signal functions of PNC for which there is little data available globally. The content questions on PNC will provide an in-depth look at PNC that is not available in the vast majority of national surveys and help to further focus programmatic delivery of PNC to newborns within the MNR program. Further, this analysis will be an opportunity to examine the performance of these questions (such as non-response and variability) and make recommendations on the questions for future studies.

CONCLUSIONS

Neonatal mortality remains a significant problem, especially in sub-Saharan African countries which have the highest rates of neonatal deaths. The recent WHO-UNICEF recommendation to implement PNC is designed to reduce neonatal deaths as well as improve the health and nutrition of newborns. The focus of this dissertation is to examine the association of PNC with neonatal mortality and newborn feeding practices in sub-Saharan Africa. In this dissertation, we provide further contextual information on how PNC is delivered by providing sub-national estimates of the specific components of PNC which have not been measured in Ghana previously. Additionally, this dissertation explores how a programmatic approach, QI interventions, can be used to improve coverage of PNC. The findings of this dissertation have the potential to alter PNC delivery in the countries studied. Results on neonatal mortality and newborn feeding can be used to alter existing guidelines and strengthen regional and national approaches toward these practices in health facilities and during home visits. Our results can also suggest for a sub-national area in Ghana which specific components of PNC need to be strengthened during implementation and also suggest if the newly recommended measures of the content of PNC need further refinement. While QI approaches are unique to each system that adopts these approaches, the results of our study can inform program managers if such an approach can be used to improve the implementation of PNC.

REFERENCES

1. United Nations Inter-agency Group for Child Mortality Estimation. Levels & trends in child mortality. report 2013. estimates developed by the UN inter-agency group for child mortality estimation. . 2013.

2. Mathers CD, Fat DM, Boerma J. *The global burden of disease: 2004 update.* World Health Organization; 2008.

3. Lawn JE, Kerber K, Enweronu-Laryea C, Cousens S. 3.6 million neonatal deaths—what is progressing and what is not? . 2010;34(6):371-386.

4. World Health Organization. WHO/UNICEF joint statement: Home visits for the newborn child: A strategy to improve survival. *Switzerland: World Health Organization*. 2009.

5. WHO & UNICEF. Home visits for the newborn child: A strategy to improve survival. http://www.who.int/maternal_child_adolescent/documents/who_fch_cah_09_02/en/. Updated 2009. Accessed 9/5/2013, .

6. Baqui AH, Ahmed S, El Arifeen S, et al. Effect of timing of first postnatal care home visit on neonatal mortality in Bangladesh: A observational cohort study. *BMJ: British Medical Journal*. 2009;339.

7. Bhutta ZA, Memon ZA, Soofi S, Salat MS, Cousens S, Martines J. Implementing community-based perinatal care: Results from a pilot study in rural Pakistan. *Bull World Health Organ*. 2008;86(6):452-459.

8. Kumar V, Mohanty S, Kumar A, et al. Effect of community-based behaviour change management on neonatal mortality in shivgarh, uttar pradesh, india: A cluster-randomised controlled trial. *The Lancet*. 2008;372(9644):1151-1162.

9. Bang AT, Bang RA, Baitule SB, Reddy MH, Deshmukh MD. Effect of home-based neonatal care and management of sepsis on neonatal mortality: Field trial in rural India. *The Lancet*. 1999;354(9194):1955-1961.

10. Ransjö-Arvidson A, Chintu K, Ng'andu N, et al. Maternal and infant health problems after normal childbirth: A randomised controlled study in Zambia. *J Epidemiol Community Health*. 1998;52(6):385-391.

11. Hannula L, Kaunonen M, Tarkka M. A systematic review of professional support interventions for breastfeeding. *J Clin Nurs*. 2008;17(9):1132-1143.

12. Olds DL, Kitzman H. Can home visitation improve the health of women and children at environmental risk? *Pediatrics*. 1990;86(1):108-116.

13. UNICEF, WHO, UNPD, World Bank. Child mortality estimates: CME info. http://www.childmortality.org/index.php?r=site/map. Updated 2013. Accessed 10, 2013.

14. Heiby J. The use of modern quality improvement approaches to strengthen african health systems: A 5-year agenda. *Int J Qual Health Care*. 2014;26(2):117-123. doi: 10.1093/intqhc/mzt093 [doi].

15. Choubina P, Beksinska M, Smit J, et al. Respiratory diseases programme in Malawi a success. *Lancet Infectious Diseases*. 2003;3(11):680.

16. Twum-Danso NA, Dasoberi IN, Amenga-Etego IA, et al. Using quality improvement methods to test and scale up a new national policy on early post-natal care in Ghana. *Health Policy Plan*. 2013. doi: czt048 [pii].

17. Singh K, Speizer I, Handa S, et al. Impact evaluation of a quality improvement intervention on maternal and child health outcomes in northern Ghana: Early assessment of a national scale-up project. *Int J Qual Health Care*. 2013;25(5):477-487. doi: 10.1093/intqhc/mzt054 [doi].

18. Bang AT, Reddy HM, Deshmukh MD, Baitule SB, Bang RA. Neonatal and infant mortality in the ten years (1993 to 2003) of the gadchiroli field trial: Effect of home-based neonatal care. *Journal of Perinatology*. 2005;25:S92-S107.

19. Moran AC, Kerber K, Sitrin D, et al. Measuring coverage in MNCH: Indicators for global tracking of newborn care. *PLoS medicine*. 2013;10(5):e1001415.

20. Unicef. Levels and trends in child mortality. *Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation*. 2011.

21. Lawn JE, Blencowe H, Oza S, et al. Progress, priorities, and potential beyond survival. *The Lancet*. 2014.

22. Lawn JE, Cousens S, Zupan J. 4 million neonatal deaths: When? where? why? *The Lancet*. 2005;365(9462):891-900.

23. Lawn JE, Blencowe H, Pattinson R, et al. Stillbirths: Where? when? why? how to make the data count? *The Lancet*. 2011;377(9775):1448-1463.

24. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L. Evidence-based, cost-effective interventions: How many newborn babies can we save? *The Lancet*. 2005;365(9463):977-988.

25. Clemens J, Elyazeed RA, Rao M, et al. Early initiation of breastfeeding and the risk of infant diarrhea in rural Egypt. *Pediatrics*. 1999;104(1):e3-e3.

26. Brandtzaeg P. Mucosal immunity: Integration between mother and the breast-fed infant. *Vaccine*. 2003;21(24):3382-3388.

27. Goldman AS. The immune system of human milk: Antimicrobial, antiinflammatory and immunomodulating properties. *Pediatr Infect Dis J*. 1993;12(8):664-672.

28. Lee AC, Cousens S, Wall SN, et al. Neonatal resuscitation and immediate newborn assessment and stimulation for the prevention of neonatal deaths: A systematic review, meta-analysis and delphi estimation of mortality effect. *BMC Public Health*. 2011;11 Suppl 3:S12-2458-11-S3-S12. doi: 10.1186/1471-2458-11-S3-S12 [doi].

29. Kirkwood BR, Manu A, ten Asbroek AH, et al. Effect of the newhints home-visits intervention on neonatal mortality rate and care practices in Ghana: A cluster randomised controlled trial. *The Lancet*. 2013.

30. Darmstadt GL, Choi Y, Arifeen SE, et al. Evaluation of a cluster-randomized controlled trial of a package of community-based maternal and newborn interventions in Mirzapur, Bangladesh. *PloS one*. 2010;5(3):e9696.

31. Bhutta ZA, Soofi S, Cousens S, et al. Improvement of perinatal and newborn care in rural Pakistan through community-based strategies: A cluster-randomised effectiveness trial. *The Lancet*. 2011;377(9763):403-412.

32. Bhandari N, Mazumder S, Taneja S, Sommerfelt H, Strand TA. Effect of implementation of integrated management of neonatal and childhood illness (IMNCI) programme on neonatal and infant mortality: Cluster randomised controlled trial. *BMJ: British Medical Journal*. 2012;344.

33. World Health Organization. *Pregnancy, childbirth, postpartum and newborn care: A guide for essential practice*. Geneva, ISBN 92 4 159084 X: World Health Organization; 2006.

34. Hannula L, Kaunonen M, Tarkka M. A systematic review of professional support interventions for breastfeeding. *J Clin Nurs*. 2008;17(9):1132-1143.

35. UNICEF. Maternal mortality. http://data.unicef.org/maternal-health/maternal-mortality. Updated 2014.

36. UNICEF. Delivery care. http://data.unicef.org/maternal-health/delivery-care. Updated 2014.

37. UNICEF. *Committed to child survival: a promise renewed-progress report 2013*. 2013.

38. Mosley WH, Chen LC. An analytical framework for the study of child survival in developing countries. *Population and development review*. 1984;10:25-45.

39. Hill K. Frameworks for studying the determinants of child survival. *Bull World Health Organ*. 2003;81(2):138-139.

40. Fort AL. Coverage of post-partum and post-natal care in Egypt in 2005–2008 and Bangladesh in 2004–2007: Levels, trends and unmet need. *Reprod Health Matters*. 2012;20(39):81-92.

41. Singh A, Padmadas SS, Mishra US, Pallikadavath S, Johnson FA, Matthews Z. Socio-economic inequalities in the use of postnatal care in India. *PloS one*. 2012;7(5):e37037.

42. Fort AL, Kothari MT, Abderrahim N. *Postpartum care: Levels and determinants in developing countries.* Macro International; 2006.

43. Khanal V, Adhikari M, Karkee R, Gavidia T. Factors associated with the utilisation of postnatal care services among the mothers of Nepal: Analysis of Nepal demographic and health survey 2011. *BMC Womens Health*. 2014;14(1):19.

44. Singh A, Yadav A, Singh A. Utilization of postnatal care for newborns and its association with neonatal mortality in India: An analytical appraisal. *BMC Pregnancy and Childbirth*. 2012;12(1):33.

45. Titaley CR, Dibley MJ. Antenatal iron/folic acid supplements, but not postnatal care, prevents neonatal deaths in Indonesia: Analysis of Indonesia demographic and health surveys 2002/2003–2007 (a retrospective cohort study). *BMJ open*. 2012;2(6).

46. Singh K, Brodish P, Haney E. Postnatal care by provider type and neonatal death in sub-saharan africa: A multilevel analysis. *BMC Public Health*. 2014;14(1):941.

47. Liese B, Dussault G. *The state of the health workforce in sub-saharan africa: Evidence of crisis and analysis of contributing factors*. World Bank: Africa Region; 2004.

48. World Health Organization, Unicef. Global strategy for infant and young child feeding. . 2003.

49. Mullany LC, Katz J, Li YM, et al. Breast-feeding patterns, time to initiation, and mortality risk among newborns in southern Nepal. *J Nutr*. 2008;138(3):599-603. doi: 138/3/599 [pii].

50. Edmond KM, Zandoh C, Quigley MA, Amenga-Etego S, Owusu-Agyei S, Kirkwood BR. Delayed breastfeeding initiation increases risk of neonatal mortality. *Pediatrics*. 2006;117(3):e380-e386.

51. UNICEF. *Improving child nutrition: The achievable imperative for global progress.* United Nations Children's Fund; 2013.

52. Hossain MM, Radwan MM, Arafa SA, Habib M, DuPont HL. Prelacteal infant feeding practices in rural Egypt. *J Trop Pediatr*. 1992;38(6):317-322.

53. El-Gilany A, Sarraf B, Al-Wehady A. Factors associated with timely initiation of breastfeeding in Al-Hassa province, Saudi Arabia. *EMHJ*. 2012;18(3).

54. World Health Organization. Evidence for the ten steps to successful breastfeeding. . 1998.

55. Carlo WA, Goudar SS, Jehan I, et al. Newborn-care training and perinatal mortality in developing countries. *N Engl J Med*. 2010;362(7):614-623.

56. Bosch-Capblanch X, Garner P. Primary health care supervision in developing countries. *Tropical medicine & international health*. 2008;13(3):369-383.

57. Rowe AK, Onikpo F, Lama M, Deming MS. The rise and fall of supervision in a project designed to strengthen supervision of integrated management of childhood illness in benin. *Health Policy Plan*. 2010;25(2):125-134. doi: 10.1093/heapol/czp054 [doi].

58. Siddiqi K, Newell J, Robinson M. Getting evidence into practice: What works in developing countries? *Int J Qual Health Care*. 2005;17(5):447-454. doi: mzi051 [pii].

59. Franco LM, Marquez L. Effectiveness of collaborative improvement: Evidence from 27 applications in 12 less-developed and middle-income countries. *BMJ Qual Saf*. 2011;20(8):658-665. doi: 10.1136/bmjqs.2010.044388 [doi].

60. Ghana Statistical Service. Ghana Multiple Indicator Cluster Survey with an enhanced malaria module and biomarker. . 2012.

61. UNICEF. Malnutrition: Nutritional status. http://www.childinfo.org/malnutrition_nutritional_status.php. Updated 2013. Accessed 10, 2013.

CHAPTER 2: POSTNATAL CARE: AN OVERVIEW AND ITS ASSOCIATION WITH NEONATAL MORTALITY

Introduction

Approximately 2.9 million neonatal deaths occur annually, accounting for close to half of under-five deaths globally (44%) [1]. Sub-Saharan Africa has the highest neonatal mortality rates (32 deaths per 1000 births) and accounts for close to 40% of the global burden (2012 data) [2]. NNM rates in sub-Saharan Africa and south Asia were the highest in 1990 and have had the least reductions [3]. The major causes of neonatal death (in 2012) are complications from preterm birth (36%), intrapartum-related conditions (previously referred to as "birth asphyxia", 23%), and infections (mostly sepsis, meningitis, and pneumonia; 23%) [3]. In the early neonatal period (0-6 days), the majority of deaths are caused by preterm births and intrapartum-related conditions, while in the later neonatal period, infections such as sepsis and pneumonia were most common [3]. In high NNM countries, infections and intrapartum-related conditions are the main causes of death. The neonatal period is critical as the daily risk of dying in this time frame is estimated to be more than 30 times that of the post-neonatal period[4]. Globally, 36% of neonatal deaths occur on the first day of life while 73% of deaths occurred during the first week of life [5].

Through a literature review, Darmstadt *et al.* recommends 16 interventions for low and middle-income countries[6] to reduce neonatal deaths. PNC is one bundle of interventions and consists of five activities: resuscitation of the newborn, breastfeeding, prevention and management of hypothermia, kangaroo mother care, and community-based pneumonia case management. PNC should be implemented through different service delivery modes (e.g. facility-based, outreach).

After the Darmstadt *et al.* recommendation, the WHO and UNICEF jointly recommended PNC to reduce neonatal mortality, highlighting the need to supplement facility-based PNC with home visits for non-institutional births. This recommendation is based primarily on four studies in south Asia which conclude that home visits can reduce neonatal mortality from 30-61% [7-10] through the management and treatment of infections such as sepsis, identification of disease and appropriate referrals, prevention of hypothermia and promotion of thermal care and appropriate cord-care. Additionally, PNC can be used to promote neonatal resuscitation which reduces neonatal deaths[11]. In a later randomized trial in Ghana, result show that home visits have a similar effect on reducing neonatal deaths as other randomized trials[12]. Three additional studies examined the effect of PNC on neonatal mortality within program settings. These studies in Bangladesh[13], Pakistan[14] and India[15] showed a reduction of 13%, 15% and 9%, respectively. These results are substantially lower than those seen in trials done outside of program settings, suggesting that effects in trials are difficult to replicate in customary or program conditions.

Apart from the evidence from trials and intervention studies, few studies have examined the association between PNC and neonatal mortality. A district-level study in India finds that PNC within 24 hours of birth does not reduce mortality, though kangaroo care, an element of PNC, is significantly associated with lower neonatal mortality[16]. In Indonesia, using data from the Demographic and Health Surveys, authors also find that PNC is not associated with lower neonatal mortality, though supplementation with folic acid is[17]. A recent 10 country study on PNC and neonatal mortality using DHS data finds that PNC is protective against neonatal death and that unskilled providers can be effective to deliver PNC[18].

The WHO-UNICEF PNC recommendation advocates facility care and home visits of non-institutional births. Facility care includes assessing the newborn for health problems (e.g. bleeding, infections) and referrals for return visits[19]. For non-institutional births, health workers make two home visits within 24 hours of birth and on day 3[20]. During this visit, they are recommended to promote early initiation and exclusive breastfeeding, kangaroo care, improved hygiene (e.g. hand-washing) and hygienic cord and skin care. Home visits in developed countries have been shown to improve breastfeeding rates and parenting skills, while in developing countries, home visits can improve coverage interventions for newborns including breastfeeding (especially early initiation of breastfeeding and exclusive breastfeeding) thermal care (including skin-to-skin contact and delayed bathing) and improved hygiene[7-10,21,22]. Mothers should be counselled to identify danger signs (feeding well, difficulty breathing, fever, colds, fits or convulsions) and both the mother and the newborn should be examined for danger signs during visits.

Few studies have explored the variation in the coverage of PNC. One study in Egypt and Bangladesh finds the majority of PNC occurs within 24 hours of birth [23]. A second study in India showed PNC coverage was much lower than care during pregnancy and birth, home births were much less likely to receive PNC and richer women more likely to have PNC than poorer women [24]. A comparative study of postpartum care (defined as care received from 1 hour after delivery of the placenta to 42 days) in 30 countries showed the average timing of postnatal care is about 2 days following birth and was associated with higher household wealth, education above the primary level, urban residence and exposure to mass media[25]. Results were similar in Nepal, where the rich and more educated were more likely to use PNC[26].

The current study has three primary objectives. First, we explore the variation in the use of PNC across 17 countries using data from the demographic and health surveys (DHS) and the multiple indicator cluster surveys (MICS). We hypothesize that newborns in richer households are more likely to receive PNC than newborns in poorer households. Second, we examine if PNC is associated with neonatal mortality. We hypothesize that newborns who receive PNC are less likely to die within the neonatal period than newborns who did not receive PNC. Third, we examine if PNC given in facilities is associated with lower neonatal mortality that PNC given during home care, hypothesizing that PNC is facilities is associated with a lower neonatal mortality than PNC given in home or other places. Finally, we examine if the association between PNC and neonatal mortality differs by sub-regions of sub-Saharan Africa. This proposed study will be one of the first to provide analysis of PNC coverage and its association with neonatal mortality in a number of sub-Saharan countries. Such information is useful to identify underserved groups for programmatic targeting as well as understand if coverage is linked with health outcomes.

DATA AND METHODS

Data and variables:

Data for this study are from the USAID-supported Demographic and Health Surveys (DHS)[27] and the UNICEF-supported Multiple Indicator Cluster Surveys[28]. DHS and MICS surveys collect data from nationally-representative probability samples of households. These are cross-sectional surveys that are harmonized across survey methodology, including sample design, questionnaires and indicators. Households are generally selected using a two-stage sample design where census enumeration areas are first selected and then households (which form clusters) are selected in the second stage. Within selected households, all women ages 15-49 are interviewed and provide information on themselves and their children for a range of health, population and nutrition issues. The analysis focusses on the last birth in the last two years before the surveys for which data on the outcomes are provided. Countries are selected for this analysis based on the availability of comparable data on PNC in sub-Saharan African countries. We include from the DHS: Benin 2011-2012, Burkina Faso 2010, Cameroon 2011, Comoros 2012, Congo Brazzaville 2012, Cote d'Ivoire 2012, Gabon 2012, Guinee 2012, Mali 2012-2013, Namibia 2013, Niger 2012, Nigeria 2013, Sierra Leone 2013, Tanzania 2010, and Uganda 2011. From the MICS, we include Ghana 2011, Madagascar (South) 2012 and Zimbabwe 2014.

The outcome variable is neonatal mortality. To examine neonatal mortality, the analysis uses information contained in the birth history provided by women. The birth history contains information on the date of birth and death of each child a women has and can therefore be used to create a binary variable which takes into account survival status and time of death. Data from birth histories and similar calendar approaches are recognized to produce some heaping of ages of children but overall, the effect on demographic rates such as mortality is small[29]. The outcome variable is coded "1" for a child that died within the first 28 days of life and "0" if he/she survived this period.

The key independent variable is PNC within 1 month which refers to any check within 1 month to the newborn following birth. We exclude a check by a friend or relative (given that these are likely to not be medical in nature). DHS asks women on the precise timing of PNC. MICS provides this information for births outside a facility that were not attended to by a skilled provider. For facility births and non-facility births with skilled delivery, we assume that if PNC is provided, it is done within a month. This is safe assumption as the questions on PNC for facility deliveries and skilled deliveries ask if the newborn is checked before the newborn leaves the facility or before the attendant leaves the home of the newborn. To investigate if the place that PNC is provided is associated with the outcome, we also create a variable for place of PNC with three categories: no PNC, PNC delivered in a facility and PNC delivered at home or other location.

As these outcomes can theoretically be associated with other variables and such associations have been shown in the literature, we introduce a number of statistical controls into the analytical models classified as individual-level controls or country-level controls. The selection of variables is guided by the Proximate Determinants of Child Survival framework which states that the mortality of children (and by extension, newborns) is influenced by biological and socioeconomic determinants[30]. We include maternal factors (age of the mother, previous birth interval, parity), personal illness control factors (use of antenatal care (ANC), receipt of tetanus toxoid vaccination (2 or more vaccines in the past 2 years for the pregnancy), skilled delivery, ever breastfed), socioeconomic determinants (educational of the woman, marital status, household wealth status and residence). The household wealth status is an index of household goods and assets constructed using Principal Component Analysis, shown to be shown to be as reliable as consumption data[31].

In addition to these variables, we include 4 binary, country-level variables to account for the variation in the supply of medical interventions such as PNC. These are: Gross Domestic Product (GDP) per capita (dichotomized as "high" when \$1000 or greater per capita or "low" when below \$1000 per capita), per capita government expenditure on health (dichotomized as "high" when \$100 or greater per capita and "low" when below \$100 per capita), number of physicians per 10 000 population (dichotomized as "high" when the value is 1 or greater and "low" when the value is below 1) and finally, the number of nurses per 1000 population (classified as "high" when the value is 1 and greater and "low" when the value is less than 1). In sub-Saharan Africa, health systems and the availability of health professionals vary widely. For example, sub-Saharan Africa has the lowest distribution of medical doctors and nurses globally and from country to country, there is wide variation in the numbers of health professionals[32]. As PNC, in part, depends on the use of available health professionals and others such as traditional birth attendants, given the variation in the availability of these, we would expect that the effect of PNC on neonatal mortality to vary by region within sub-Saharan Africa and also include a variable for sub-region in sub-Saharan Africa (West and Central vs East and Southern).

Methods

We use descriptive statistics and multivariate models to examine the association between the main predictor and the outcomes in the study. First, we describe the sample using frequencies of the variables in the study. Then, we produce cross-tabulations of key variables by the outcome variables.

Finally, we model the outcome variable on the key variable, with a number of statistical controls. As neonatal mortality is a binary outcome, a logistic regression model can be used, assuming that the error term follows a logistic distribution. However, the data come from 17 countries and thus the data are clustered within countries. Due to this, we use multilevel models (MLMs) where individual women (level 1) are nested within countries (level 2). In the analysis, we compared the MLMs to logistic regression using an LR (Likliehood-Ratio) test which indicated that the MLMs perform better than the single-level logistic regressions. For the multilevel analysis, we ran a null model with only the outcome variable to decompose the variance at the individual and country levels. The final models shown include both individual and country-level variables. The univariate tables and country-level data are presented using sampling weights assigned in the MICS and DHS datafiles while the multivariate models are unweighted. Data are unweighted.

RESULTS

Table 2.1 shows a comparison of data collected by the DHS and MICS survey programs on the topic of PNC. DHS collects data on the provider, place and timing of the first check following birth but no information on any subsequent check following birth. MICS segments births into facility birth, non-facility but births with a skilled attendant and finally, all other births (i.e. non-facility, not attended by a skilled attendant). For facility births, no direct information is provider on the type of provider as this is assumed to be a skilled provider and no timing of the first check is provided though the timing of the length of the facility stay is provided. Information on the place of PNC is provided indirectly through knowing where the birth occurred. For non-facility births which were attended by a skilled provider, the provider and place of PNC is given though no information on the timing of PNC is given. For non-facility births for which a skilled provider was not present, MICS provides data on the place, timing and type of provider. MICS also collects data on the provider, timing and place of any second check on the newborn for births in facilities and non-facility, skilled deliveries. This is not collected for non-facility, non-skilled births though.

Figure 2.1 shows a scatterplot of PNC provided to newborns within a month for the 17 countries in the study by household wealth status, comparing the richest quintile to the poorest quintile (weighted figures). The overall pattern is that newborns from the wealthiest households are much more likely to receive PNC than newborns in the poorest households. The only exception is in Tanzania where the opposite occurs. Figure 2.2 shows where PNC is provided (weighted data). Overall, PNC for newborns is highly variable, from about 6 percent in Tanzania to close to 90 percent in Zimbabwe and the vast majority of PNC is provided in facilities while only a small percentage of PNC is given at homes/other locations. The exception to this is Madagascar where PNC is provided more at homes/other locations than in facilities.

Table 2.2 shows the sample distribution for the 17 countries. Overall, 2 percent of births resulted in neonatal deaths in the sample. Less than half of the newborns received PNC (42 percent) and the vast majority of this was provided in facilities (37 percent) while only a small percentage was provided in homes/other locations (5 percent). A majority of women received antenatal care (55 percent), tetanus toxoid during the last pregnancy (54 percent) and had a skilled delivery (62 percent). A large majority of newborns were ever breastfed (97 percent). About half of the sample did not have any education and more than half live in rural areas (69 percent). The majority of the sample is married (89 percent) and about 40 percent is in the lowest two poorest wealth quintiles.

Figure 2.3 shows a bivariate analysis of PNC and neonatal deaths by country. The figure illustrates that across all countries, neonatal deaths are fewer when PNC care is received by the newborn, though the difference in Niger is small. Table 2.3, model 1, shows the results of a multi-level model where neonatal mortality is the outcome. The model controls for individual level characteristics and country-level characteristics. The results indicate that after controlling for individual and country variables, newborns who receive PNC are less likely to die within the first month of birth compared with newborns who did not receive PNC (OR: 0.51, p-value: 0.000). Model 1 also indicates that prior contact with the health care system is associated with reduced odds of neonatal death. For example, ANC and tetanus toxoid are associated with a 14 percent reduction in mortality (OR: 0.86, p-value: 0.023 and OR: 0.86, p-value: 0.028, respectively). However, skilled attendance is not associated with neonatal mortality (OR: 1.12, p-value: 0.125). The results also show that as parity increases, the odds of dying in the neonatal period also increase (see table 2.3).

Table 2.3, model 2, shows an alternate model where we examine if the location of where PNC is provided is associated with neonatal mortality. Results indicate that PNC given in a facility is associated with a 52% reduction in neonatal mortality (OR: 0.48, p-value: 0.000) while PNC provided at home/other locations is associated with a reduction of 30% reduction (OR: 0.70, p-value: 0.015). However, the confidence intervals of these odds overlap (see table 2.3). Holding the sample characteristics at their means, the predicted probability of neonatal death at a facility and at home/other locations are similar (facility: 0.9 vs Home/other: 1.1).

To examine if the association of PNC is different according to different regions in sub-Saharan Africa, we use an interaction term between PNC within 1 month and a dummy variable for the sub-region in the study area with West and Central Africa being the referent category. The results shown in table 2.3, model 3 indicate no difference in neonatal mortality by region (OR: 0.90, p-value: 0.580).

DISCUSSION

This is only one of two multi-country studies to examine if PNC is associated with neonatal mortality using national population based survey data. Our results indicate that PNC is associated with reductions in neonatal mortality, a finding similar to Singh, et. al.[18] . Further, we show that PNC in facility vs home/other locations of care provide about the same level of reduction in mortality.

Finally, our findings also show that the association of PNC is different in East and Southern Africa compared with West and Central Africa.

These findings overall imply that PNC is an important intervention to reduce neonatal deaths in these sub-Saharan African countries. One of the surprising findings is that facility and non-facility PNC produced about the same level of association on the outcome of neonatal mortality. In the sample, among newborns who received PNC, very few received non-facility care. The association that is observed may be due to selection bias in those who received non-facility care vs facility care. Pregnancies/births which are not problematic do not present for delivery or PNC at a facility while those that do participate in facility care may be more likely to be higher-risk and face higher mortality in any case.

Prior contact with the health system is also shown in this study to be associated with reductions in neonatal mortality. This occurs with ANC as well as receiving tetanus toxoid immunizations which are both known to reduce neonatal mortality. However, skilled birth attendance is not associated with the outcome. This may occur as the women who present for skilled birth attendance may be women who are at higher risk of complications during pregnancy and delivery. This finding is similar to another multi-country study where skilled attendance was not associated with neonatal mortality in women who received skilled attendance in sub-Saharan Africa[33].

In this study, there are a number of limitations that should be kept in mind when interpreting the results. Our data are cross-sectional in nature and examine associations between the outcome and main variable, PNC, and do not examine causal associations. While we are able to control for a number of known covariates, we could not control for several other covariates related to the contextual factors around pregnancies and births. For example, newborn's birth weight is a key determinant of newborn survival but is not available for all newborns in the sample. This leads to omitted variable bias in our results. We use a multi-level model framework to examine the outcome of neonatal mortality and PNC. The inclusion of a large number of countries was done primarily to provide sufficient cases of neonatal deaths and thereby ensure that the study is sufficiently powered. The results of this analysis are at the aggregate level for a group of sub-Saharan African countries and can show, after controlling for country-level differences, if PNC is associated with the outcome of NNM. Due to this, results cannot be generalized to the country-level and due to the low numbers of cases of neonatal deaths, country-level analysis is not feasible. We proposed to examine if breastfeeding mediated the relationship between postnatal care and neonatal mortality though variation on breastfeeding was very low. Due to using a multi-level framework, the contribution of each country does not reflect their actual population size and consequently results may be driven in part by the larger samples of certain countries in the analysis. The DHS currently recommends using de-normalized sample weights though the appropriate sampling fraction for each country and their population sizes used to create these weights are not publicly available. In any case, since the weights account for non-response which is typically low in DHS, we would expect that using the weights would not produce markedly different results.

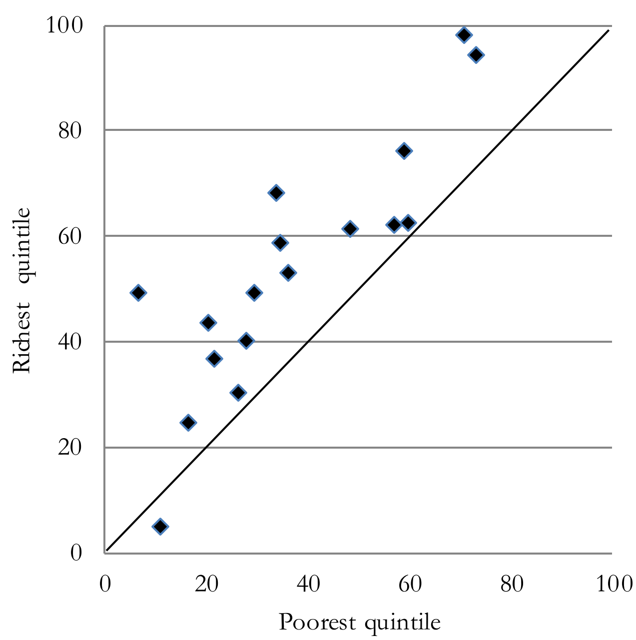
Our analysis shows the potential of PNC to improve newborn survival in a number of countries in sub-Saharan Africa and as such, the continued implementation of PNC is recommended. Tailored analyses of this type need to be continued to monitor progress and examine over time if the gains from PNC delivered in homes are sustained and how these can be further developed, given than many births in the developing world take place outside of facilities. Further to this, with the recent release of new MICS data, there is the potential and opportunity to examine if home visits, which occur on the second day of birth, as recommended by WHO and UNICEF are associated with newborn survival as intended.

TABLES AND FIGURES

Table 2.1. Comparison of DHS and MICS data on PNC

Data collected	DHS	MICS		
		Type of delivery		
	All births	*Facility births*	*Non-facility, skilled births*	*Non-facility, non-skilled births*
1st check:				
Provider of PNC	Yes	No	Yes	Yes
Place of PNC	Yes	Yes	Yes	Yes
Timing of PNC	Yes	No	No	Yes
2nd check:				
Provider of PNC	No	Yes	Yes	No
Place of PNC	No	Yes	Yes	No
Timing of PNC	No	Yes	Yes	No

Figure 2.1. Scatterplot of PNC within 1 month among richest and poorest quintiles



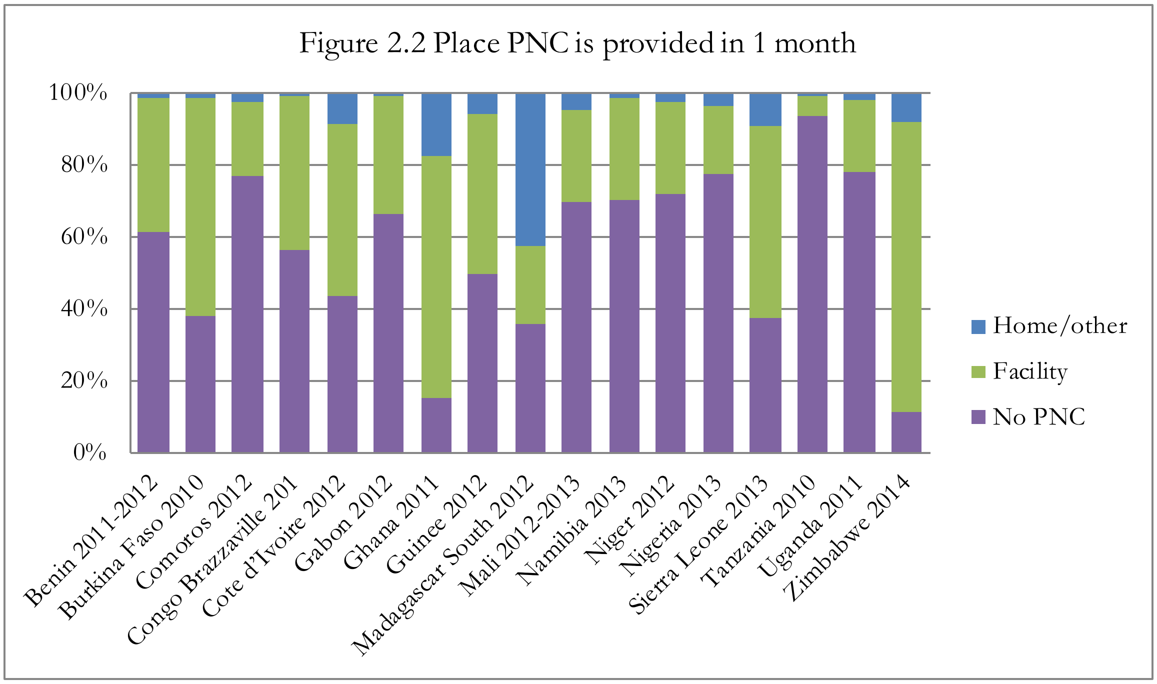


Figure 2.2 Place PNC is provided in 1 month
100%
80%
60%
40%
20%
0%
Benin 2011-2012
Burkina Faso 2010
Comoros 2012
Congo Brazzaville 201
Cote d'Ivoire 2012
Gabon 2012
Ghana 2011
Guinee 2012
Madagascar South 2012
Mali 2012-2013
Namibia 2013
Niger 2012
Nigeria 2013
Sierra Leone 2013
Tanzania 2010
Uganda 2011
Zimbabwe 2014
Home/other
Facility
No PNC

Table 2.2 Weighted distribution of sample for 14 DHS and 3 MICS countries

	Benin 2011-2012	Burkina Faso 2010	Comoros 2012	Congo Brazzaville 2012	Cote d'Ivoire 2012	Gabon 2012	Ghana 2011	Guinee 2012	Madagascar South 2012
Outcome									
Neonatal mortality									
Yes	1.7	1.8	2.4	1.7	2.4	3.1	2.5	2.2	2.5
No	98.3	98.2	97.6	98.3	97.6	96.9	97.5	97.8	97.5
Key variables									
PNC within 1 month									
Yes	38.4	61.8	22.9	43.4	56.4	43.3	84.8	50.5	64.4
Yes: Facility	37.3	60.8	20.3	42.6	47.8	32.5	67.6	44.6	22.0
Yes: Home/other	1.1	1.0	2.6	0.8	8.6	0.9	17.2	5.9	42.4
No	61.6	38.2	77.1	56.6	43.6	56.7	15.2	49.5	35.6
Maternal factors									
Age of mother									
15-19	6.2	8.6	8.5	14.0	12.2	14.9	6.2	14.3	21.1
20-24	22.1	26.6	22.7	25.8	26.3	25.8	18.4	23.1	28.1
25-29	31.8	25.3	24.4	25.8	27.3	24.3	25.3	25.4	18.8
30-34	22.1	19.9	23.5	18.1	18.7	18.3	24.6	17.1	15.5
35-39	12.0	12.9	15.1	12.6	10.1	11.1	16.5	12.8	10.5
40-49	5.7	6.8	5.8	3.8	5.4	5.6	9.0	7.3	6.0
Previous birth interval									
First birth (and twins)	20.8	17.6	22.4	23.7	22.5	27.9	21.8	21.2	19.7
<18 months	2.6	1.9	9.2	3.4	3.1	4.8	2.9	1.4	8.5
18-23 months	6.5	6.0	12.4	7.3	6.1	8.7	6.3	5.7	10.1
24-29 months	13.8	13.2	13.7	12.6	13.1	11.7	12.2	9.5	20.3
30-35 months	14.0	17.7	10.7	10.2	13.2	8.1	12.6	15.7	13.5
36-47 months	20.3	23.4	13.6	15.0	16.4	12.0	18.0	21.1	15.0
48-53 months	6.2	6.0	4.9	6.1	5.3	4.7	6.2	7.2	3.7
54+ months	15.7	14.2	13.1	21.7	20.3	22.1	20.0	18.3	9.2

Parity									
1	20.5	17.5	22.1	23.4	22.1	27.6	21.6	21.1	19.4
2-3	38.7	33.8	35.3	42.4	37.3	38.2	36.9	33.0	31.1
4-5	24.5	23.3	23.6	22.9	22.8	20.1	23.8	23.5	22.5
6+	16.3	25.3	19.0	11.2	17.7	14.1	17.8	22.4	26.9
Personal illness control									
Antenatal care (4+ with any provider)									
Yes	58.7	32.5	47.6	76.0	42.8	75.6	89.4	56.2	65.6
No	41.3	67.5	52.4	24.0	57.2	24.4	10.6	43.8	34.4
Tetanus toxoid (2+ during last pregnancy)									
Yes	59.4	70.3	36.2	59.9	52.1	66.5	54.7	70.1	48.6
No	40.6	29.7	63.8	40.1	47.9	33.5	45.3	29.9	51.4
Skilled delivery									
Yes	85.6	74.2	85.6	94.1	61.4	91.2	68.4	46.2	28.5
No	14.4	25.8	14.4	5.9	38.6	8.8	31.6	53.8	71.5
Ever breastfed									
Yes	94.0	99.2	93.5	94.9	96.6	90.3	98.9	98.3	97.1
No	6.0	0.8	6.5	5.1	3.4	9.7	1.1	1.7	3.0
Socio-economic determinants									
Education of mother									
None	69.7	83.4	43.3	7.0	62.4	5.8	36.8	75.5	48.5
Primary	16.7	10.8	24.9	31.1	26.5	25.9	22.3	13.6	38.4
Secondary+	13.6	5.7	31.8	61.9	11.2	68.3	40.9	10.9	13.1
Marital status									
Married/cohabiting	93.6	97.1	94.5	78.3	83.4	70.3	89.8	92.3	75.7
Not currently married/cohabiting	6.4	2.9	5.5	21.7	16.6	29.7	10.2	7.7	24.3
Household wealth status									
Poorest quintile	20.3	20.2	23.0	22.2	24.3	21.3	22.2	22.9	22.1
Second quintile	20.5	21.9	20.8	23.0	20.4	21.6	21.6	21.4	22.8
Middle quintile	19.4	22.0	21.1	20.2	20.7	22.5	19.7	20.7	22.7

Fourth quintile	19.7	21.0	18.5	19.0	18.6	19.3	18.0	19.1	19.4
Richest quintile	20.1	14.9	16.6	15.5	15.9	15.2	18.5	15.9	13.1
Residence									
Urban	41.3	17.0	28.4	61.4	38.7	84.3	42.3	26.5	5.4
Rural	58.7	83.0	71.6	38.6	61.3	15.7	57.7	73.5	94.6
Country-level characteristics									
GDP per capita (USD)									
High ($1000 per capita and greater)	-	-	-	-	-	-	-	-	-
Low (less than $1000 per capita)	-	-	-	-	-	-	-	-	-
Per capita government expenditure on health at average exchange rate (USD)									
High ($100 per capita and greater)	-	-	-	-	-	-	-	-	-
Low (less than $100 per capita)	-	-	-	-	-	-	-	-	-
# physicians per 1000 population									
High (0.1 or greater)	-	-	-	-	-	-	-	-	-
Low (less than 0.1)	-	-	-	-	-	-	-	-	-
# nurses per 1000 population									
High (1 or greater)	-	-	-	-	-	-	-	-	-
Low (less than 1)	-	-	-	-	-	-	-	-	-
Region in sub-Saharan Africa									
West and Central	-	-	-	-	-	-	-	-	-
East and Southern	-	-	-	-	-	-	-	-	-
N	5,130	5,988	1,298	3,426	3,039	2,102	2,526	2,818	1,160

Table 2. Weighted distribution of sample for 14 DHS and 3 MICS countries (continued)

	Mali 2012-2013	Namibia 2013	Niger 2012	Nigeria 2013	Tanzania 2010	Uganda 2011	Sierra Leone 2013	Zimbabwe 2014	Total
Outcome									
Neonatal mortality									
Yes	2.3	1.7	1.6	3.1	2.1	2.1	3.7	2.5	2.4
No	97.7	98.3	98.4	96.9	97.9	97.9	96.3	97.5	97.6
Key variables									
PNC within 1 month									
Yes	30.2	29.7	28.1	22.6	6.9	21.9	62.6	88.5	42.1
Yes: Facility	25.4	28.7	25.7	19.3	5.7	19.6	53.6	80.7	37.0
Yes: Home/other	4.9	1.0	2.4	3.4	0.7	2.1	9.1	7.7	4.7
No	69.8	70.3	71.9	77.4	93.1	78.1	37.4	11.5	57.9
Maternal factors									
Age of mother									
15-19	11.3	10.7	9.6	8.5	10.2	10.3	13.5	13.1	10.5
20-24	22.9	25.5	23.1	22.7	27.1	28.2	23.0	28.4	24.3
25-29	28.6	25.5	27.4	28.0	25.4	27.5	26.1	24.7	26.8
30-34	19.2	20.1	20.8	20.1	17.5	16.2	18.0	19.6	19.6
35-39	12.1	12.3	13.0	13.4	14.2	12.5	12.9	10.2	12.7
40-49	5.8	5.9	6.1	7.3	5.5	5.4	6.5	4.0	6.2
Previous birth interval									
First birth (and twins)	17.1	32.2	13.6	20.3	19.9	17.2	22.0	27.4	20.8
<18 months	3.9	2.4	4.1	4.1	3.6	6.1	2.5	2.7	3.6
18-23 months	8.1	4.9	11.3	9.9	8.0	12.9	6.9	4.6	8.0
24-29 months	14.4	8.2	20.6	15.7	16.9	20.5	12.0	8.7	14.2
30-35 months	14.2	7.7	18.1	15.1	15.6	13.7	13.9	9.4	14.0
36-47 months	20.2	9.8	18.3	18.1	16.0	15.0	16.7	16.5	17.8
48-53 months	5.7	4.9	4.3	4.4	5.0	3.4	5.7	6.0	5.3

54+ months	16.4	29.8	9.7	12.4	14.9	11.1	20.4	24.7	16.4
Parity									
1	17.0	31.7	13.4	20.1	19.6	17.1	21.7	27.2	20.5
2-3	33.4	42.7	27.4	32.3	35.7	31.5	35.0	44.5	35.2
4-5	27.1	17.4	24.6	22.6	23.2	22.4	24.8	20.6	23.2
6+	22.5	8.2	34.5	25.0	21.5	29.0	18.6	7.8	21.1
Personal illness control									
Antenatal care (4+ with any provider)									
Yes	41.0	62.0	33.1	51.1	38.4	46.2	76.0	75.3	54.3
No	59.0	38.0	66.9	48.9	61.6	53.8	24.0	24.7	45.8
Tetanus toxoid (2+ during last pregnancy)									
Yes	36.8	33.9	50.2	48.7	44.1	52.2	86.7	32.2	54.4
No	63.2	66.1	49.8	51.3	55.9	47.8	13.3	67.8	45.6
Skilled delivery									
Yes	61.2	89.0	33.4	42.4	49.7	60.9	62.6	80.0	62.2
No	38.8	11.0	66.6	57.6	50.3	39.1	37.4	20.0	37.8
Ever breastfed									
Yes	97.3	95.7	98.8	98.1	97.1	98.3	97.4	98.1	97.3
No	2.7	4.3	1.2	1.9	2.9	1.7	2.6	1.9	2.7
Socio-economic determinants									
Education of mother									
None	81.6	5.6	85.3	47.6	25.6	12.9	64.7	1.1	50.0
Primary	9.1	22.5	9.6	18.1	67.0	63.9	15.3	30.6	23.1
Secondary+	9.3	71.9	5.1	34.3	7.4	23.2	20.1	68.3	26.9
Marital status									
Married/cohabiting	96.7	44.2	98.3	95.6	84.0	85.5	84.7	86.1	88.9
Not currently married/cohabiting	3.3	55.8	1.7	4.4	16.0	14.5	15.3	13.9	11.1
Household wealth status									
Poorest quintile	20.4	21.3	19.3	23.2	21.0	22.4	23.0	20.8	21.7
Second quintile	20.2	22.6	20.5	22.8	23.9	22.0	21.0	20.0	21.6

Middle quintile	19.4	21.7	20.8	18.9	21.7	19.5	21.9	17.0	20.2
Fourth quintile	22.1	20.0	21.1	18.0	18.8	18.1	19.1	24.6	19.7
Richest quintile	17.8	14.4	18.3	17.1	14.6	18.0	14.9	17.6	16.7
Residence									
Urban	20.3	47.5	13.5	35.3	20.9	14.6	25.7	29.3	31.4
Rural	79.7	52.5	86.5	64.7	79.1	85.4	74.3	70.7	68.6
Country-level characteristics									
GDP per capita (USD)									
High ($1000 per capita and greater)	-	-	-	-	-	-	-	-	38.6
Low (less than $1000 per capita)	-	-	-	-	-	-	-	-	61.4
Per capita government expenditure on health at average exchange rate (USD)									
High ($100 per capita and greater)	-	-	-	-	-	-	-	-	46.8
Low (less than $100 per capita)	-	-	-	-	-	-	-	-	53.3
# physicians per 1000 population									
High (0.1 or greater)	-	-	-	-	-	-	-	-	46.1
Low (less than 0.1)	-	-	-	-	-	-	-	-	53.9
# nurses per 1000 population									
High (1 or greater)	-	-	-	-	-	-	-	-	33.4
Low (less than 1)	-	-	-	-	-	-	-	-	66.6
Region in sub-Saharan Africa									
West and Central	-	-	-	-	-	-	-	-	77.8
East and Southern	-	-	-	-	-	-	-	-	22.2
N	3,965	1,947	5,143	12,473	3,266	3,092	4,820	3,902	66,096

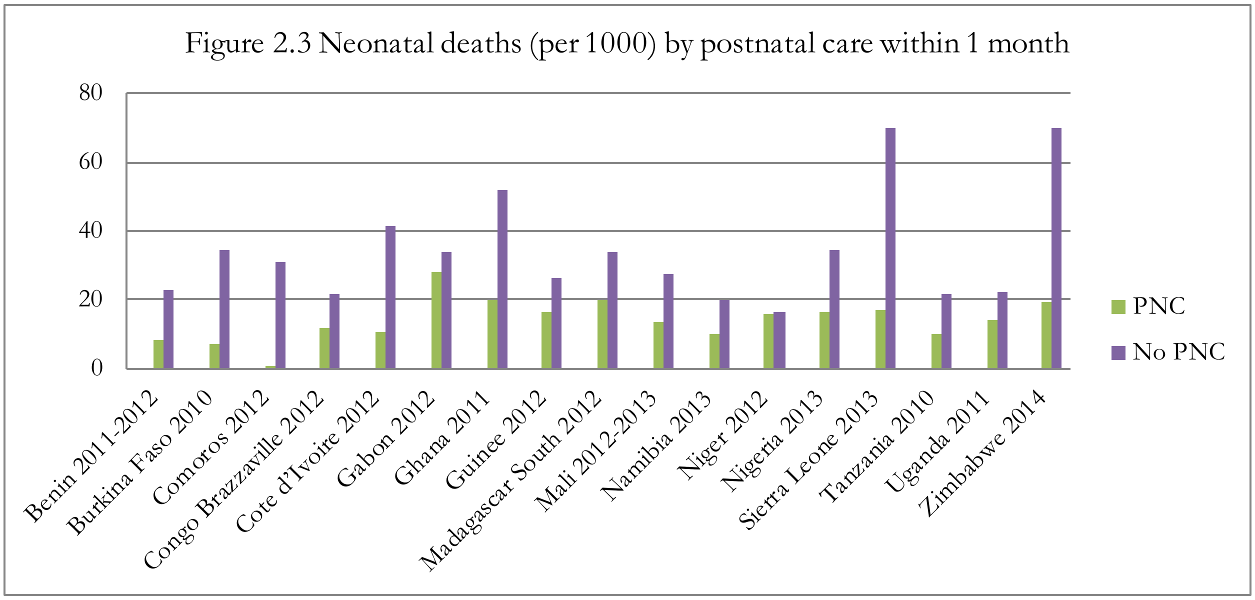


Figure 2.3 Neonatal deaths (per 1000) by postnatal care within 1 month
80
60
40
20
0
PNC
No PNC
Benin 2011-2012
Burkina Faso 2010
Comoros 2012
Congo Brazzaville 2012
Cote d'Ivoire 2012
Gabon 2012
Ghana 2011
Guinee 2012
Madagascar South 2012
Mali 2012-2013
Namibia 2013
Niger 2012
Nigeria 2013
Sierra Leone 2013
Tanzania 2010
Uganda 2011
Zimbabwe 2014

Table 2.3 Multilevel logistic regression for neonatal deaths, 14 DHS and 3 MICS countries

	Neonatal death											
	Model 1	p-value	95% CI		Model 2	p-value	95% CI		Model 3	p-value	95% CI	
Fixed Effects												
Individual Characteristics												
Key variables												
PNC within 1 month												
Yes	0.51	0.000	0.44	0.59	-	-	-	-	0.52	0.000	0.45	0.61
No	1.00				-	-	-	-	1.00	-	-	-
PNC within 1 month by place												
Yes: Facility	-	-	-	-	0.48	0.000	0.41	0.56	-	-	-	-
Yes: Home/other	-	-	-	-	0.70	0.015	0.53	0.93	-	-	-	-
No	-	-	-	-	1.00	-	-	-	-	-	-	-
Interaction: Region*PNC within 1 month												
East and Southern Africa and PNC	-	-	-	-	-	-	-	-	0.90	0.580	0.62	1.31
West and Central Africa and No PNC	-	-	-	-	-	-	-	-	1.00	-	-	-
Maternal factors												
Age of mother												
15-19	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
20-24	0.79	0.033	0.64	0.98	0.79	0.033	0.64	0.98	0.79	0.033	0.64	0.98
25-29	0.65	0.001	0.51	0.83	0.65	0.001	0.51	0.83	0.65	0.001	0.51	0.83
30-34	0.79	0.096	0.60	1.04	0.79	0.097	0.60	1.04	0.79	0.095	0.60	1.04
35-39	0.86	0.335	0.63	1.17	0.86	0.346	0.64	1.17	0.86	0.334	0.63	1.17
40-49	1.03	0.860	0.73	1.45	1.03	0.862	0.73	1.45	1.03	0.864	0.73	1.45
Previous birth interval												
First birth (and twins)	8.14	0.000	4.42	14.99	8.18	0.000	4.45	15.04	8.15	0.000	4.43	15.00
<18 months	2.11	0.000	1.61	2.76	2.11	0.000	1.61	2.77	2.11	0.000	1.61	2.76
18-23 months	1.15	0.257	0.90	1.47	1.15	0.264	0.90	1.47	1.15	0.255	0.90	1.47
24-29 months	1.00	0.993	0.81	1.24	1.00	0.997	0.81	1.24	1.00	0.994	0.81	1.24
30-35 months	0.96	0.698	0.77	1.19	0.96	0.703	0.77	1.19	0.96	0.699	0.77	1.19
36-47 months (ref)	1.00	-	-	-	1.00	-	-	-	1.00			
48-53 months	0.80	0.153	0.58	1.09	0.80	0.155	0.58	1.09	0.80	0.154	0.58	1.09
54+ months	1.00	0.977	0.81	1.23	1.00	0.993	0.81	1.23	1.00	0.978	0.81	1.23
Parity												
1	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
2-3	5.55	0.000	3.06	10.07	5.57	0.000	3.07	10.09	5.55	0.000	3.06	10.07

4-5	6.96	0.000	3.72	13.01	6.96	0.000	3.73	13.00	6.96	0.000	3.72	13.01
6+	7.88	0.000	4.16	14.93	7.88	0.000	4.16	14.91	7.89	0.000	4.16	14.94
Personal illness control												
Antenatal care (4+ with any provider)												
Yes	0.86	0.023	0.75	0.98	0.86	0.022	0.75	0.98	0.86	0.021	0.75	0.98
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Tetanus toxoid (2+ during last pregnancy)												
Yes	0.86	0.028	0.76	0.98	0.86	0.027	0.76	0.98	0.86	0.027	0.76	0.98
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Skilled delivery												
Yes	1.12	0.125	0.97	1.29	1.16	0.043	1.00	1.35	1.12	0.122	0.97	1.29
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Ever breastfed												
Yes	0.01	0.000	0.01	0.01	0.01	0.000	0.01	0.01	0.01	0.000	0.01	0.01
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Socio-economic determinants												
Education of mother												
None	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Primary	1.11	0.204	0.94	1.31	1.11	0.213	0.94	1.31	1.11	0.209	0.94	1.31
Secondary+	0.91	0.358	0.76	1.11	0.91	0.343	0.75	1.10	0.92	0.361	0.76	1.11
Marital status												
Married/cohabiting	0.96	0.662	0.79	1.16	0.95	0.624	0.79	1.15	0.96	0.658	0.79	1.16
Not currently married/cohabiting	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Household wealth status												
Poorest quintile	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Second quintile	1.24	0.013	1.05	1.47	1.23	0.017	1.04	1.46	1.24	0.014	1.05	1.47
Middle quintile	1.24	0.022	1.03	1.49	1.23	0.027	1.02	1.47	1.24	0.022	1.03	1.48
Fourth quintile	1.20	0.075	0.98	1.47	1.19	0.087	0.97	1.46	1.20	0.077	0.98	1.47
Richest quintile	1.24	0.094	0.96	1.60	1.23	0.109	0.96	1.58	1.24	0.098	0.96	1.59
Residence												
Urban	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Rural	1.18	0.054	1.00	1.39	1.17	0.061	0.99	1.38	1.17	0.055	1.00	1.38
Country characteristics												
GDP per capita (USD)												
High ($1000 per capita and greater)	0.68	0.380	0.29	1.60	0.68	0.371	0.29	1.59	0.68	0.390	0.29	1.62
Low (less than $1000 per capita)	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Per capita government expenditure on health at average exchange rate (USD)												

High ($100 per capita and greater)	1.41	0.381	0.65	3.05	1.43	0.368	0.66	3.10	1.41	0.392	0.65	3.06
Low (less than $100 per capita)	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
# physicians per 1000 population												
High (0.1 or greater)	1.92	0.133	0.82	4.50	1.91	0.139	0.81	4.50	1.90	0.142	0.81	4.50
Low (less than 0.1)	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
# nurses per 1000 population												
High (1 or greater)	0.38	0.053	0.14	1.01	0.37	0.049	0.14	1.00	0.38	0.056	0.14	1.02
Low (less than 1)	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Region in sub-Saharan Africa												
West and Central	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
East and Southern	0.97	0.929	0.46	2.01	0.97	0.941	0.47	2.03	1.00	0.999	0.47	2.11
Random effects												
Country-level variance (SE)	0.30(0.11)				0.30(0.11)				0.30(0.11)			
Log-likelihood	-5299.36				-5295.19				-5299.21			
AIC	10668.72				10662.37				10670.41			
Log-likelihood ratio test (Chi-square)	260.7(0.000)				265.3(0.000)				253.1(0.000)			
N						66558						

REFERENCES

1. Unicef. Levels and trends in child mortality. *Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation*. 2011.

2. United Nations Inter-agency Group for Child Mortality Estimation. Levels & trends in child mortality. report 2013. estimates developed by the UN inter-agency group for child mortality estimation. . 2013.

3. Lawn JE, Blencowe H, Oza S, et al. Progress, priorities, and potential beyond survival. *The Lancet*. 2014.

4. Lawn JE, Cousens S, Zupan J. 4 million neonatal deaths: When? where? why? *The Lancet*. 2005;365(9462):891-900.

5. Lawn JE, Blencowe H, Pattinson R, et al. Stillbirths: Where? when? why? how to make the data count? *The Lancet*. 2011;377(9775):1448-1463.

6. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L. Evidence-based, cost-effective interventions: How many newborn babies can we save? *The Lancet*. 2005;365(9463):977-988.

7. Bang AT, Bang RA, Baitule SB, Reddy MH, Deshmukh MD. Effect of home-based neonatal care and management of sepsis on neonatal mortality: Field trial in rural India. *The Lancet*. 1999;354(9194):1955-1961.

8. Baqui AH, Ahmed S, El Arifeen S, et al. Effect of timing of first postnatal care home visit on neonatal mortality in Bangladesh: A observational cohort study. *BMJ: British Medical Journal*. 2009;339.

9. Kumar V, Mohanty S, Kumar A, et al. Effect of community-based behaviour change management on neonatal mortality in Shivgarh, Uttar Pradesh, India: A cluster-randomised controlled trial. *The Lancet*. 2008;372(9644):1151-1162.

10. Bhutta ZA, Memon ZA, Soofi S, Salat MS, Cousens S, Martines J. Implementing community-based perinatal care: Results from a pilot study in rural Pakistan. *Bull World Health Organ*. 2008;86(6):452-459.

11. Lee AC, Cousens S, Wall SN, et al. Neonatal resuscitation and immediate newborn assessment and stimulation for the prevention of neonatal deaths: A systematic review, meta-analysis and delphi estimation of mortality effect. *BMC Public Health*. 2011;11 Suppl 3:S12-2458-11-S3-S12. doi: 10.1186/1471-2458-11-S3-S12 [doi].

12. Kirkwood BR, Manu A, ten Asbroek AH, et al. Effect of the newhints home-visits intervention on neonatal mortality rate and care practices in Ghana: A cluster randomised controlled trial. *The Lancet*. 2013.

13. Darmstadt GL, Choi Y, Arifeen SE, et al. Evaluation of a cluster-randomized controlled trial of a package of community-based maternal and newborn interventions in Mirzapur, Bangladesh. *PloS one*. 2010;5(3):e9696.

14. Bhutta ZA, Soofi S, Cousens S, et al. Improvement of perinatal and newborn care in rural Pakistan through community-based strategies: A cluster-randomised effectiveness trial. *The Lancet*. 2011;377(9763):403-412.

15. Bhandari N, Mazumder S, Taneja S, Sommerfelt H, Strand TA. Effect of implementation of integrated management of neonatal and childhood illness (IMNCI) programme on neonatal and infant mortality: Cluster randomised controlled trial. *BMJ: British Medical Journal*. 2012;344.

16. Singh A, Yadav A, Singh A. Utilization of postnatal care for newborns and its association with neonatal mortality in India: An analytical appraisal. *BMC Pregnancy and Childbirth*. 2012;12(1):33.

17. Titaley CR, Dibley MJ. Antenatal iron/folic acid supplements, but not postnatal care, prevents neonatal deaths in Indonesia: Analysis of Indonesia demographic and health surveys 2002/2003–2007 (a retrospective cohort study). *BMJ open*. 2012;2(6).

18. Singh K, Brodish P, Haney E. Postnatal care by provider type and neonatal death in sub-saharan Africa: A multilevel analysis. *BMC Public Health*. 2014;14(1):941.

19. World Health Organization. *Pregnancy, childbirth, postpartum and newborn care: A guide for essential practice*. Geneva, ISBN 92 4 159084 X: World Health Organization; 2006.

20. World Health Organization. WHO/UNICEF joint statement: Home visits for the newborn child: A strategy to improve survival. *Switzerland: World Health Organization*. 2009.

21. Olds DL, Kitzman H. Can home visitation improve the health of women and children at environmental risk? *Pediatrics*. 1990;86(1):108-116.

22. Hannula L, Kaunonen M, Tarkka M. A systematic review of professional support interventions for breastfeeding. *J Clin Nurs*. 2008;17(9):1132-1143.

23. Fort AL. Coverage of post-partum and post-natal care in egypt in 2005–2008 and Bangladesh in 2004–2007: Levels, trends and unmet need. *Reprod Health Matters*. 2012;20(39):81-92.

24. Singh A, Padmadas SS, Mishra US, Pallikadavath S, Johnson FA, Matthews Z. Socio-economic inequalities in the use of postnatal care in India. *PloS one*. 2012;7(5):e37037.

25. Fort AL, Kothari MT, Abderrahim N. *Postpartum care: Levels and determinants in developing countries.* Macro International; 2006.

26. Khanal V, Adhikari M, Karkee R, Gavidia T. Factors associated with the utilisation of postnatal care services among the mothers of Nepal: Analysis of Nepal demographic and health survey 2011. *BMC Womens Health*. 2014;14(1):19.

27. ICF International. The DHS program. http://dhsprogram.com/. Updated 2014.

28. UNICEF. Multiple indicator cluster surveys. http://mics.unicef.org/. Updated 2015.

29. Arnold F. Assessment of the quality of birth history data in the demographic and health surveys. 1990.

30. Mosley WH, Chen LC. An analytical framework for the study of child survival in developing countries. *Population and development review*. 1984:25-45.

31. Filmer D, Pritchett LH. Estimating wealth effects without expenditure Data—Or tears: An application to educational enrollments in states of India. *Demography*. 2001;38(1):115-132.

32. Liese B, Dussault G. *The state of the health workforce in sub-saharan africa: Evidence of crisis and analysis of contributing factors*. World Bank: Africa Region; 2004.

33. Singh K, Brodish P, Suchindran C. A regional multilevel analysis: Can skilled birth attendants uniformly decrease neonatal mortality? *Matern Child Health J*. 2014;18(1):242-249.

CHAPTER 3: POSTNATAL CARE AND NEWBORN FEEDING PRACTICES IN 15 SUB-SAHARAN AFRICAN COUNTRIES

Introduction

Breastfeeding is recognized as a key intervention to improve the health and survival of children and the use of optimal breastfeeding practices such as exclusive breastfeeding is one of the most effective means to reduce under nutrition, an underlying cause of under-five mortality[1]. The World Health Organization (WHO) and the United National Children's Fund (UNICEF) recommend early initiation of breastfeeding[2] which refers to breastfeeding of a newborn within an hour of birth. Global monitoring efforts by UNICEF also include initiation of breastfeeding within one day of birth which provides more detailed information on the feeding patterns of newborns and the behaviors of women. Early initiation of breastfeeding has a number of health benefits, one of which is to reduce neonatal mortality[3-5]. The ingestion of breastmilk within the first few days of life can have positive effects on a newborn's immune systems such as the provision of immunoglobulins and lymphocytes [6-8], priming of the gastrointestinal tract and decreasing the permeability of the tract to pathogens, including HIV[9,10]. Another health benefit of early initiation of breastfeeding is reduced rates of diarrhea among infants, as demonstrated in Egypt and Pakistan[11,12].

Early initiation of breastfeeding is also associated with skin-to-skin contact with the mother[13,14], a form of thermal care which is a recommended means to reduce neonatal mortality[15]. Early breastfeeding is also associated with a number of factors related to contact with the health system. For example, in Brazil, early initiation is associated with vaginal delivery as well as other factors such as antenatal guidance on breastfeeding and having a full term pregnancy[16]. Other studies point out that breastfeeding within an hour of birth is less likely to occur when women have caesarian sections, even in the presence of hospital practices that favor breastfeeding[17,18]. In a review article, authors find that higher socio-economic status is associated with lower odds of breastfeeding initiation but this pattern is only seen in developing countries[19].

Prelacteal feeds (PLFs) represent a departure from optimal newborn feeding practices. PLFs are any liquid other than breast milk that is given to the newborn before breastfeeding is established between the mother and newborn. The WHO and UNICEF outline that for successful breastfeeding, PLFs should be avoided and PLFs should not be encouraged unless medically indicated[20]. These feeds usually occur within the first few days of life and are associated with a number of negative health outcomes for the newborn and mother. These include insufficient maternal milk production, newborn diarrhea and reduced length of breastfeeding duration[21,22]. PLFs can also expose newborns to infections through the ingestion of contaminated food and liquids which can act on the GI tract to increase permeability to pathogens, and hence, increase newborn infections[9,11]. A number of studies have shown factors related to PLFs. For example, PLFs are negatively associated with early initiation of breastfeeding (within an hour of birth)[23]. In India, PLFS were associated with lower maternal education among hospital-delivered infants[24] . However, in rural, Western Uganda, more educated women were more prone to provide PLFs to newborns[25]. In low socio-economic settlements in Karachi, Pakistan, PLFs were associated with having a birth attendant[26]. In a national study in Nepal, women without education, who were not working, who had no antenatal care and were first time mothers were more likely to provide PLFs[27]. Both in India and Vietnam, newborns of women with a cesarean section were more likely to ingest PLFs[24,28].

In a recent joint statement, the WHO and UNICEF recommend that all newborns, regardless of place of birth (whether in a facility or not), should receive a basic package of care, including postnatal care which includes the promotion and support of exclusive breastfeeding and the early initiation of breastfeeding[29]. Interventions such as thermal care, hygienic cord care, examination for danger signs and improving parental knowledge of care seeking are also recommended. The evidence on the importance of PNC from developing countries comes mainly from South Asian countries (India, Bangladesh and Pakistan) and are from interventions and trails at sub-national levels (such as districts, villages and communities) [30-32].

Currently, there is a gap in the literature on how interventions such as PNC are associated with newborn feeding practices at the national level, when delivered through usual services of the government and non-governmental sources of care i.e. outside of an intervention setting. The literature is especially sparse in terms of studies for sub-Saharan Africa. The only study we could find relating PNC with breastfeeding in sub-Saharan Africa was a small, cross-sectional study in Ethiopia[33] where PNC and being in an urban area increased the odds of timely initiation of breastfeeding. Our current study attempts to address these gaps. The main of objective of this paper is to examine the association between PNC and two key newborn feeding practices: early breastfeeding and prelacteal feeds and to examine if the type of provider of PNC is important to these outcomes. We use data from nationally representative surveys in 15 sub-Saharan African countries in a pooled, multi-level analysis, controlling for a number of individual and country-level variables. The results of this paper demonstrate how PNC is performing and provide indications on which types of providers are best suited for the delivery of this intervention, as it relates to newborn feeding.

DATA AND METHODS

Data and Variables:

Data for this study are from the USAID-supported Demographic and Health Surveys (DHS)[34]. DHS surveys collect data from nationally-representative probability samples of households.

These are cross-sectional surveys harmonized across survey methodology, including sample design and questionnaires. Households are selected using a two-stage sample design where census enumeration areas are first selected and then a random sample of households is selected in the second stage. Within selected households, all women ages 15-49 are interviewed and provide information on themselves and their children for a range of health, population and nutrition issues. This analysis focuses on the last birth in the last two years before the surveys for which information on PNC is provided. Sub-Saharan African countries are selected for this analysis based on the availability of comparable data on PNC. We include Benin 2011-2012, Burkina Faso 2010, Comoros 2012, Congo Brazzaville 2012, Cote d'Ivoire 2012, Gabon 2012, Guinee 2012, Mali 2012-2013, Namibia 2013, Niger 2012, Nigeria 2013, Sierra Leone 2013, Tanzania 2010, Uganda 2011 and Zimbabwe 2011.

There are two outcome variables. The first is the percentage of newborns who were breastfeed within 1 day of birth among all newborns. The second outcome variable is the percentage of newborns who received a PLF i.e. a feed that occurs within 3 days of births that is not breastmilk. The measure of PLFs is based on asking the mother if, within the first 3 days after delivery, was the newborn given anything to drink, other than breast milk. This is asked for newborns who were ever breastfed and as such, PLFs is collected for a sub-sample of all births.

The key independent variable is PNC within 1 day which refers to any check within 1 day to a newborn following birth. We exclude a check by a friend or relative (given that these are likely to not be medical in nature). Given that PLFs can occur anytime within 3 days, we attempt to establish PNC preceding PLFs by defining PNC as a check within 1 day of birth instead of 3 days. Both of these outcomes are binary. To investigate if the type of PNC is associated with the outcomes, we also create a variable for PNC provided by three categories of caregivers: physicians, nurses/midwives/auxillary midwives and finally, traditional birth attendants/community health workers/other.

The outcomes in this study have been shown to be associated with a number of demographic characteristics. As such, in our models, we introduce a number of statistical controls into the analytical models, classified as individual-level controls or country-level controls. The following variables are included: age of the mother, previous birth interval, parity, caesarian section of birth, use of antenatal care (ANC), receipt of tetanus toxoid vaccination, skilled delivery, educational level of the woman, marital status, media access (regular access to print and mass media), place of residence and a wealth index of household goods and assets; all of these variables are provided as standard recode variables in the DHS datafiles. The wealth index, which is constructed using Principal Component Analysis, uses household-level ownership of goods and assets and is shown to be shown to be as reliable as consumption data[35].

We include 4 binary, country-level variables to account for the variation in the supply of PNC. The four country-level variables are: Gross Domestic Product (GDP) per capita (dichotomized as "high" when $1000 or greater per capita or "low" when below $1000 per capita), per capita government expenditure on health (dichotomized as "high" when $100 or greater per capita and "low" when below $100 per capita), number of physicians per 1000 population (dichotomized as "high" when the value is 0.1 or greater and "low" when the value is below 0.1) and finally, the number of nurses per 1000 population (classified as "high" when the value is 1 and greater and "low" when the value is less than 1). Sub-Saharan Africa, for example, has the lowest distribution of medical doctors and nurses globally and from country to country, there is wide variation in the numbers of health professionals[36]. Finally, since there are prominent recommendations on newborn feeding practices in areas of high HIV prevalence, we included a dummy variable for HIV prevalence ("high" when 5% or greater and "low" when less than 5%) as an explanatory variable in the models.

Methods

We use descriptive statistics and multivariate models to examine the association between the main predictor and the outcomes in the study. First, we describe the sample using frequencies of the variables in the study. Then, we produce cross-tabulations of key variables by the outcome variables. These descriptive statistics are run using the sample weights provided by the DHS. Finally, we model the outcome variables on the key variables (in two separate models), with a number of statistical controls. As breastfeeding within 1 day and PLFs are binary outcomes, a logistic regression model can be used, assuming that the error term follows a logistic distribution. However, the data come from 15 countries, which suggests that data are clustered within countries. Due to this, we use multilevel models (MLMs) where individual women (level 1) are nested within countries (level 2). In the analysis, we compared the MLMs to logistic regression using a Likliehood-ratio (LR) test which indicated that the MLMs perform better than the single-level logistic regressions. For the multilevel analysis, we ran a null model with only the outcome variable to decompose the variance at the individual and country levels. The final models shown include both individual and country-level variables. Multilevel models are run without sample weights.

RESULTS

Table 3.1 shows the sample characteristics by country. Overall, breastfeeding within a day of birth is high (81 percent) though it varies considerably across the 15 countries, ranging from 66 percent in Cote d'Ivoire to 94 percent in Mali. Levels of prelacteal feeds are lower at 39 percent overall with a low of 11 percent in Namibia to 65 percent in Cote d'Ivoire. PNC is low overall. Only 15 percent of the sample received PNC within a day, of which the vast majority was provided by a nurse (12 percent) and only 2 and 1 percent provided by physicians and by TBA/CHWs/others respectively. In the sample, about half of the women had a child within the past 2.5 years and had 3 or fewer children. Caesarian sections are uncommon (4 percent). More than half of the women had contact with the health system through ANC care (52 percent), receipt of tetanus toxoid (56 percent) and had a skilled delivery (62 percent). The majority of the sample is married, has no education, no regular access to media and about 40 percent is classified into the poorest or second lowest wealth quintiles.

Table 3.2 shows the bivariate relations between the outcomes and key characteristics. Overall, newborns receiving PNC within 1 day are significantly more likely to initiate breastfeeding within a day and less likely to receive a prelacteal feed. This relationship is shown in Figure 3.1 by country using weighted data. In 7 of the 15 countries, newborns who received PNC were more likely to be breastfed early compared with newborns who did not receive PNC while in Comoros, Congo (Brazzaville), and Uganda, the opposite relationship occurs. Figure 3.2 shows prelacteal feeds by PNC among newborns who were breastfed (weighted data). While overall newborns receiving PNC were significantly less likely to receive a prelacteal feed, patterns by country vary considerably (Figure 3.2) with 5 countries showing statistical significance of this relationship and 4 showing the opposite pattern.

In the bivariate analysis, women receiving antenatal care, tetanus toxoid and skilled delivery were significantly more likely to breastfeed within a day and less likely to provide a prelacteal feed to the newborn. A caesarian birth was significantly associated with breastfeeding within 1 day but not with PLFs. Women with no education were less likely to breastfeed early and more likely to provide a prelacteal feed. While household wealth is positively associated with early breastfeeding, the association is negative with prelacetal feeds. Women in urban areas are more likely than rural women to initiate breastfeeding early and less likely to give a prelacetal feed. Bivariate analysis of the country-level variables also shows some interesting relationships. Lower levels of GDP, expenditures, physician and nurse density are associated with greater initiation of early breastfeeding and lesser levels of prelacteal feeds. In countries with higher HIV prevalence, early initiation of breastfeeding is higher and prelacteal feeds are lower.

Table 3.3 shows that after controlling for individual and country-level variables, PNC within 1 day is significantly associated with higher odds of breastfeeding within 1 day (OR: 1.35, 95% CI: 1.27-1.44). The odds of breastfeeding within 1 day were significantly lower for women who had a caesarian section compared with those that did not have a caesarian section (OR: 0.26, 95% CI: 0.23-0.28). Many of the variables related to contact with the health care system that were significant at the bivariate level were also significant in the multilevel model. These include ANC (OR: 1.07, 95% CI: 1.02-1.12), tetanus coverage (OR: 1.10, 95% CI: 1.05-1.15) and skilled delivery (OR: 1.48, 95% CI: 1.40-1.56). Several socio-economic variables were significantly associated with early initiation of breastfeeding. Compared to women with no education, women with primary education were significantly more likely to initiate breastfeeding within an hour (OR: 1.10, 95% CI: 1.04-1.17) though the association with secondary or higher education was not significant (OR: 1.06, 95% CI: 0.99-1.14). Women in rural areas were significantly less likely to initiate breastfeeding within a day than those in urban areas (OR: 0.92, 95% CI: 0.87-0.98). Married women were more likely to breastfeed within a day than those who were not married (OR: 1.13, 95% CI: 1.05-1.21). No overall pattern by wealth was seen. Of the country-level controls in the model, higher HIV prevalence was associated with increased odds of early initiation of breastfeeding (OR: 2.13, 95% CI: 1.19-3.82).

Model 3 shows that the provider of PNC is significantly associated with the early initiation of breastfeeding. While the provision of PNC from physicians is not associated with early initiation of breastfeeding, PNC from nurses/midwives/auxillary midwives and TBA/CHW/others were associated with higher odds of breastfeeding within 1 day (Nurses/midwives/aux. midwives OR: 1.39, 95% CI: 1.29-1.50, TBA/CHW/Other OR: 1.95, CI: 1.60-2.36). Other results from this model reflected the same results seen in model 2.

Table 3.3 shows that after controlling for individual and country-level variables, PNC within 1 day is not significantly associated with prelacteal feeds (OR: 1.04, 95% CI: 0.98-1.09). Age is significantly associated with the outcome in the model with older women tending to have lower odds of providing prelacteal feeds to newborn while birth spacing and parity were not associated with prelacteal feeds. Caesarian section delivery was significantly associated with PLFs (OR: 1.60, 95% CI: 1.46-1.76). Contact with the health care system through ANC, tetanus toxoid vaccination and skilled delivery were significantly associated with lower odds of prelacteal feeds (See Table 3.3). For example, skilled delivery was associated with a 42% reduction in odds of prelacteal feeding (OR: 0.58, 95% CI: 0.56-0.61) while antenatal care was associated with a 10 percent reduction in odds of prelacteal feeds (OR: 0.90, CI: 0.87-0.94). Education showed a clear gradient with prelacteal feeds; as the educational level of the woman increased, the odds of prelacteal feeding decreased (see Table 3.3). Of the country-level characteristics, only the density of physicians was significantly associated with prelacteal feeds in the models: higher density of physicians was associated with higher odds of prelacteal feeds (OR: 2.26, CI: 1.22-4.17). In model 3 of the second panel of Table 3.3, the type of provider of PNC is not associated with prelacteal feeds. Other results were similar to model 2 of the second panel of Table 3.3.

DISCUSSION

PNC is one of the current strategies that is recommended for scale-up and implementation in many developing countries to improve health outcomes for newborns and mothers. While several trials and intervention studies show that PNC can improve newborn feeding patterns[30-32], this is the first study to demonstrate this association at the national level using data from multiple countries in sub-Saharan Africa. Our results indicate that coverage of PNC is low across all countries

The major findings of this research are that PNC is associated with early initiation of breastfeeding (within 1 day) though not with prelacteal feeds (non-breast milk feeds within 3 days). These findings are important as they suggest that PNC when delivered through customary care (as opposed to intervention and trial conditions) can be an effective strategy to improve early breastfeeding of newborns. A lack of association with PLFs may indicate that the educational component regarding the avoidance of PLFs is not strong in these countries. These findings highlight the need to strengthen clinical practice so that providers of PNC can move beyond promoting early initiation of breastfeeding to provide more emphasis on the avoidance of PLFs which by definition would improve exclusive breastfeeding rates in these countries.

Our findings also indicate that both trained medical personal (nurses, midwives and auxillary midwives) and untrained providers of PNC are associated with increased odds of early breastfeeding though the type of provider of PNC is not associated with PLFs. These results indicate that even untrained persons may play an important role in early breastfeeding. Given that all of the countries that we studied are developing countries, use of untrained persons for this type of intervention may indeed be a cost-effective and useful approach for governments to consider especially since early initiation of breastfeeding does not require specific technologies. However, for community care to reach women who do not deliver in facilities needs a specific set of circumstances such as identifying such women as well as being able to know when a birth occurs and being able to reach the woman and newborn in a timely manner. These conditions may be met through mobile technology interventions, though these will need to be piloted and examined for effectiveness. Nevertheless, these finding also suggest that these providers are not sufficiently trained to educate women more on avoiding prelacteal feeds or perhaps, that the implementation of training on this is weak. It should also be kept in mind that many newborns undergo mixed feeding, which may fall under cultural norms. Addressing these are a key part of the effort needed to deter PLFs, in addition to the assistance needed in clinics and facilities.

A third important finding from this study is that, with the exception of caesarian section, contact with the formal health care system is associated with improved newborn feeding practices. This is seen in other studies in Nepal and India. This underscores the utility of the continuum of care that is the focus of programmatic interventions in maternal and child health and further reinforces the need to implement around this continuum framework. Delivery mode by caesarian section, however, is associated with poorer newborn feeding outcomes, a finding that is reflected in a number of other studies[24,28,37-39], even in the presence of baby-friendly policies[17]. This finding may also be a reflection that some mothers, after a caesarian section, may not be able to breastfeed immediately due to the surgical procedure or that the newborn may be unwell.

Our study has a number of important limitations that should be kept in mind when interpreting these findings. One of the key issues in interpreting findings on PNC is that the current data source does not include any information on the content of PNC. For example, in some cases, women are counselled on breastfeeding while in others, women do not receive this kind of care. Due to not having this kind of data, all of these cases are treated identically. Studies show that counseling on breastfeeding is associated with better feeding outcomes[16,40] though this study is unable to provide that kind of in-depth account of what occurred during contact with health services. The data we use are cross-sectional in nature and are not able to provide causal linkages between PNC and the outcomes though we are able to examine associations. One of the more studied variables on breastfeeding initiation is breastfeeding within 1 hour of birth. With our data, we could study the association of PNC within an hour and breastfeeding within the same time period. However, we considered that PNC within 1 hour unnecessarily censored the data and that many newborns would not have had time to receive PNC. Hence, we opted to study breastfeeding within 1 day. The literature also identifies a number of additional factors that predict early initiation of breastfeeding and PLFs, some of which were not available for analysis. For example, the Baby Friendly Hospital Initiative policy, developed by WHO and UNICEF[41], promotes early breastfeeding and avoidance of PLFs which should theoretically be associated with our outcomes. In the current study, we did not have data on the implementation of this policy and could not control for this in models. Several studies point out that intentions to breastfeed are important predictors of initiation and duration of breastfeeding[42-45]; these variables were not available in our data, which can lead to bias in our results. Dealing with sample weights is a challenge for analysis of this kind. In general, the effective sample sizes cover a range of values usually around 5000 women (though Nigeria is much higher at over 12 000 cases). This means that the relative contribution of each country is not reflective of their actual population size and that results may be driven in part by the larger samples in the analysis. Appropriate sample weight can be constructed though there are concerns over this. The DHS sample weights must be de-normalized as recommended by the DHS for multi-level analysis. However, the appropriate sampling fraction for each country and their population sizes used to create these weights are not publicly available. However, as the DHS weights account for low levels of non-response, we would expect that using the weights would not produce markedly different results.

This study is one of the first to examine PNC as it is relates to newborn feeding in sub-Saharan Africa, an understudied geographic area for this topic. Our findings are consistent with trials and intervention studies in terms of the positive relationship between early breastfeeding and PNC. Our results also suggest that certain elements of PNC need to be strengthened to further encourage the avoidance of PLFs. Our results point to several policy recommendations. First, levels of PNC coverage is currently low, however, we find that PNC is associated with early initiation of breastfeeding; further support for the deployment of PNC interventions is recommended. Further, PNC is not associated with prelacteal feeding which may indicate that the overall package of PNC may need some re-tailoring to ensure that educational, training and roll-out of PNC can address this harmful feeding practice.

Further research at a country-level is needed to understand if the results of this aggregate, multi-country study are reflected within each of these countries. This would provide more grounded evidence on how national programs can respond to PNC implementation. We also note that PNC coverage is lower than skilled attendance. This is particularly surprising given that certain checks, such as checking for bleeding, are provided immediately after birth and therefore, most skilled births should have registered as having PNC.

Further work on elucidating what women identify as a "check", the method used by DHS, should be done. More recent findings from the Multiple Indicator Cluster Surveys supported by UNICEF have used a different method of identifying PNC wherein more probing and detailed information is requested from respondents. In the case of the Ghana 2011 MICS and Zimbabwe 2014 MICS, levels of skilled birth attendance and PNC are similar, which may indicate the DHS data are underestimating PNC coverage. Further, as the levels of PNC rise in countries, there should be further analysis efforts to examine how PNC is associated with breastfeeding within 1 hour of birth, rather than 1 day as is currently done in this analysis. Our analysis, despite limitations is one of the few to provide an in-depth account into how current programming on PNC may be contributing to improvements in newborn feeding practices and indicates specific entry points and areas where the roll-out of PNC can be further developed.

TABLES AND FIGURES

Table 3.1. Weighted distribution of sample for 15 DHS countries

	Benin 2011-2012	Burkina Faso 2010	Comoros 2012	Congo Brazzaville 2012	Cote d'Ivoire 2012	Gabon 2012	Guinee 2012	Mali 2012-2013
Outcomes								
Breastfeeding within 1 day of birth								
Yes	80.9	80.5	76.3	69.8	66.2	70.0	73.1	94.0
No	19.1	19.5	23.7	30.2	33.8	30.0	26.9	6.0
Prelacteal feeding[1]								
Yes	18.1	35.9	37.5	36.1	65.6	41.3	59.1	21.1
No	81.9	64.1	62.5	63.9	34.4	58.7	40.9	78.9
Key variables								
PNC within 1 day								
Yes	20.6	18.0	10.3	15.4	24.8	12.7	16.7	13.5
By Physician	2.0	0.2	1.6	2.7	2.7	1.2	4.4	1.7
By Nurse/ Midwife/Aux. midwife	17.4	17.5	8.2	12.6	17.5	11.2	9.5	7.2
By TBA/CHW/Other	1.1	0.2	0.6	0.1	4.6	0.2	2.8	4.5
No	79.4	82.0	89.7	84.6	75.2	87.3	83.3	86.5
Maternal factors								
Age of mother								
15-19	6.2	8.6	8.5	14.0	12.2	14.9	14.3	11.3
20-24	22.1	26.6	22.7	25.8	26.3	25.8	23.1	22.9
25-29	31.8	25.3	24.4	25.8	27.3	24.3	25.4	28.6
30-34	22.1	19.9	23.5	18.1	18.7	18.3	17.1	19.2
35-39	12.0	12.9	15.1	12.6	10.1	11.1	12.8	12.1
40-49	5.7	6.8	5.8	3.8	5.4	5.6	7.3	5.8
Previous birth interval								
First birth (and twins)	20.8	17.6	22.4	23.7	22.5	27.9	21.2	17.1
<18 months	2.6	1.9	9.2	3.4	3.1	4.8	1.4	3.9
18-23 months	6.5	6.0	12.4	7.3	6.1	8.7	5.7	8.1
24-29 months	13.8	13.2	13.7	12.6	13.1	11.7	9.5	14.4
30-35 months	14.0	17.7	10.7	10.2	13.2	8.1	15.7	14.2
36-47 months (ref)	20.3	23.4	13.6	15.0	16.4	12.0	21.1	20.2
48-53 months	6.2	6.0	4.9	6.1	5.3	4.7	7.2	5.7
54+ months	15.7	14.2	13.1	21.7	20.3	22.1	18.3	16.4

Parity								
1	20.5	17.5	22.1	23.4	22.1	27.6	21.1	17.0
2-3	38.7	33.8	35.3	42.4	37.3	38.2	33.0	33.4
4-5	24.5	23.3	23.6	22.9	22.8	20.1	23.5	27.1
6+	16.3	25.3	19.0	11.2	17.7	14.1	22.4	22.5
C-section								
Yes	6.1	2.1	11.4	6.6	3.0	10.6	3.0	3.0
No	93.9	97.9	88.6	93.4	97.0	89.4	97.0	97.0
Personal illness control								
Antenatal care (4+ with any provider)								
Yes	58.7	32.5	47.6	76.0	42.8	75.6	56.2	41.0
No	41.3	67.5	52.4	24.0	57.2	24.4	43.8	59.0
Tetanus toxoid (2+ during last pregnancy)								
Yes	59.4	70.3	36.2	59.9	52.1	66.5	70.1	36.8
No	40.6	29.7	63.8	40.1	47.9	33.5	29.9	63.2
Skilled delivery								
Yes	85.6	74.2	85.6	94.1	61.4	91.2	46.2	61.2
No	14.4	25.8	14.4	5.9	38.6	8.8	53.8	38.8
Socio-economic determinants								
Education of mother								
None	69.7	83.4	43.3	7.0	62.4	5.8	75.5	81.6
Primary	16.7	10.8	24.9	31.1	26.5	25.9	13.6	9.1
Secondary+	13.6	5.7	31.8	61.9	11.2	68.3	10.9	9.3
Marital status								
Married/cohabiting	93.6	97.1	94.5	78.3	83.4	70.3	92.3	96.7
Not currently married/cohabiting	6.4	2.9	5.5	21.7	16.6	29.7	7.7	3.3
Media access								
Yes	22.5	9.2	26.6	25.9	17.0	46.7	17.0	23.7
No	77.5	90.8	73.4	74.1	83.0	53.3	83.0	76.3
Household wealth status								
Poorest quintile	20.3	20.2	23.0	22.2	24.3	21.3	22.9	20.4
Second quintile	20.5	21.9	20.8	23.0	20.4	21.6	21.4	20.2
Middle quintile	19.4	22.0	21.1	20.2	20.7	22.5	20.7	19.4
Fourth quintile	19.7	21.0	18.5	19.0	18.6	19.3	19.1	22.1
Richest quintile	20.1	14.9	16.6	15.5	15.9	15.2	15.9	17.8
Residence								
Urban	41.3	17.0	28.4	61.4	38.7	84.3	26.5	20.3

Rural	58.7	83.0	71.6	38.6	61.3	15.7	73.5	79.7
Country-level characteristics								
GDP per capita (USD)								
High ($1000 per capita and greater)	-	-	-	-	-	-	-	-
Low (less than $1000 per capita)	-	-	-	-	-	-	-	-
Per capita government expenditure on health at average exchange rate (USD)								
High ($100 per capita and greater)	-	-	-	-	-	-	-	-
Low (less than $100 per capita)	-	-	-	-	-	-	-	-
# physicians per 1000 population								
High (0.1 or greater)	-	-	-	-	-	-	-	-
Low (less than 0.1)	-	-	-	-	-	-	-	-
# nurses per 1000 population								
High (1 or greater)	-	-	-	-	-	-	-	-
Low (less than 1)	-	-	-	-	-	-	-	-
HIV Prevalence								
High (5%+)	-	-	-	-	-	-	-	-
Low (<5%)	-	-	-	-	-	-	-	-
N	5,130	5,988	1,298	3,426	3,039	2,102	2,818	3,965

[1] Denominator is ever-breast fed newborns

TBA: Traditional Birth Attendant
CHW: Community Health Worker

Table 3.1. Weighted distribution of sample for 15 DHS countries (continued)

	Namibia 2013	Niger 2012	Nigeria 2013	Sierra Leone 2013	Tanzania 2010	Uganda 2011	Zimbabwe 2011	All countries
Outcomes								
Breastfeeding within 1 day of birth								
Yes	89.1	78.6	73.7	89.1	90.5	88.7	91.7	80.1
No	10.9	21.4	26.3	10.9	9.5	11.3	8.3	19.8
Prelacteal feeding[1]								
Yes	10.2	49.1	58.4	20.7	30.8	41.1	13.1	39.1
No	89.8	50.9	41.6	79.3	69.2	58.9	86.9	60.9
Key variables								
PNC within 1 day								
Yes	15.3	10.7	11.4	26.4	1.2	8.8	9.5	14.6
By Physician	5.6	0.2	4.5	1.5	0.1	1.8	1.6	2.3
By Nurse/ Midwife/Aux. midwife	9.5	8.8	5.9	21.0	0.9	6.7	7.7	10.9
By TBA/CHW/Other	0.2	1.7	1.0	3.9	0.2	0.3	0.2	1.5
No	84.7	89.3	88.6	73.6	98.8	91.2	90.5	85.4
Maternal factors								
Age of mother								
15-19	10.7	9.6	8.5	13.5	10.2	10.3	12.4	10.4
20-24	25.5	23.1	22.7	23.0	27.1	28.2	31.2	24.5
25-29	25.5	27.4	28.0	26.1	25.4	27.5	27.6	27.1
30-34	20.1	20.8	20.1	18.0	17.5	16.2	16.3	19.3
35-39	12.3	13.0	13.4	12.9	14.2	12.5	9.0	12.6
40-49	5.9	6.1	7.3	6.5	5.5	5.4	3.5	6.1
Previous birth interval								
First birth (and twins)	32.2	13.6	20.3	22.0	19.9	17.2	29.3	20.7
<18 months	2.4	4.1	4.1	2.5	3.6	6.1	2.4	3.5
18-23 months	4.9	11.3	9.9	6.9	8.0	12.9	3.6	8.1
24-29 months	8.2	20.6	15.7	12.0	16.9	20.5	6.8	14.3
30-35 months	7.7	18.1	15.1	13.9	15.6	13.7	8.7	14.2
36-47 months (ref)	9.8	18.3	18.1	16.7	16.0	15.0	14.9	17.8
48-53 months	4.9	4.3	4.4	5.7	5.0	3.4	5.8	5.2
54+ months	29.8	9.7	12.4	20.4	14.9	11.1	28.5	16.3
Parity								
1	31.7	13.4	20.1	21.7	19.6	17.1	29.0	20.4
2-3	42.7	27.4	32.3	35.0	35.7	31.5	47.4	35.1

4-5	17.4	24.6	22.6	24.8	23.2	22.4	16.6	23.1
6+	8.2	34.5	25.0	18.6	21.5	29.0	6.9	21.4
C-section								
Yes	15.7	1.4	2.2	4.0	5.2	5.5	4.5	4.3
No	84.3	98.6	97.8	96.0	94.8	94.5	95.5	95.7
Personal illness control								
Antenatal care (4+ with any provider)								
Yes	62.0	33.1	51.1	76.0	38.4	46.2	59.2	51.4
No	38.0	66.9	48.9	24.0	61.6	53.8	40.8	48.6
Tetanus toxoid (2+ during last pregnancy)								
Yes	33.9	50.2	48.7	86.7	44.1	52.2	42.8	55.4
No	66.1	49.8	51.3	13.3	55.9	47.8	57.2	44.6
Skilled delivery								
Yes	89.0	33.4	42.4	62.6	49.7	60.9	64.9	61.6
No	11.0	66.6	57.6	37.4	50.3	39.1	35.1	38.4
Socio-economic determinants								
Education of mother								
None	5.6	85.3	47.6	64.7	25.6	12.9	1.1	51.8
Primary	22.5	9.6	18.1	15.3	67.0	63.9	31.3	22.7
Secondary+	71.9	5.1	34.3	20.1	7.4	23.2	67.5	25.5
Marital status								
Married/cohabiting	44.2	98.3	95.6	84.7	84.0	85.5	87.3	89.3
Not currently married/cohabiting	55.8	1.7	4.4	15.3	16.0	14.5	12.7	10.7
Media access								
Yes	34.9	7.4	22.2	7.5	18.0	16.0	19.8	19.1
No	65.1	92.6	77.8	92.5	82.0	84.0	80.2	80.9
Household wealth status								
Poorest quintile	21.3	19.3	23.2	23.0	21.0	22.4	22.2	21.8
Second quintile	22.6	20.5	22.8	21.0	23.9	22.0	21.1	21.7
Middle quintile	21.7	20.8	18.9	21.9	21.7	19.5	19.5	20.4
Fourth quintile	20.0	21.1	18.0	19.1	18.8	18.1	21.2	19.5
Richest quintile	14.4	18.3	17.1	14.9	14.6	18.0	16.0	16.6
Residence								
Urban	47.5	13.5	35.3	25.7	20.9	14.6	29.3	31.5
Rural	52.5	86.5	64.7	74.3	79.1	85.4	70.7	68.5
Country-level characteristics								

GDP per capita (USD)								
High ($1000 per capita and greater)	-	-	-	-	-	-	-	37.7
Low (less than $1000 per capita)	-	-	-	-	-	-	-	62.3
Per capita government expenditure on health at average exchange rate (USD)								
High ($100 per capita and greater)	-	-	-	-	-	-	-	50.7
Low (less than $100 per capita)	-	-	-	-	-	-	-	49.3
# physicians per 1000 population								
High (0.1 or greater)	-	-	-	-	-	-	-	43.9
Low (less than 0.1)	-	-	-	-	-	-	-	56.1
# nurses per 1000 population								
High (1 or greater)	-	-	-	-	-	-	-	36.2
Low (less than 1)	-	-	-	-	-	-	-	63.8
HIV Prevalence								
High (5%+)	-	-	-	-	-	-	-	17.6
Low (<5%)	-	-	-	-	-	-	-	82.4
N	1,947	5,143	12,473	4,820	3,266	3,092	2,448	60,956

[1] Denominator is ever-breast fed newborns

TBA: Traditional Birth Attendant

CHW: Community Health Worker

Table 3.2. Percentage of all newborns breastfed within a day and percentage of newborns receiving prelacteal feeds among ever breastfed newborns, by key characteristics (unweighted), 15 DHS countries

	All newborns		Ever breastfed newborns	
	Breastfeeding within:		Prelacteal feed	
	1 day	*p-value*		*p-value*
Key dependent variables				
PNC within 1 day				
Yes	84.2	0.000	35.3	0.000
No	79.8		39.3	
Maternal factors				
Age of mother				
15-19	76.3	0.000	42.5	0.000
20-24	80.1		38.9	
25-29	81.9		37.0	
30-34	81.4		37.7	
35-39	80.8		38.6	
40-45	80.4		40.7	
45-49	79.9		45.3	
Previous birth interval				
First birth (and twins)	81.8	0.000	38.7	0.000
<18 months	76.8		39.6	
18-23 months	78.2		41.6	
24-29 months	80.5		41.6	
30-35 months	82.1		40.7	
36-47 months	81.8		39.7	
48-53 months	81.5		35.7	
54+ months	81.5		33.7	
Parity				
1	77.0	0.000	39.6	0.000
2-3	81.9		35.6	
4-5	82.2		38.2	
6+	79.9		43.2	
C-section				
Yes	62.4	0.000	38.3	0.710
No	81.3		38.7	
Breastfed within 1 hr				
Yes	-		28.0	0.000
No	-		47.3	
Personal illness control				
Antenatal care (4+ with any provider)				
Yes	82.0	0.000	33.9	0.000
No	78.9		43.8	

Tetanus toxoid (2+ during last pregnancy)				
Yes	81.5	0.000	35.5	0.000
No	79.2		42.7	
Skilled delivery				
Yes	82.8	0.000	30.9	0.000
No	76.7		51.4	
Socio-economic determinants				
Education of mother				
None	79.3	0.000	42.7	0.000
Primary	82.4		37.1	
Secondary+	81.2		32.2	
Marital status				
Married/cohabiting	80.7	0.001	39.4	0.000
Not currently married/cohabiting	79.0		33.2	
Media access				
Yes	81.6	0.001	33.6	0.000
No	80.3		39.8	
Household wealth status				
Poorest quintile	77.2	0.000	43.2	0.000
Second quintile	79.2		40.8	
Middle quintile	82.1		38.1	
Fourth quintile	82.3		35.7	
Richest quintile	83.1		33.3	
Residence				
Urban	81.7	0.000	34.2	0.000
Rural	80.0		40.6	
Country characteristics				
GDP per capita (USD)				
High ($1000 + per capita)	74.0	0.000	49.7	0.000
Low (< $1000 per capita)	84.7		31.6	
Per capita government expenditure on health at average exchange rate (USD)				
High ($100 + per capita)	77.5	0.000	44.3	0.000
Low (<$100 per capita)	83.7		32.7	
# physicians per 1000 population				0.000
High (0.1+)	75.7	0.000	50.6	
Low (< 0.1)	84.3		29.2	
# nurses per 1000 population				
High (1+)	79.1	0.000	44.1	0.000
Low (<1)	81.4		35.6	
HIV Prevalence				
High (5%+)	90.2	0.000	24.9	0.000
Low (<5%)	78.5		41.6	
N	61,018		59,309	

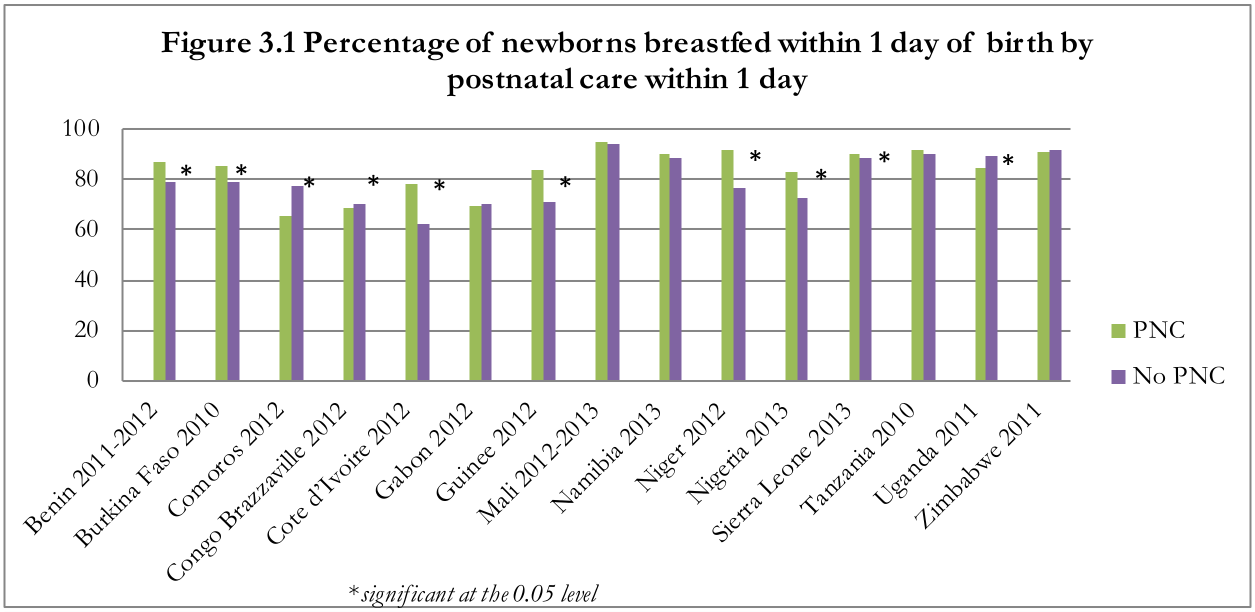


Figure 3.1 Percentage of newborns breastfed within 1 day of birth by postnatal care within 1 day
100
80
60
40
20
0
Benin 2011-2012
Burkina Faso 2010
Comoros 2012
Congo Brazzaville 2012
Cote d'Ivoire 2012
Gabon 2012
Guinee 2012
Mali 2012-2013
Namibia 2013
Niger 2012
Nigeria 2013
Sierra Leone 2013
Tanzania 2010
Uganda 2011
Zimbabwe 2011
PNC
No PNC
*significant at the 0.05 level

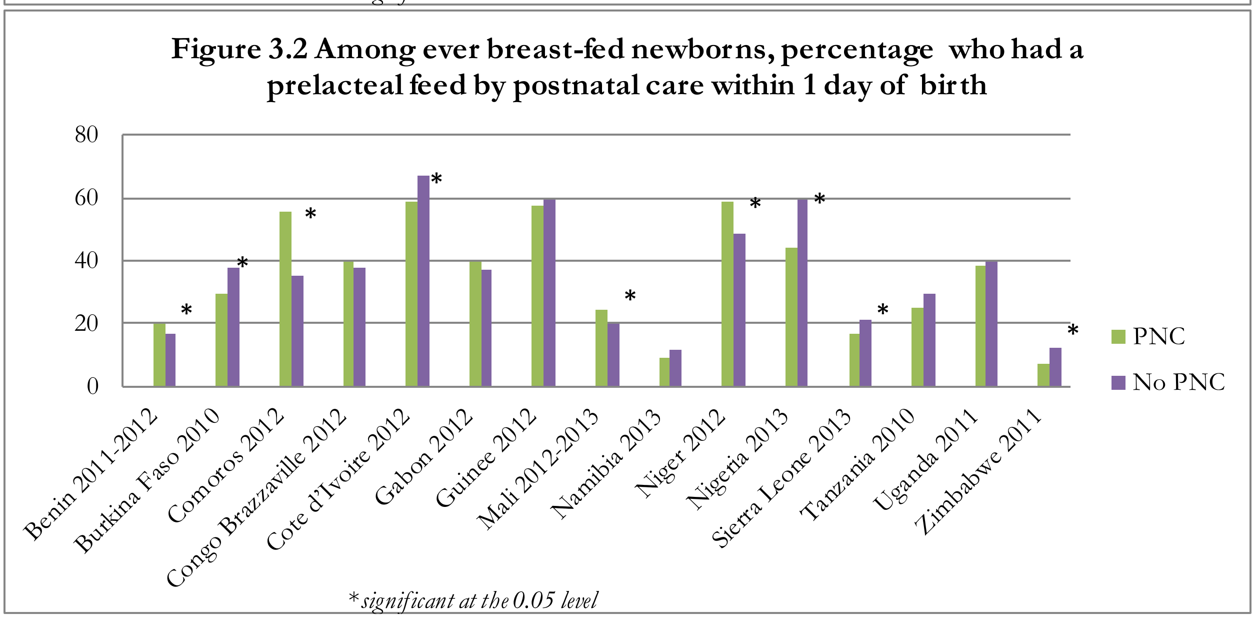


Figure 3.2 Among ever breast-fed newborns, percentage who had a prelacteal feed by postnatal care within 1 day of birth
80
60
40
20
0
Benin 2011-2012
Burkina Faso 2010
Comoros 2012
Congo Brazzaville 2012
Cote d'Ivoire 2012
Gabon 2012
Guinee 2012
Mali 2012-2013
Namibia 2013
Niger 2012
Nigeria 2013
Sierra Leone 2013
Tanzania 2010
Uganda 2011
Zimbabwe 2011
PNC
No PNC
*significant at the 0.05 level

Table 3.3. Multilevel logistic regression for initial breastfeeding among all newborns and prelacteal feeds among ever breastfed newborns, 15 DHS countries

	All newborns Breastfeeding within 1 day							
	Model 1	p-value	95 % CI		Model 2	p-value	95 % CI	
Fixed Effects								
Individual Characteristics								
Key variables								
PNC within 1 day								
Yes	1.35	0.000	1.27	1.44	-	-	-	-
No	1.00	-	-	-	-	-	-	-
Provider of PNC within 1 day								
By Physician	-	-	-	-	0.93	0.269	0.81	1.06
By Nurse/Midwife	-	-	-	-	1.39	0.000	1.29	1.50
By TBA/CHW/Other	-	-	-	-	1.95	0.000	1.60	2.36
No	-	-	-	-	1.00	-	-	-
Maternal factors								
Age of mother								
15-19	1.00	-	-	-	1.00	-	-	-
20-24	1.08	0.049	1.00	1.17	1.09	0.043	1.00	1.17
25-29	1.15	0.002	1.05	1.26	1.16	0.001	1.06	1.26
30-34	1.13	0.020	1.02	1.25	1.14	0.014	1.03	1.26
35-39	1.12	0.050	1.00	1.26	1.13	0.038	1.01	1.27
40-49	1.16	0.027	1.02	1.33	1.17	0.020	1.03	1.34
Previous birth interval								
First birth (and twins)	0.35	0.000	0.24	0.49	0.35	0.000	0.24	0.50
<18 months	0.78	0.000	0.69	0.88	0.78	0.000	0.69	0.88
18-23 months	0.92	0.070	0.84	1.01	0.92	0.069	0.84	1.01
24-29 months	1.01	0.733	0.94	1.09	1.01	0.721	0.94	1.09
30-35 months	1.01	0.805	0.94	1.09	1.01	0.813	0.94	1.09
36-47 months (ref)	1.00	-	-	-	1.00	-	-	-
48-53 months	0.93	0.190	0.84	1.04	0.93	0.194	0.84	1.04
54+ months	0.89	0.003	0.83	0.96	0.89	0.003	0.83	0.96
Parity								
1	1.00	-	-	-	1.00	-	-	-
2-3	0.48	0.000	0.34	0.68	0.48	0.000	0.34	0.69
4-5	0.49	0.000	0.34	0.70	0.49	0.000	0.34	0.71
6+	0.45	0.000	0.32	0.65	0.45	0.000	0.32	0.65
C-section								
Yes	0.26	0.000	0.23	0.28	0.26	0.000	0.24	0.29
No					1.00	-	-	-
Breastfed within 1 hour								
Yes	-	-	-	-	-	-	-	-
No	-	-	-	-	-	-	-	-
Personal illness control								
Antenatal care (4+ with any provider)								
Yes	1.07	0.009	1.02	1.12	1.07	0.008	1.02	1.12
No	1.00	-	-	-	1.00	-	-	-
Tetanus toxoid (2+ during last pregnancy)								
Yes	1.10	0.000	1.05	1.15	1.10	0.000	1.05	1.15
No	1.00	-	-	-	1.00	-	-	-
Skilled delivery								
Yes	1.48	0.000	1.40	1.56	1.50	0.000	1.42	1.59
No	1.00	-	-	-	1.00	-	-	-

Socio-economic determinants								
Education of mother								
None	1.00	-	-	-	1.00	-	-	-
Primary	1.10	0.002	1.04	1.17	1.10	0.002	1.04	1.17
Secondary+	1.06	0.081	0.99	1.14	1.07	0.061	1.00	1.15
Marital status								
Married/cohabiting	1.13	0.001	1.05	1.21	1.13	0.001	1.05	1.21
Not currently married/cohabiting	1.00	-	-	-	1.00	-	-	-
Media access								
Yes	0.96	0.221	0.90	1.02	0.96	0.260	0.91	1.03
No	1.00	-	-	-	1.00	-	-	-
Household wealth status								
Poorest quintile	1.00	-	-	-	1.00	-	-	-
Second quintile	1.05	0.084	0.99	1.12	1.05	0.115	0.99	1.11
Middle quintile	1.19	0.000	1.12	1.28	1.19	0.000	1.11	1.27
Fourth quintile	1.09	0.023	1.01	1.17	1.08	0.030	1.01	1.17
Richest quintile	1.10	0.040	1.00	1.21	1.11	0.031	1.01	1.22
Residence								
Urban	1.00	-	-	-	1.00	-	-	-
Rural	0.92	0.006	0.87	0.98	0.92	0.004	0.86	0.97
Country characteristics								
GDP per capita (USD)								
High ($1000 + per capita)	0.60	0.137	0.30	1.18	0.60	0.138	0.30	1.18
Low (< $1000 per capita)	1.00	-	-	-	1.00	-	-	-
Per capita government expenditure on health at average exchange rate (USD)								
High ($100 + per capita)	1.08	0.800	0.58	2.03	1.08	0.819	0.57	2.02
Low (<$100 per capita)	1.00	-	-	-	1.00	-	-	-
# physicians per 1000 population								
High (0.1+)	0.62	0.052	0.38	1.00	0.62	0.054	0.38	1.01
Low (< 0.1)	1.00	-	-	-	1.00	-	-	-
# nurses per 1000 population								
High (1+)	1.36	0.348	0.72	2.57	1.37	0.338	0.72	2.59
Low (<1)	1.00	-	-	-	1.00	-	-	-
HIV Prevalence								
High (5%+)	2.13	0.011	1.19	3.82	2.14	0.011	1.19	3.83
Low (<5%)	1.00	-	-	-	1.00	-	-	-
Random effects								
Country-level variance (SE)	0.147(0.055)				0.147(.055)			
Log-likeliehood	-28043.57				-28021.71			
AIC	56159.13				56119.41			
Log-likelihood ratio test (Chi-square)	715.1***				712.06***			
N	61018				61018			

***significant at the 0.01 level

Table 3.3. Multilevel logistic regression for initial breastfeeding among all newborns and prelacteal feeds among ever breastfed newborns, 15 DHS countries (continued)

	Among ever breastfed newborns, Prelacteal feeds							
	Model 3	p-value	95 % CI		Model 4	p-value	95 % CI	
Fixed Effects								
Individual Characteristics								
Key variables								
PNC within 1 day								
Yes	1.04	0.195	0.98	1.09	-	-	-	-
No	1.00	-	-	-	-	-	-	-
Provider of PNC within 1 day								
By Physician	-	-	-	-	0.94	0.343	0.83	1.07
By Nurse/Midwife	-	-	-	-	1.03	0.315	0.97	1.09
By TBA/CHW/Other	-	-	-	-	1.20	0.017	1.03	1.39
No	-	-	-	-	1.00	-	-	-
Maternal factors								
Age of mother								
15-19	1.00	-	-	-	1.00	-	-	-
20-24	0.93	0.038	0.86	1.00	0.93	0.040	0.86	1.00
25-29	0.84	0.000	0.78	0.91	0.85	0.000	0.78	0.92
30-34	0.85	0.000	0.77	0.93	0.85	0.000	0.77	0.93
35-39	0.85	0.002	0.77	0.94	0.85	0.002	0.77	0.94
40-49	0.91	0.117	0.81	1.02	0.91	0.127	0.81	1.03
Previous birth interval								
First birth (and twins)	1.19	0.374	0.81	1.77	1.20	0.374	0.81	1.77
<18 months	1.07	0.181	0.97	1.19	1.07	0.185	0.97	1.19
18-23 months	1.04	0.332	0.96	1.12	1.04	0.332	0.96	1.12
24-29 months	1.03	0.399	0.96	1.10	1.03	0.400	0.96	1.10
30-35 months	0.98	0.624	0.92	1.05	0.98	0.623	0.92	1.05
36-47 months (ref)	1.00	-	-	-	1.00	-	-	-
48-53 months	0.97	0.457	0.88	1.06	0.97	0.455	0.88	1.06
54+ months	0.96	0.231	0.90	1.03	0.96	0.230	0.90	1.03
Parity								
1	1.00	-	-	-	1.00	-	-	-
2-3	0.97	0.868	0.65	1.43	0.97	0.869	0.65	1.43
4-5	1.03	0.889	0.69	1.53	1.03	0.891	0.69	1.53
6+	1.05	0.794	0.71	1.57	1.05	0.797	0.71	1.57
C-section								
Yes	1.60	0.000	1.46	1.76	1.61	0.000	1.47	1.77
No	1.00	-	-	-	1.00	-	-	-
Breastfed within 1 hour								
Yes	0.57	0.000	0.55	0.59	0.57	0.000	0.55	0.59
No	1.00	-	-	-	1.00	-	-	-
Personal illness control								
Antenatal care (4+ with any provider)								
Yes	0.90	0.000	0.87	0.94	0.90	0.000	0.87	0.94
No	1.00	-	-	-	1.00	-	-	-
Tetanus toxoid (2+ during last pregnancy)								
Yes	0.87	0.000	0.83	0.90	0.87	0.000	0.83	0.90
No	1.00	-	-	-	1.00	-	-	-
Skilled delivery								
Yes	0.58	0.000	0.56	0.61	0.59	0.000	0.56	0.62
No	1.00	-	-	-	1.00	-	-	-

Socio-economic determinants								
Education of mother								
None	1.00	-	-	-	1.00	-	-	-
Primary	0.86	0.000	0.82	0.91	0.86	0.000	0.82	0.91
Secondary+	0.78	0.000	0.73	0.83	0.78	0.000	0.73	0.83
Marital status								
Married/cohabiting	1.02	0.624	0.95	1.09	1.02	0.622	0.95	1.09
Not currently married/cohabiting	1.00	-	-	-	1.00	-	-	-
Media access								
Yes	0.99	0.777	0.94	1.05	0.99	0.796	0.94	1.05
No	1.00	-	-	-	1.00	-	-	-
Household wealth status								
Poorest quintile	1.00	-	-	-	1.00	-	-	-
Second quintile	0.98	0.418	0.93	1.03	0.98	0.386	0.93	1.03
Middle quintile	0.95	0.116	0.90	1.01	0.95	0.102	0.90	1.01
Fourth quintile	1.01	0.836	0.94	1.07	1.01	0.866	0.94	1.07
Richest quintile	1.04	0.309	0.96	1.13	1.04	0.296	0.96	1.13
Residence								
Urban	1.00	-	-	-	1.00	-	-	-
Rural	1.04	0.125	0.99	1.10	1.04	0.143	0.99	1.09
Country characteristics								
GDP per capita (USD)								
High ($1000 + per capita)	1.14	0.765	0.48	2.68	1.14	0.762	0.48	2.69
Low (< $1000 per capita)	1.00	-	-	-	1.00	-	-	-
Per capita government expenditure on health at average exchange rate (USD)								
High ($100 + per capita)	1.11	0.803	0.50	2.45	1.10	0.809	0.50	2.44
Low (<$100 per capita)	1.00	-	-	-	1.00	-	-	-
# physicians per 1000 population								
High (0.1+)	2.26	0.009	1.22	4.17	2.26	0.009	1.22	4.18
Low (< 0.1)	1.00	-	-	-	1.00	-	-	-
# nurses per 1000 population								
High (1+)	0.63	0.266	0.28	1.42	0.63	0.269	0.28	1.42
Low (<1)	1.00	-	-	-	1.00	-	-	-
HIV Prevalence								
High (5%+)	0.60	0.168	0.29	1.24	0.60	0.171	0.29	1.25
Low (<5%)	1.00	-	-	-	1.00	-	-	-
Random effects								
Country-level variance (SE)	0.237(0.09)				0.238(0.09)			
Log-likeliehood	-34632.369				-34629.4			
AIC	69338.7				69336.8			
Log-likelihood ratio test (Chi-square)	1803.4***				1808.2***			
N	59309				59309			

***significant at the 0.01 level

REFERENCES

1. Bhutta ZA, Ahmed T, Black RE, et al. What works? interventions for maternal and child undernutrition and survival. *The Lancet*. 2008;371(9610):417-440.

2. World Health Organization, UNICEF. Global strategy for infant and young child feeding. . 2003.

3. Mullany LC, Katz J, Li YM, et al. Breast-feeding patterns, time to initiation, and mortality risk among newborns in southern Nepal. *J Nutr*. 2008;138(3):599-603. doi: 138/3/599 [pii].

4. Edmond KM, Zandoh C, Quigley MA, Amenga-Etego S, Owusu-Agyei S, Kirkwood BR. Delayed breastfeeding initiation increases risk of neonatal mortality. *Pediatrics*. 2006;117(3):e380-e386.

5. Huffman SL, Zehner ER, Victora C. Can improvements in breast-feeding practices reduce neonatal mortality in developing countries? *Midwifery*. 2001;17(2):80-92.

6. Brandtzaeg P. Mucosal immunity: Integration between mother and the breast-fed infant. *Vaccine*. 2003;21(24):3382-3388.

7. Goldman AS, Garza C, Nichols BL, Goldblum RM. Immunologic factors in human milk during the first year of lactation. *J Pediatr*. 1982;100(4):563-567.

8. Goldman AS. The immune system of human milk: Antimicrobial, anti-inflammatory and immunomodulating properties. *Pediatr Infect Dis J*. 1993;12(8):664-672.

9. Goldman AS. Modulation of the gastrointestinal tract of infants by human milk. interfaces and interactions. an evolutionary perspective. *J Nutr*. 2000;130(2S Suppl):426S-431S.

10. Rollins NC, Filteau SM, Coutsoudis A, Tomkins AM. Feeding mode, intestinal permeability, and neopterin excretion: A longitudinal study in infants of HIV-infected South African women. *JAIDS J Acquired Immune Defic Syndromes*. 2001;28(2):132-139.

11. Badruddin SH, Islam A, Hendricks KM, et al. Dietary risk factors associated with acute and persistent diarrhea in children in Karachi, Pakistan. *Am J Clin Nutr*. 1991;54(4):745-749.

12. Clemens J, Elyazeed RA, Rao M, et al. Early initiation of breastfeeding and the risk of infant diarrhea in rural Egypt. *Pediatrics*. 1999;104(1):e3-e3.

13. Sinusas K, Gagliardi A. Initial management of breastfeeding. *Am Fam Physician*. 2001;64(6):981-988.

14. World Health Organization. Reproductive Health. *Pregnancy, childbirth, postpartum and newborn care: A guide for essential practice*. World Health Organization; 2003.

15. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L. Evidence-based, cost-effective interventions: How many newborn babies can we save? *The Lancet*. 2005;365(9463):977-988.

16. Vieira TO, Vieira GO, Giugliani ER, Mendes CM, Martins CC, Silva LR. Determinants of breastfeeding initiation within the first hour of life in a Brazilian population: Cross-sectional study. *BMC Public Health*. 2010;10:760-2458-10-760. doi: 10.1186/1471-2458-10-760 [doi].

17. Rowe-Murray HJ, Fisher JR. Baby friendly hospital practices: Cesarean section is a persistent barrier to early initiation of breastfeeding. *Birth*. 2002;29(2):124-131.

18. Boccolini CS, Carvalho MLd, Oliveira, Maria Inês Couto de, Leal MdC, Carvalho MS. Factors that affect time between birth and first breastfeeding. *Cadernos de Saúde Pública*. 2008;24(11):2681-2694.

19. Dennis C. Breastfeeding initiation and duration: A 1990-2000 literature review. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*. 2002;31(1):12-32.

20. World Health Organization. Evidence for the ten steps to successful breastfeeding. . 1998.

21. Hossain MM, Radwan MM, Arafa SA, Habib M, DuPont HL. Prelacteal infant feeding practices in rural egypt. *J Trop Pediatr*. 1992;38(6):317-322.

22. Lakati A, Makokha O, Binns C, Kombe Y. The effect of pre-lacteal feeding on full breastfeeding in Nairobi, Kenya. *East African journal of public health*. 2010;7(3).

23. El-Gilany A, Sarraf B, Al-Wehady A. Factors associated with timely initiation of breastfeeding in Al-Hassa province, Saudi Arabia. *EMHJ*. 2012;18(3).

24. Patel A, Banerjee A, Kaletwad A. Factors associated with prelacteal feeding and timely initiation of breastfeeding in hospital-delivered infants in India. *J Hum Lact*. 2013;29(4):572-578. doi: 10.1177/0890334412474718 [doi].

25. Wamani H, Astrom AN, Peterson S, Tylleskar T, Tumwine JK. Infant and young child feeding in western Uganda: Knowledge, practices and socio-economic correlates. *J Trop Pediatr*. 2005;51(6):356-361. doi: fmi048 [pii].

26. Fikree FF, Ali TS, Durocher JM, Rahbar MH. Newborn care practices in low socioeconomic settlements of Karachi, Pakistan. *Soc Sci Med*. 2005;60(5):911-921.

27. Khanal V, Adhikari M, Sauer K, et al. Factors associated with the introduction of prelacteal feeds in Nepal: Findings from the Nepal demographic and health survey 2011. *Int Breastfeed J*. 2013;8(1):9.

28. Nguyen PH, Keithly SC, Nguyen NT, Nguyen TT, Tran LM, Hajeebhoy N. Prelacteal feeding practices in Vietnam: Challenges and associated factors. *BMC Public Health*. 2013;13:932-2458-13-932. doi: 10.1186/1471-2458-13-932 [doi].

29. WHO & UNICEF. Home visits for the newborn child: A strategy to improve survival. http://www.who.int/maternal_child_adolescent/documents/who_fch_cah_09_02/en/. Updated 2009. Accessed 9/5/2013, .

30. Baqui AH, Ahmed S, El Arifeen S, et al. Effect of timing of first postnatal care home visit on neonatal mortality in Bangladesh: A observational cohort study. *BMJ: British Medical Journal*. 2009;339.

31. Bhutta ZA, Memon ZA, Soofi S, Salat MS, Cousens S, Martines J. Implementing community-based perinatal care: Results from a pilot study in rural Pakistan. *Bull World Health Organ*. 2008;86(6):452-459.

32. Kumar V, Mohanty S, Kumar A, et al. Effect of community-based behaviour change management on neonatal mortality in Shivgarh, Uttar Pradesh, India: A cluster-randomised controlled trial. *The Lancet*. 2008;372(9644):1151-1162.

33. Setegn T, Gerbaba M, Belachew T. Determinants of timely initiation of breastfeeding among mothers in Goba Woreda, outh east Ethiopia: A cross sectional study. *BMC Public Health*. 2011;11:217-2458-11-217. doi: 10.1186/1471-2458-11-217 [doi].

34. ICF International. The DHS program. http://dhsprogram.com/. Updated 2014.

35. Filmer D, Pritchett LH. Estimating wealth effects without expenditure Data—Or tears: An application to educational enrollments in states of India. *Demography*. 2001;38(1):115-132.

36. Liese B, Dussault G. *The state of the health workforce in sub-saharan africa: Evidence of crisis and analysis of contributing factors*. World Bank: Africa Region; 2004.

37. Chien L, Tai C. Effect of delivery method and timing of breastfeeding initiation on breastfeeding outcomes in Taiwan. *Birth*. 2007;34(2):123-130.

38. El-Gilany A, Abdel-Hady DM. Newborn first feed and prelacteal feeds in Mansoura, Egypt. *BioMed research international*. 2014;2014.

39. Vieira TO, Vieira GO, Giugliani ER, Mendes CM, Martins CC, Silva LR. Determinants of breastfeeding initiation within the first hour of life in a Brazilian population: Cross-sectional study. *BMC Public Health*. 2010;10:760-2458-10-760. doi: 10.1186/1471-2458-10-760 [doi].

40. Patel A, Banerjee A, Kaletwad A. Factors associated with prelacteal feeding and timely initiation of breastfeeding in hospital-delivered infants in India. *J Hum Lact*. 2013;29(4):572-578. doi: 10.1177/0890334412474718 [doi].

41. World Health Organization (WHO). Baby-friendly hospital initiative. http://www.who.int/nutrition/topics/bfhi/en/. Updated 2015.

42. Donath S, Amir LH. Relationship between prenatal infant feeding intention and initiation and duration of breastfeeding: A cohort study. *Acta Paediatrica*. 2003;92(3):352-356.

43. Earle S. Factors affecting the initiation of breastfeeding: Implications for breastfeeding promotion. *Health Promot Int*. 2002;17(3):205-214.

44. Scott JA, Binns CW, Aroni R. The influence of reported paternal attitudes on the decision to breast-feed. *J Paediatr Child Health*. 1997;33(4):305-307.

45. Scott J, Landers M, Hughes RM, Binns C. Factors associated with breastfeeding at discharge and duration of breastfeeding. *J Paediatr Child Health*. 2001;37(3):254-261.

CHAPTER 4: CAN A QUALITY IMPROVEMENT INTERVENTION IMPROVE POST NATAL CARE COVERAGE AND CONTENT? A CASE STUDY IN GHANA

Introduction

The health and survival situation of children and newborns in Ghana necessitate improvements to avoid preventable deaths and morbidity. Ghana's rates of under-five and neonatal mortality remain comparatively high, standing at 72 and 38 deaths per 1000 live births (2012)[1]. Levels of exclusive breastfeeding are somewhat low at 45% in Ghana, similar to other countries in West Africa (Sierra Leone: 32 percent and Benin 43 percent[2]. In Ghana, about 1 in 5 newborns receive a prelacteal feed, that is, any liquid other than breast milk given to the newborn before breastfeeding is established. About 46 percent are breastfed within an hour and 84 percent are breastfed within a day[3]. As part of the effort to improve newborn health and survival, Ghana created policies on postnatal care (PNC). The first policy implemented in 1999 promoted two contacts of health workers with newborns, the first during the second week of life and a second contact at 6 weeks. A follow-up policy in 2008 changed the timing of the first contact to within 3 days of life[4]. The 2008 policy revision proposed two visits within the first week of life, to encourage healthy behaviors and detect early warning signs of illness for the mother and newborn.

Quality improvement (QI) interventions are one strategy that can be used to implement PNC. Quality improvement interventions refer to changes in "health care systems, services, or supplies for the purpose of increasing the likelihood of optimal clinical quality of care measured by positive health outcomes for individuals and populations"[5]. The QI literature has examined a range of issues including strategies to improve service delivery, indicator development and monitoring and improving management of facilities[6-8]. While the popularity of QI interventions in Africa is increasing[9], the few QI approaches evaluated have shown limited results. Clinical training and supervision, which has long been part of quality improvement, has shown only a limited impact on health care services and health outcomes [10-12], while audit and feedback approaches, which summarize health care performance with or without follow-up recommendations[13], have shown no to limited impact [14]. However, testing and implementing change ideas, which describe the type of process to be modified, have shown to improve quality and performance of health facilities[15]. In Ghana, developing, testing and implementing facility and community-based categories of process changes (on early pregnancy identification, promotion of ANC visits, encouraging skilled delivery and PNC) were significantly associated with increased skilled delivery and post-natal care (PNC) during the scale up of a national policy on PNC[16] . Another study evaluated the pilot phase of a QI intervention, Project Fives Alive! on key maternal and child outcomes. The study found improvements in skilled deliveries as well as underweight infants attending wellness clinics[17].

The Maternal and Newborn Referrals project (MNR) is implemented to improve access to maternal and newborn care and improve maternal and newborn health outcomes. This is done using a QI approach to improve referrals of pregnant women with complications to higher-level facilities. MNR is a supplement to the Project Fives Alive! in Ghana and is funded by the Bill & Melinda Gates Foundation (BMGF). The MNR project was launched in August 2012 and is implemented in three districts in the North and three in the Central regions of Ghana. The MNR uses an existing platform, the Improvement Collaborative Network (ICN), to fulfil its work. The ICN was developed as part of the Project Fives Alive! [18] , of which, one major feature is learning sessions for selected health staff different health facilities every 4-6 months. In the learning sessions, staff share experiences and learn about change ideas, data analysis and learning improvements. The intervention occurs in two stages. In the first stage, a subset of health facilities tests change ideas based on the work of the ICN team in that district, and then, these are scaled-up in the second stage to more facilities. As the MNR promotes use of maternal health services (such as ANC and skilled delivery) and newborn health care, we would expect to see improvements in PNC as this is a part of the continuum of care usually offered to women and newborns.

The intervention districts of MNR use an integrated community-facility approach where health workers and community members (such as pregnant women and their families) are part of the ICNs. The community-facility approach is used to ensure that solutions to improving referrals are culturally acceptable to women in the community and also clinically relevant to health staff. The comparison groups of the MNR, however, use a facility-only approach. The intervention and comparison districts were not selected using a formal selection criterion. In fact, these districts were districts in which Project Fives Alieve! were already working in. It should also be noted that the specific aims of the MNR interventions did not directly address PNC though it did address known correlates of PNC such as skilled delivery.

To enhance monitoring of PNC program outcomes, countries and programs on newborn survival are advised by the Interagency Newborn Indicators Technical Working Group (chaired by Save the Children) to measure the content of PNC. This includes measuring five signal functions of PNC: checking the newborn's cord, assessing the mother's temperature, counseling and observing breastfeeding, the provision of information on newborn danger signs and weighing the newborn[19]. These are signal functions that can be performed during a PNC check in a facility immediately following birth or at a later point, or during home visits. All of these functions can be performed by all levels of health workers including community health workers. At present, data on these signal functions have not been collected and are rare. Thus far, only one country has collected these indicators in a national-level survey (Nigeria DHS 2013) though no in-depth analysis of these data has been done[20].

The objectives of this paper are to examine if the MNR program is associated with PNC. More specifically, we examine if the MNR program is associated with changes in PNC use over the short (1 year post-intervention) and long term (more than 2 years, post-intervention). Given that the intervention areas use community-facility approaches and the comparison areas use facility-only approaches, these comparisons are essentially to examine the added benefit of the integrated community-facility approach over the facility-only approach on the outlined outcomes. Further, given the dearth of knowledge on the content of PNC, we examine these measures and if the MNR is associated with each of the five signal functions.

DATA AND METHODS

Data sources:

We use data from the evaluation of the Maternal and Newborns Referral Project (MNR), Ghana. The evaluation uses a quasi-experimental design where 3 consecutive waves of household surveys collected data from the same districts for intervention and non-randomly assigned comparison districts in the North and Central regions of the country. The data were collected in 2012, 2013 and 2015. These surveys were designed for district-level representation. The 2012 baseline study was conducted before MNR was implemented.

For each survey, samples were stratified into the North and the Central regions. In the 2012 survey, three districts were selected and within these, 30 communities were randomly selected. In each subsequent wave of the surveys, the same districts were selected but different communities were randomly selected. In each selected community, 7 women with a birth in the past 12 months were selected, and 14 women, regardless of recent birth status, were also selected. Therefore, in each round of the survey, the target sample is 1260 women, 630 in intervention and 630 in the comparison areas. Of these 630 women, at least 210 women should have a recent birth and 420 other women. To identify the recent birth sample, women with a birth in the 12 months preceding the survey were listed by community health workers and community leaders; after the listing was complete, a random sample was selected. In addition, two women neighbors of recently pregnant women were interviewed for the survey. All three waves contain data on PNC coverage for the mother and the newborn and PNC within 1 week. Data were collected on the five signal functions in only the final wave of the surveys and only for the Central region.

The outcome variables are immediate PNC checks for the mother, immediate PNC checks for the newborn, and PNC within one week of birth. Immediate checks for the mother was assessed with the question, "Before you were discharged (or before your delivery attendant left), did someone check on your health?". A similar approach was used to assess immediate checks for the newborn. For PNC within 1 week, the following question was used, "Did you go for a PNC visit within a week of birth or did someone come to your home to check on you and your baby?". The questions were asked of all women who had a birth in the three years before to the survey, regardless of place of delivery and type of birth attendant. PNC for the mother and the newborn refer to immediate checks following birth. PNC within 1 week refers to a further and separate check within a week of birth, not including the immediate check. All three outcomes are binary. As the three waves of the survey were spaced within 1-2 years of each other, there is the possibility that if we use a reference period of two years before the survey for indicators, we could potentially include pre-intervention data when studying the midterm and endline surveys. Therefore, for this analysis, we limit PNC to births in the 1 year preceding the survey.

Data on the signal functions were assessed using five separate questions, recorded for all births in the three years before the survey. All of these variables had dichotomous response categories of "yes" and "no". At the time of the dissertation, only data for the signal functions for the Central region were available for analysis.

In order to examine if MNR was associated with PNC variables over the short-term, three separate linear probability models are used controlling for background factors, clustering and a time dummy for "0" at baseline, and "1" at mid-term (T1). We also include a variable to identify the intervention and comparison groups (P, where "1" refers to intervention and "0" refers to comparison groups). We include an interaction term between the time variable and the intervention/comparison variable which examines if the effect of the program on intervention and comparison groups is different from baseline to midterm (P*T1). To examine if MNR is associated with the outcomes over the long term, we use a similar approach to the above where we include a variable for the intervention and comparison groups, a time dummy for midterm, a time dummy for endline (T2) and two interaction terms (P*T1 and P*T2). Table 4.1 shows a list of control variables and their categorizations. The program effects are the coefficients of the interaction terms.

Regarding if the MNR program is associated with the signal functions, we use five different multivariate logistic models using only the endline data with an appropriate intervention and control variable in the Central region only where these data were collected. We produce simulations to examine the program effects.

RESULTS

Table 4.1 shows the characteristics of the sample of women with a birth in the last year at baseline by intervention and comparison groups. We tested if the characteristics were different using t-tests, the results of which are in table 4.1. Overall, the sample is split about evenly between the North and the Central regions. The majority of women is below age 30, had 3 or fewer children, is married and does not have any employment. Approximately 48 percent of these women have no education. Use of antenatal care is high (96 percent) while skilled delivery is much lower (56 percent). Only 14 percent had complications during labor or delivery. Table 4.1 also shows differences in various characteristics of the populations. For example, women in the comparison districts are significantly more likely to be poor than in the intervention districts. While the use of antenatal care services were the same in both intervention and comparison districts, women in the intervention districts are significantly more likely to use skilled delivery. Additionally, women in the intervention districts are significantly more educated compared with women in the comparison districts.

Figure 4.1 shows the key outcomes over the three survey waves and by region. In general, PNC for the mother, newborn and PNC within 1 week are high in the intervention and the comparison areas and did not change over time. By region, there are underlying patterns. In the North, PNC for mothers and newborns declined by the midterm but increased by the endline for the intervention groups to near baseline levels. PNC within 1 week in the North initially increased then declined to close to baseline levels for the intervention group. For the comparison group for this variable, levels declined across the three survey waves. In the Central region, PNC for the mother and newborn declined across the entire study period. PNC within 1 week rose slightly in intervention and comparison groups in the Central region.

The five signal functions of PNC are presented for the Central region in Table 4.2. Overall, coverage of the various elements is slightly higher in the intervention compared with the comparison groups though differences are small (less than five percentage points). Coverage in the intervention group ranges from 46 percent (counselling on danger signs) to 74 percent (counseled and observed on breastfeeding). The levels of non-response for these variables were low (below 5 percent, data not shown).

Table 4.3 shows the results of three linear probability models for the outcome variables between waves 1 and 2. Based on the interaction terms, the program had a small, significant negative effect of about 0.13 on immediate PNC for the mother and immediate PNC for the newborn. The program had a small, significant positive effect of 0.17 for PNC within 1 week for the mother or newborn. Interestingly, across the three models, the vast majority of the explanatory variables are not significant. The exception is skilled birth attendance which shows a significantly negative association for all three outcomes.

Table 4.4 shows the association of program implementation on PNC for the mother, the newborn and PNC for mother or newborn within a week of birth for waves one to three using linear probability models. Results are similar to those seen at midterm where the program effects, based on coefficient of the interaction terms from these models, show small significant negative effects for immediate PNC for the mother and immediate PNC for the newborn. Again, the program had a small significant positive effect of 0.19 on PNC within 1 week for the mother or newborn.

In the final part of the analysis, we examine in Table 4.5 if newborns in the intervention areas are more likely to receive specific components of PNC. Despite slightly higher coverage of the five signal functions in the intervention districts at the descriptive level (Table 4.2), results of the models and simulations (data not shown) reveal that newborns in the intervention areas are no more likely to receive any of the five studied components of PNC compared with newborns in the comparison areas. However, while many of the variables in the models are not associated with the signal functions, skilled delivery is consistently significantly associated with all of the five variables. For example, newborns to skilled births are more than three times as likely to have their temperature assessed than newborns that newborn who are not born using a skilled attendant (OR: 3.71, CI: 1.76-7.85, p-value: 0.001).

DISCUSSION

While the Millennium Development Goals brought maternal health and under-five mortality to the forefront of the global development agenda through goals 4 and 5 over the past 15 years, the launch of the Sustainable Development Goals (SDG) in 2015 will usher in further emphasis on these areas. For example, SDG goal 3 is to ensure healthy lives and promote well-being at all ages, with targets to end preventable newborn and under-five deaths by 2030[21,22]. This will create a need to continue to innovate and adjust programming to improve outcomes for mothers and newborns. QI interventions are an important and growing class of interventions that are being adopted in the developing world and as such, there is a need to better understand how these programs perform in the field[23].

This paper essentially compared two approaches: community-facility activities in the intervention areas to facility-only activities in the comparison areas, to examine if these approaches had differential effects on immediate PNC for mothers, newborns and PNC within 1 week. The major findings are that the MNR program, which sought neonatal mortality reductions through improving referrals to higher-level facilities for pregnant women with complications, had over the short and longer term, a small but negative association with immediate PNC checks for the mother and immediate PNC checks for the newborn. This result may have occurred as women, after receiving skilled delivery, may not see the need to return to facilities or accept further care such as PNC for themselves or the newborn. The lack of positive association between the intervention and the outcomes may also be partially explained by the fact that the program itself did not focus on PNC as an outcome but worked more on improving antenatal care and skilled delivery[24].

There was also a small positive association with PNC within 1 week for the mother or newborn at midterm and endline. This may have occurred as the newborns and women who are checked immediately following birth may be used to using formal health care, and perhaps are more prone to seek or accept such care when available. Regarding the signal functions, newborns in the intervention areas were no more likely to receive any of the five components of PNC than those in comparison areas. Such a finding may be due to the program not emphasizing the implementation of these signal functions[24]. In future work, two major issues should be examined. First, to examine PNC in the context of a QI intervention, a program that specifically addresses PNC should be evaluated. Further, since this study lacked a control group, future studies should attempt to investigate if a facility-only approach can improve PNC coverage.

Methodologically, the signal functions studied in this paper are a first for the scientific community, that is, this is the first time that the key components that contribute to PNC have been defined for quantitative measurement. Firstly, the variables show low levels of non-response which is a preliminary indication of high data quality. Secondly, the signal functions show an expected pattern of association with skilled delivery which is another indication that these variables are conceptually capturing what is intended by survey questions.

The findings also point to a number of useful entry points for programs. Skilled delivery is associated with the signal functions. This highlights the importance of skilled delivery as a potential entry point for improving PNC coverage as women and newborns are essentially captive audiences for PNC after the birth experience is complete. The signal functions were not associated with the vast majority of the variables in the models though they were associated with skilled delivery. This may indicate that methodologically, to further study these variables, additional in-depth information on skilled delivery and the birthing process may be needed as women, while they may be able to accept or refuse PNC, they may not be able to actually control the services that they are actually given.

Strikingly, complications during the birth process and during labor were not associated with PNC coverage or with the signal functions in all but one of the models. This is particularly surprising since women and newborns who have complications should receive additional care following birth to prevent bleeding and infections. Clinically, these results may indicate the need to ensure that there is continuity from birth to PNC and women and newborns with complications should be better monitored and receive additional care. An alternative explanation may be that women simply did not recognize that the follow-up they received was PNC. Another surprising finding is that skilled delivery is associated with lower odds of the PNC for the mother, newborn and within 1 week. This too may be attributed to inability of women to recognize PNC and differentiate it from delivery care. It is therefore possible that self-reports of PNC may be underestimated.

This analysis has a number of limitations. Firstly, the study could not examine causal linkages between the program and the outcomes in the study as the intervention and comparison groups were not randomized. However, the study was able to produce associations between the program and key outcomes. In the analysis, we did not include district level variables as these resulted in unstable models and hence, were removed from the analysis. Further, the data presented on the signal functions were only available for the Central region at the time of analysis which reduced the sample sizes available for analysis. This may imply that this part of the study is not sufficiently powered to detect statistically significant differences. Finally, there is qualitative evidence that the community-facility approach, intended to be in the intervention area only, was also used in the comparison areas. This may have reduced the overall program effect that is seen, as we are unable to statistically control for the spill-over[25].

The findings of this paper show that the MNR project, a QI intervention, had limited effects on improving immediate PNC for mothers and newborns. This represents a potential opportunity to refine programming to improve elements of the program to directly address PNC, which was not an explicit part of the original program. This paper also documents that signal functions which comprise aspects of PNC can be collected in household surveys. As this study is one of the few to examine the programmatic implementation of PNC through a QI intervention, further research is needed to document how similar programmatic approaches can be used to improve PNC coverage and strengthen the evidence base around PNC implementation. While questions on the signal functions appear to work, additional cognitive testing and validation of these questions should occur to ensure that the intention of the questions matches the thinking of respondents.

These types of evaluations form a necessary and important part of the literature as they fulfil an identified need for further evidence on evaluating the effectiveness of implementing PNC recommendations[26] and further, that these results can lead to improved programming for mothers and newborns in sub-Saharan Africa.

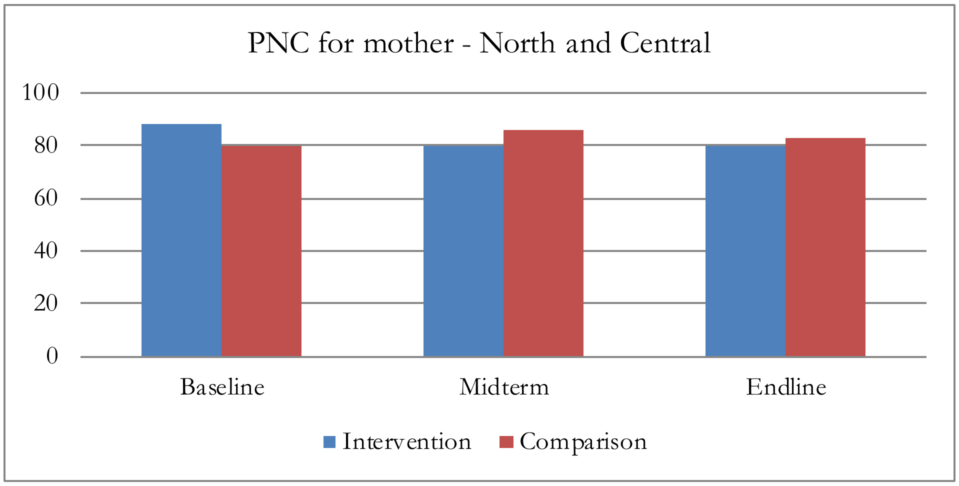
Tables and Figures

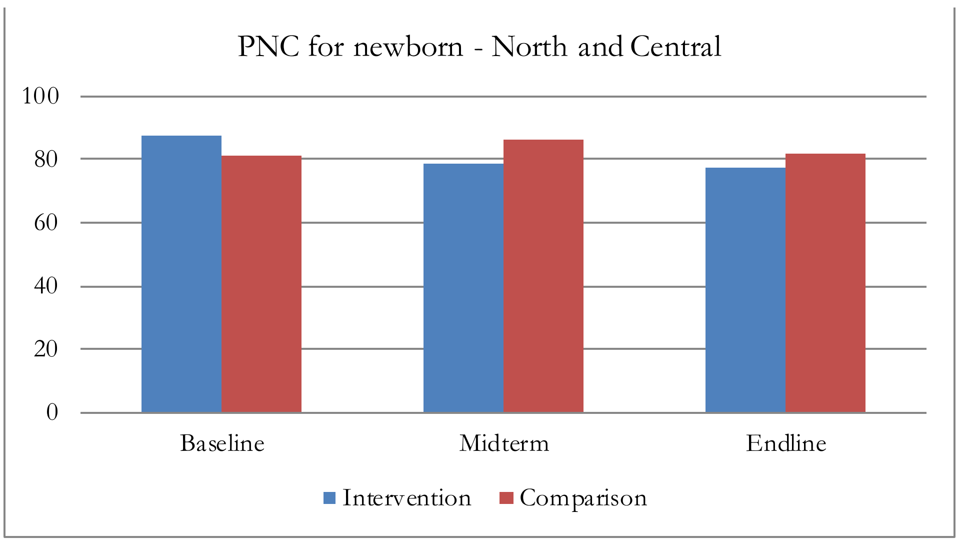
Table 4.1 Baseline characteristics for women with a birth in the last year

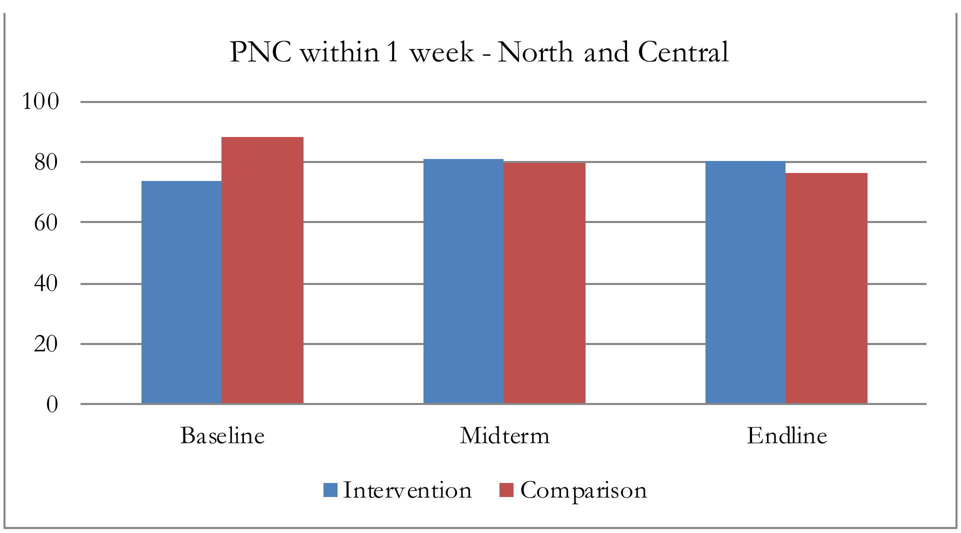
Variables	Total	Intervention	Comparison	*p-value*
Region				
North	48.8	55.3	44.7	0.067
Central	51.2	44.8	55.2	
Age of mother				
14-19	10.7	11.2	10.3	0.034
20-24	26.9	26.0	27.9	
25-29	20.6	23.2	18.0	
30-34	22.2	22.8	21.6	
35-50	19.5	16.8	22.3	
Parity				
1	22.9	21.8	24.0	0.009
2-3	30.5	35.1	25.8	
4-5	25.9	24.9	26.9	
6+	20.8	18.3	23.3	
Education of mother				
None	47.4	40.7	54.1	0.000
Preschool/primary	20.6	16.8	24.4	
Middle	26.6	34.4	18.7	
Secondary+	5.5	8.1	2.8	
Married/cohabiting				
Yes	87.2	86.0	88.3	0.074
No	12.9	14.0	11.7	
Employed				
Yes	46.8	47.7	45.9	0.557
No	53.2	52.3	54.1	
Religion				
Christian	58.3	62.1	54.4	0.389
Muslim	22.9	14.7	31.1	
Traditional/none	18.8	23.2	14.5	
Household wealth status				
Poor	43.3	27.0	40.3	0.000
Non-poor	56.7	73.0	59.7	
Regular access to media				
Yes	27.6	30.9	24.4	0.104
No	72.4	69.1	75.6	
Use of ANC				
Yes	96.1	96.5	95.4	0.408
No	3.9	3.5	4.6	
Skilled birth attendance				

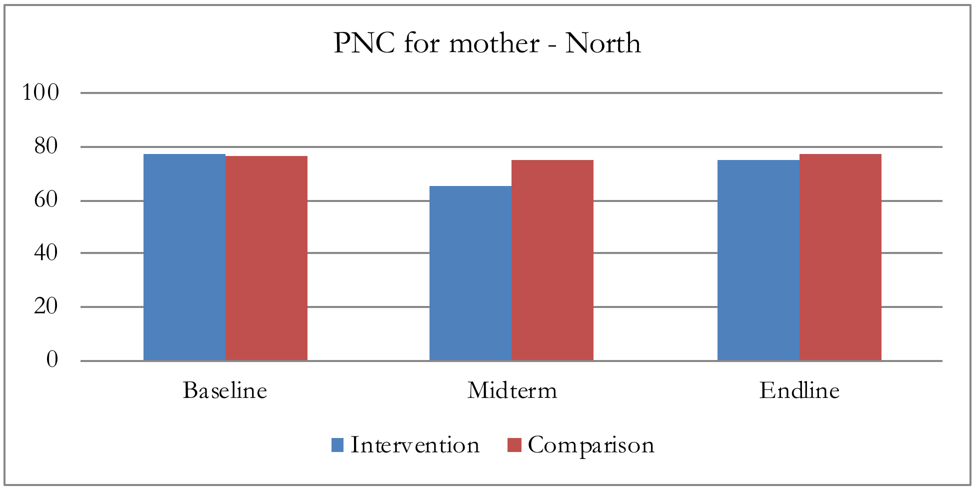
Yes	56.0	60.4	49.8	0.000
No	44.0	39.7	50.2	
Complications during labor or delivery				
Yes	13.8	18.3	13.1	0.688
No	86.2	81.8	86.9	
N	568	285	283	

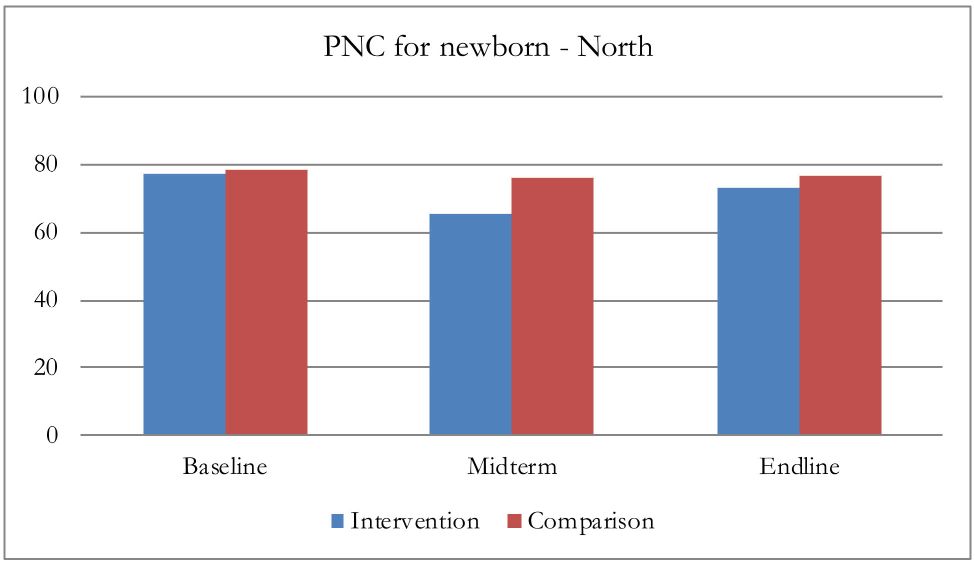
Figure 4.1 PNC indicators by survey round and region

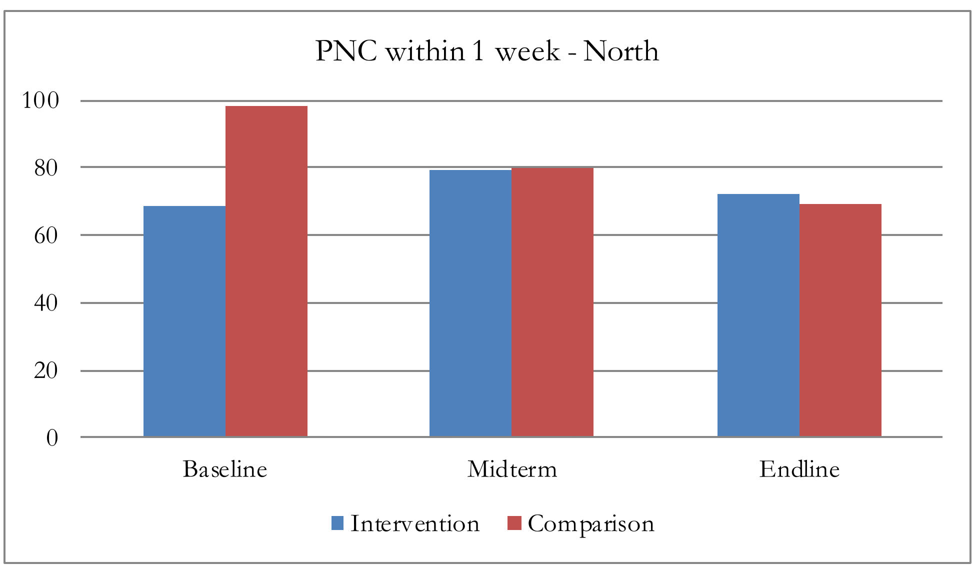


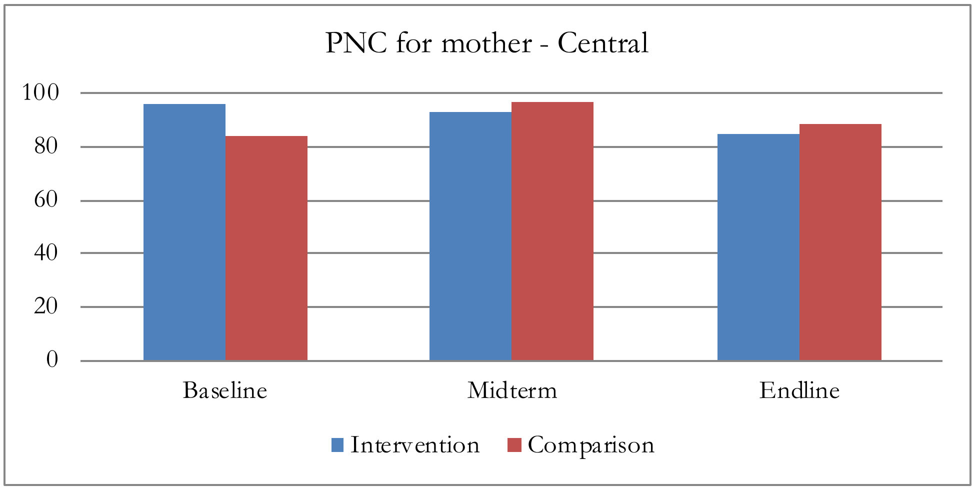


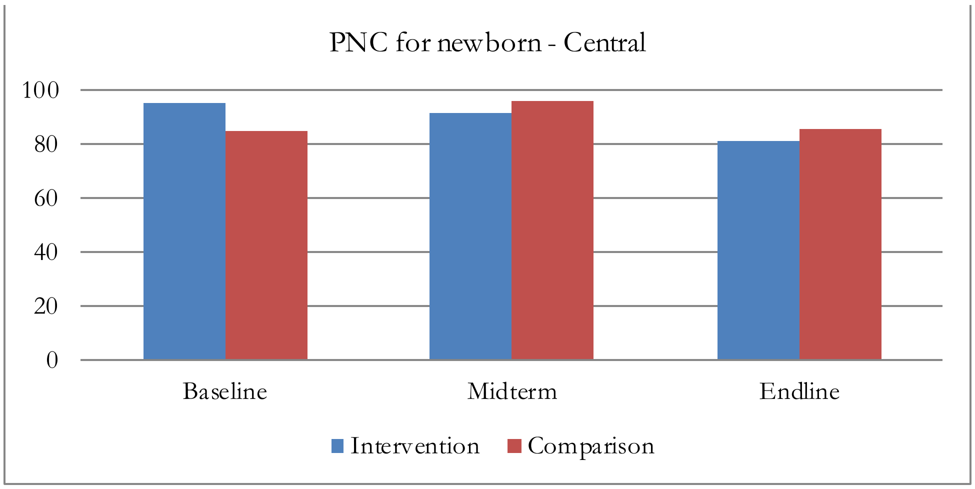



PNC for mother - North
100
80
60
40
20
0
Baseline
Midterm
Endline
Intervention
Comparison


PNC for newborn - North
100
80
60
40
20
0
Baseline
Midterm
Endline
Intervention
Comparison


PNC within 1 week - North
100
80
60
40
20
0
Baseline
Midterm
Endline
Intervention
Comparison


PNC for mother - Central
100
80
60
40
20
0
Baseline
Midterm
Endline
Intervention
Comparison


PNC for newborn - Central
100
80
60
40
20
0
Baseline
Midterm
Endline
Intervention
Comparison

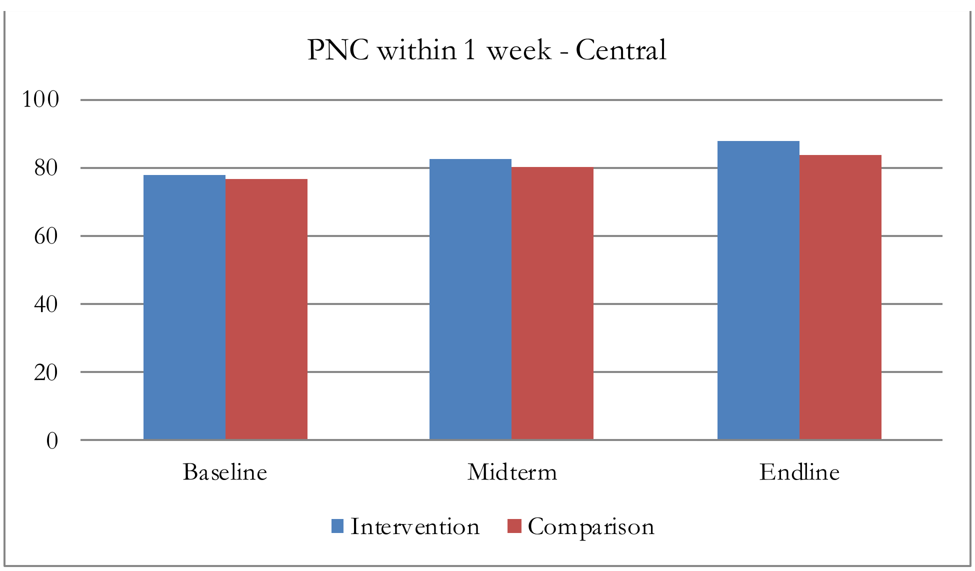

PNC within 1 week - Central
100
80
60
40
20
0
Baseline
Midterm
Endline
Intervention
Comparison

Table 4.2 PNC content at endline, Central region

Variables	Intervention	Comparison
PNC Content: signal functions	n=186	n=136
Cord examined	70.4	65.4
Temperature of newborn assessed	67.2	62.5
Weight of newborn assessed	75.3	71.3
Mother counseled on danger signs for newborn	45.7	41.9
Mother counseled on breastfeeding and observed	74.2	71.3

Table 4.3. Association of the MNH program with PNC over the short term (wave 1 to wave 2)

	PNC for mother				PNC for newborn			
Variable	Coeff.	*p-value*	95% CI		Coeff.	*p-value*	95% CI	
Area								
Intervention	0.0439	0.145	-0.015	0.103	0.030	0.337	-0.031	0.090
Comparison	-	-	-	-	-	-	-	-
Time								
Baseline	-	-	-	-	-	-	-	-
Midterm	0.0424	0.232	-0.028	0.112	0.037	0.296	-0.033	0.108
Interaction between time and area								
Intervention and Midterm	-0.1293	0.006	-0.220	-0.04	-0.125	0.009	-0.218	-0.032
Comparison and baseline	-	-	-	-	-	-	-	-
Region								
North	-0.1003	0.002	-0.162	-0.04	-0.085	0.009	-0.148	-0.021
Central	-	-	-	-	-	-	-	-
Age of mother								
14-19	-	-	-	-	-	-	-	-
20-24	-0.0089	0.818	-0.085	0.067	0.003	0.935	-0.072	0.079
25-29	-0.0124	0.784	-0.102	0.077	-0.011	0.803	-0.102	0.079
30-34	-0.0266	0.607	-0.129	0.075	-0.013	0.800	-0.116	0.090
35-50	0.0024	0.964	-0.103	0.107	0.021	0.682	-0.081	0.124
Parity								
1	-	-	-	-	-	-	-	-
2-3	-0.0145	0.612	-0.071	0.042	-0.008	0.785	-0.067	0.051
4-5	-0.0196	0.644	-0.104	0.064	-0.009	0.832	-0.092	0.074
6+	0.0066	0.893	-0.090	0.104	0.003	0.954	-0.096	0.101
Education of mother								
None	-	-	-	-	-	-	-	-
Preschool/primary	-0.0436	0.188	-0.109	0.022	-0.022	0.512	-0.088	0.044
Middle school	-0.0173	0.567	-0.077	0.042	0.015	0.601	-0.041	0.071
Secondary +	0.0197	0.55	-0.045	0.085	0.019	0.576	-0.048	0.085
Married/cohabiting								
Yes	-0.0244	0.452	-0.088	0.04	-0.022	0.539	-0.094	0.049
No	-	-	-	-	-	-	-	-
Access to media								
Yes	0.0370	0.061	-0.002	0.076	0.023	0.255	-0.017	0.062
No	-	-	-	-	-	-	-	-
Household wealth status								
Rich	-0.0135	0.578	-0.061	0.034	-0.021	0.401	-0.069	0.028
Non-rich	-	-	-	-	-	-	-	-
Use of ANC								
Yes	-0.0238	0.665	-0.132	0.085	-0.011	0.844	-0.124	0.102
No	-	-	-	-	-	-	-	-

Skilled birth attendance								
Yes	-0.3090	0.000	-0.366	-0.25	-0.298	0.000	-0.357	-0.240
No	-	-	-	-	-	-	-	-
Complications during labor or delivery-mother								
Yes	-0.1559	0.453	-0.566	0.254	-	-	-	-
No	-	-	-	-	-	-	-	-
Complications during labor or delivery-newborn								
Yes	-	-	-	-	-0.037	0.539	-0.158	0.083
No	-	-	-	-	-	-	-	-
N		1115					1111	

Table 4.3 Association of the MNH program with PNC over the short term (wave 1 to wave 2) (continued)

	PNC within 1 week			
Variable	Coeff.	*p-value*	95% CI	
Area				
Intervention	-0.173	0.000	-0.238	-0.108
Comparison	-	-	-	-
Time				
Baseline	-	-	-	-
Midterm	-0.111	0.001	-0.175	-0.047
Interaction between				
Intervention and	0.170	0.000	0.080	0.260
Comparison and	-	-	-	-
Region				
North	0.118	0.001	0.051	0.186
Central	-	-	-	-
Age of mother				
14-19	-	-	-	-
20-24	0.053	0.236	-0.034	0.140
25-29	0.047	0.345	-0.051	0.145
30-34	0.060	0.272	-0.047	0.167
35-50	0.036	0.555	-0.084	0.156
Parity				
1	-	-	-	-
2-3	-0.064	0.064	-0.132	0.004
4-5	-0.092	0.037	-0.179	-0.006
6+	-0.086	0.100	-0.188	0.016
Education of mother				
None	-	-	-	-
Preschool/ primary	0.040	0.293	-0.035	0.115
Middle school	0.020	0.609	-0.058	0.099
Secondary +	0.022	0.701	-0.089	0.132
Married/cohabiting				
Yes	-0.001	0.971	-0.078	0.075
No	-	-	-	-
Access to media				
Yes	0.056	0.040	0.003	0.110
No	-	-	-	-
Household wealth status				
Rich	0.038	0.145	-0.013	0.089
Non-rich	-	-	-	-
Use of ANC				
Yes	0.284	0.000	0.158	0.411
No	-	-	-	-
Skilled birth attendance				
Yes	-0.147	0.000	-0.197	-0.098
No	-	-	-	-
Complications during labor or delivery-mother				

Yes	0.003	0.921	-0.061	0.068
No	-	-	-	-
Complications during labor or delivery-newborn				
Yes	0.079	0.241	-0.053	0.212
No	-	-	-	-
N		1124		

Table 4.4 Association of the MNH program with PNC over the long term (wave 1 to wave 3)

Variable	PNC for mother				PNC for newborn			
	Coeff.	*p-value*	95% CI		Coeff.	*p-value*	95% CI	
Area								
Intervention	0.040	0.169	-0.017	0.098	0.027	0.372	-0.032	0.086
Comparison	-	-	-	-	-	-	-	-
Time								
Baseline	-	-	-	-	-	-	-	-
Midterm	0.044	0.137	-0.014	0.101	0.038	0.200	-0.020	0.097
Endline	0.015	0.595	-0.042	0.072	-0.007	0.825	-0.065	0.052
Interaction between time and area								
Intervention and Endline	-0.099	0.017	-0.180	-0.017	-0.100	0.019	-0.183	-0.017
Intervention and Midterm	-0.127	0.002	-0.207	-0.046	-0.126	0.003	-0.208	-0.044
Comparison and baseline	-	-	-	-	-	-	-	-
Region								
North	-0.043	0.099	-0.093	0.008	-0.028	0.286	-0.080	0.024
Central	-	-	-	-	-	-	-	-
Age of mother								
14-19	-	-	-	-	-	-	-	-
20-24	-0.030	0.374	-0.095	0.036	-0.012	0.716	-0.079	0.054
25-29	-0.041	0.270	-0.113	0.031	-0.032	0.401	-0.106	0.042
30-34	-0.060	0.141	-0.140	0.020	-0.041	0.325	-0.123	0.041
35-50	-0.021	0.639	-0.110	0.067	-0.005	0.911	-0.096	0.086
Parity								
1	-	-	-	-	-	-	-	-
2-3	-0.007	0.785	-0.057	0.043	-0.004	0.883	-0.055	0.047
4-5	0.012	0.715	-0.053	0.077	0.013	0.710	-0.054	0.079
6+	0.012	0.749	-0.064	0.089	0.015	0.710	-0.063	0.093
Education of mother								
None	-	-	-	-	-	-	-	-
Preschool/primary	-0.019	0.479	-0.073	0.034	0.002	0.949	-0.053	0.057
Middle school	0.006	0.843	-0.051	0.063	0.028	0.355	-0.031	0.086
Secondary +	0.031	0.448	-0.050	0.113	0.042	0.318	-0.041	0.126
Married/cohabiting								
Yes	0.003	0.929	-0.053	0.058	-0.001	0.984	-0.057	0.056
No	-	-	-	-	-	-	-	-
Access to media								
Yes	0.039	0.052	0.000	0.078	0.027	0.183	-0.013	0.067
No	-	-	-	-	-	-	-	-
Household wealth status								
Rich	0.013	0.523	-0.026	0.051	0.009	0.642	-0.030	0.049
Non-rich	-	-	-	-	-	-	-	-

Use of ANC								
Yes	-0.050	0.320	-0.150	0.049	-0.064	0.225	-0.168	0.040
No	-	-	-	-	-	-	-	-
Skilled birth attendance								
Yes	-0.302	0.000	-0.339	- 0.265	-0.295	0.000	-0.333	- 0.257
No	-	-	-	-	-	-	-	-
Complications during labor or delivery- mother								
Yes	0.003	0.909	-0.042	0.047	-	-	-	-
No	-	-	-	-	-	-	-	-
Complications after delivery- newborn								
Yes	-	-	-	-	-0.096	0.026	-0.181	- 0.012
No	-	-	-	-	-	-	-	-
N		1647				1644		

Table 4.4 Association of the MNH program with PNC over the long term (wave 1 to wave 3) (continued)

	PNC within 1 week			
Variable	Coeff	*p-value*	95% CI	
Area				
Intervention	-	0.000	-	-
Comparison	-	-	-	-
Time				
Baseline	-	-	-	-
Midterm	-	0.001	-	-
Endline	-	0.000	-	-
Interaction between time and area				
Intervention and Endline	0.187	0.000	0.095	0.279
Intervention and Midterm	0.171	0.000	0.079	0.262
Comparison and baseline	-	-	-	-
Region				
North	0.050	0.091	-	0.107
Central	-	-	-	-
Age of mother				
14-19	-	-	-	-
20-24	0.022	0.550	-	0.096
25-29	0.031	0.453	-	0.113
30-34	0.033	0.480	-	0.123
35-50	0.040	0.431	-	0.141
Parity				
1	-	-	-	-
2-3	-	0.119	-	0.012
4-5	-	0.286	-	0.033
6+	-	0.056	-	0.002
Education of mother				
None	-	-	-	-
Preschool/primary	0.022	0.469	-	0.083
Middle school	0.001	0.965	-	0.066
Secondary +	0.047	0.323	-	0.139
Married/cohabiting				
Yes	0.011	0.732	-	0.074
No	-	-	-	-
Access to media				
Yes	0.035	0.121	-	0.080
No	-	-	-	-
Household wealth status				
Rich	0.030	0.178	-	0.074
Non-rich	-	-	-	-
Use of ANC				
Yes	0.257	0.000	0.144	0.371
No	-	-	-	-
Skilled birth attendance				
Yes	-	0.000	-	-
No	-	-	-	-
Complications during labor or delivery- mother				
Yes	0.028	0.276	-	0.079
No	-	-	-	-

Complications after delivery-newborn				
Yes	0.028	0.556	-	0.123
No	-	-	-	-
N		1658		

Table 4.5 Association of the MNR program with content of PNC, Central region, endline data

Variable	Cord examined				Temperature of newborn assessed				Weight of newborn assessed			
	OR	p-value	95% CI		OR	p-value	95% CI		OR	p-value	95% CI	
Area												
Intervention	1.19	0.537	0.68	2.08	1.11	0.694	0.64	1.94	1.20	0.594	0.60	2.41
Comparison	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Age of mother												
14-19	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
20-24	1.05	0.918	0.37	2.97	0.47	0.221	0.13	1.63	0.65	0.52	0.16	2.55
25-29	0.68	0.473	0.23	2.01	0.68	0.567	0.17	2.70	1.03	0.95	0.35	3.00
30-34	0.68	0.533	0.20	2.38	0.40	0.196	0.10	1.65	0.48	0.28	0.12	1.85
35-50	0.91	0.895	0.23	3.62	0.68	0.601	0.16	3.00	0.36	0.10	0.10	1.24
Parity												
1	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
2-3	1.65	0.168	0.80	3.39	1.87	0.136	0.81	4.34	1.59	0.18	0.80	3.16
4-5	1.56	0.407	0.52	4.67	1.81	0.252	0.64	5.12	1.65	0.37	0.53	5.16
6+	2.31	0.125	0.78	6.81	1.47	0.480	0.48	4.48	1.74	0.27	0.64	4.74
Education of mother												
None	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Preschool/primary	0.98	0.970	0.35	2.72	1.07	0.895	0.38	3.03	0.84	0.72	0.33	2.16
Middle	1.46	0.425	0.56	3.86	1.28	0.599	0.50	3.29	1.25	0.62	0.50	3.09
Secondary+	1.57	0.516	0.38	6.40	3.25	0.078	0.87	12.13	-	-	-	-
Married/cohabiting												
Yes	1.48	0.111	0.91	2.40	2.00	0.024	1.10	3.61	1.56	0.19	0.79	3.08
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Employed												
Yes	0.82	0.386	0.52	1.30	0.94	0.784	0.57	1.54	1.58	0.17	0.81	3.11
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Religion												
Christian	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Muslim	0.96	0.935	0.37	2.48	1.83	0.310	0.55	6.10	0.95	0.93	0.30	3.04
Traditional/none	1.16	0.787	0.37	3.65	0.86	0.780	0.29	2.55	1.15	0.84	0.29	4.58
Access to media												
Yes	2.20	0.006	1.28	3.79	1.22	0.366	0.78	1.92	1.73	0.04	1.02	2.94
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Household wealth status												
Rich	0.67	0.379	0.27	1.68	0.44	0.087	0.17	1.14	0.43	0.08	0.17	1.10
Non-rich	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Use of ANC												
Yes	0.60	0.551	0.10	3.46	0.81	0.773	0.19	3.47	0.70	0.68	0.12	4.12
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Skilled birth attendance												
Yes	4.43	0.001	1.88	10.45	3.71	0.001	1.76	7.85	5.79	0.00	2.88	11.65

No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
Complications after delivery- newborn												
Yes	0.55	0.258	0.19	1.60	0.82	0.735	0.25	2.67	1.01	0.99	0.30	3.43
No	1.00	-	-	-	1.00	-	-	-	1.00	-	-	-
N						322						

Table 4.5 Association of the MNR program with content of PNC, Central region, endline data (continued)

	Mother counseled on danger signs for newborn				Mother counseled on breastfeeding and observed			
Variable	OR	p-value	95% CI		OR	p-value	95% CI	
Area								
Intervention	1.20	0.516	0.68	2.10	1.17	0.585	0.65	2.10
Comparison	1.00	-	-	-	1.00	-	-	-
Age of mother								
14-19	1.00	-	-	-	1.00	-	-	-
20-24	1.50	0.340	0.64	3.54	0.71	0.579	0.20	2.53
25-29	1.33	0.580	0.46	3.84	0.59	0.435	0.15	2.30
30-34	1.98	0.332	0.48	8.22	0.30	0.128	0.06	1.45
35-50	2.32	0.149	0.72	7.41	0.37	0.122	0.10	1.33
Parity								
1	1.00	-	-	-	1.00	-	-	-
2-3	1.15	0.702	0.55	2.42	1.30	0.598	0.47	3.62
4-5	1.60	0.436	0.47	5.46	3.28	0.118	0.73	14.83
6+	1.54	0.502	0.42	5.73	2.95	0.083	0.86	10.16
Education of mother								
None	1.00	-	-	-	1.00	-	-	-
Preschool/primary	0.93	0.847	0.43	2.03	1.47	0.465	0.51	4.28
Middle	0.98	0.968	0.41	2.36	1.66	0.428	0.45	6.11
Secondary+	0.92	0.864	0.33	2.57	2.69	0.209	0.56	12.98
Married/cohabiting								
Yes	0.80	0.350	0.49	1.30	1.40	0.306	0.72	2.73
No	1.00	-	-	-	1.00	-	-	-
Employed								
Yes	1.07	0.768	0.65	1.77	1.10	0.750	0.59	2.09
No	1.00	-	-	-	1.00	-	-	-
Religion								
Christian	1.00	-	-	-	1.00	-	-	-
Muslim	1.11	0.839	0.39	3.11	0.72	0.558	0.23	2.26
Traditional/none	0.39	0.232	0.08	1.89	0.52	0.313	0.14	1.92
Access to media								
Yes	1.45	0.086	0.95	2.22	1.77	0.039	1.03	3.03
No	1.00	-	-	-	1.00	-	-	-
Household wealth status								
Rich	0.79	0.459	0.42	1.50	0.24	0.010	0.08	0.69
Non-rich	1.00	-	-	-	1.00	-	-	-
Use of ANC								
Yes	0.82	0.740	0.24	2.81	1.05	0.950	0.25	4.43
No	1.00	-	-	-	1.00	-	-	-
Skilled birth attendance								
Yes	2.34	0.024	1.13	4.87	5.61	0.000	2.75	11.44

No	1.00	-	-	-	1.00	-	-	-
Complications after								
Yes	0.78	0.550	0.33	1.81	0.73	0.576	0.24	2.25
No	1.00	-	-	-	1.00	-	-	-
N					322			

REFERENCES

1. UNICEF, WHO, UNPD, World Bank. Child mortality estimates: CME info. http://www.childmortality.org/index.php?r=site/map. Updated 2013. Accessed 10, 2013.

2. UNICEF. Malnutrition: Nutritional status. http://www.childinfo.org/malnutrition_nutritional_status.php. Updated 2013. Accessed 10, 2013.

3. Ghana Statistical Service. Ghana Multiple Indicator Cluster Survey with an enhanced malaria module and biomarker. 2012.

4. Ministry of Health Ghana. National reproductive health service protocols. 1999.

5. U.S. Department of Health and Human Services. Closing the quality gap series: Quality improvement interventions to address health disparities. http://effectivehealthcare.ahrq.gov/index.cfm/search-for-guides-reviews-and-reports/?productid=983&pageaction=displayproduct. Updated 2012.

6. Dohlie MB, Mielke E, Mumba FK, Wambwa GE, Rukonge A, Mongo W. Using practical quality improvement approaches and tools in reproductive health services in East Africa. *Jt Comm J Qual Improv*. 1999;25(11):574-587.

7. Nolan T, Angos P, Cunha AJ, et al. Quality of hospital care for seriously ill children in less-developed countries. *The Lancet*. 2001;357(9250):106-110.

8. du Mortier S, Arpagaus M. Quality improvement programme on the frontline: An international committee of the Red Cross experience in the Democratic Republic of Congo. *Int J Qual Health Care*. 2005;17(4):293-300. doi: mzi042 [pii].

9. Heiby J. The use of modern quality improvement approaches to strengthen African health systems: A 5-year agenda. *Int J Qual Health Care*. 2014;26(2):117-123. doi: 10.1093/intqhc/mzt093 [doi].

10. Carlo WA, Goudar SS, Jehan I, et al. Newborn-care training and perinatal mortality in developing countries. *N Engl J Med*. 2010;362(7):614-623.

11. Bosch-Capblanch X, Garner P. Primary health care supervision in developing countries. *Tropical medicine & international health*. 2008;13(3):369-383.

12. Rowe AK, Onikpo F, Lama M, Deming MS. The rise and fall of supervision in a project designed to strengthen supervision of integrated management of childhood illness in Benin. *Health Policy Plan*. 2010;25(2):125-134. doi: 10.1093/heapol/czp054 [doi].

13. Oxman AD, Thomson MA, Davis DA, Haynes RB. No magic bullets: A systematic review of 102 trials of interventions to improve professional practice. *CMAJ*. 1995;153(10):1423-1431.

14. Siddiqi K, Newell J, Robinson M. Getting evidence into practice: What works in developing countries? *Int J Qual Health Care*. 2005;17(5):447-454. doi: mzi051 [pii].

15. Franco LM, Marquez L. Effectiveness of collaborative improvement: Evidence from 27 applications in 12 less-developed and middle-income countries. *BMJ Qual Saf*. 2011;20(8):658-665. doi: 10.1136/bmjqs.2010.044388 [doi].

16. Twum-Danso NA, Dasoberi IN, Amenga-Etego IA, et al. Using quality improvement methods to test and scale up a new national policy on early post-natal care in Ghana. *Health Policy Plan*. 2013. doi: czt048 [pii].

17. Singh K, Speizer I, Handa S, et al. Impact evaluation of a quality improvement intervention on maternal and child health outcomes in northern Ghana: Early assessment of a national scale-up project. *Int J Qual Health Care*. 2013;25(5):477-487. doi: 10.1093/intqhc/mzt054 [doi].

18. The University of North Carolina at Chapel Hill and the University of Ghana. Midline assessment of the maternal and newborn referrals project. . 2014.

19. Moran AC, Kerber K, Sitrin D, et al. Measuring coverage in MNCH: Indicators for global tracking of newborn care. *PLoS medicine*. 2013;10(5):e1001415.

20. National Population Commission (NPC) [Nigeria] and ICF International. Nigeria demographic and health survey 2013. 2014.

21. United Nations Department of Economic and Social Affairs. Open working group proposal for sustainable development goals. https://sustainabledevelopment.un.org/focussdgs.html. Updated 2015.

22. United Nations. Goal 3: Ensure healthy lives and promote well-being for all at all ages. http://www.un.org/sustainabledevelopment/health/. Updated 2015.

23. Althabe F, Bergel E, Cafferata ML, et al. Strategies for improving the quality of health care in maternal and child health in low-and middle-income countries: An overview of systematic reviews. *Paediatr Perinat Epidemiol*. 2008;22(s1):42-60.

24. University of North Carolina at Chapel Hill & the Institute for Statistical, Social and Economic Research at the University of Ghana. Project fives alive! MNH referral change package. . 2015.

25. University of North Carolina at Chapel Hill & the Institute for Statistical, Social and Economic Research at the University of Ghana. Qualitative evaluation of the maternal and newborn referral project in ghana. A qualitative report based on interviews with quality improvement teams, couples with recent pregnancy experiences, and mothers-in-law. . 2015.

26. World Health Organization. *WHO recommendations on postnatal care of the mother and newborn*. World Health Organization; 2014.

CHAPTER 5: CONCLUSIONS

The WHO and UNICEF recommends that countries promote and implement PNC to improve newborn survival and feeding practices. This recommendation was initially in part due to support the now expired MDGs (specifically MDG 4). However, the recommendation continues to be a key strategy as it has direct programmatic and policy implications for the newly adopted Sustainable Development Goals (SDGs). SDG 3, for example, will aim to end preventable newborn and under-five deaths[1], for which PNC can be used as a strategy. The evidence base on the effectiveness of PNC in improving the survival and health of newborns is lacking[2]. This dissertation aims to improve the evidence base regarding PNC, its association with neonatal mortality and feeding practices. This dissertation also evaluates how a specific QI strategy can be used to improve PNC coverage, and finally, measures the content of PNC using household survey data.

Unique to this study is that we have included a large number of countries into the analysis of the association of PNC with neonatal mortality and feeding practices. Further, we examine how a promising approach, QI interventions, can be used in the field to promote and improve PNC coverage. Finally, this is one of the first studies to measure and present details on the content of PNC.

PROGRAMATIC IMPLICATIONS

Our results indicate that coverage of PNC is low across all countries and in some countries, much lower than skilled attendance at delivery. This indicates a point of entry to improve the continuum of care that is routinely used to develop programs and policies in the maternal and child health field.

The findings of chapter 2 imply that PNC is an important intervention that can be used to reduce neonatal deaths in sub-Saharan African countries. Therefore, expanded and continued implementation is recommended. However, the analysis also points out coverage gaps in PNC. Newborns from wealthier households are more likely prone to receiving PNC compared with newborns in poorer households. Realignment of policies and programs need to address inequalities in coverage.

Chapter 3 shows that PNC is associated with early initiation of breastfeeding (within 1 day) but not with prelacteal feeds (PLFs) (non-breast milk feeds within 3 days) and suggests that PNC when delivered through customary care (as opposed to intervention and trial conditions) can be an effective strategy to improve early breastfeeding of newborns. A lack of association of PNC with PLFs indicates the need to improve clinical guidance and practice to ensure that providers of PNC can move beyond the promotion of early initiation of breastfeeding towards further emphasis on avoiding PLFs, which by definition, supports improves exclusive breastfeeding. Our results also indicate that trained and untrained providers of PNC are associated with improved odds of early breastfeeding. Continuing to use both provider types for improving PNC coverage can be a cost-effective strategy for the developing countries in the analysis. However, neither provider type was associated with prelacteal feed reductions which imply that further work is needed to improve service delivery through both types of providers.

Chapter 4 shows that the MNR, a QI intervention, has little effect on improving immediate PNC coverage for mothers and newborns. Due to this, further understanding and research is needed to elucidate the reasons for such a finding and later, to examine if indeed other programmatic approaches can be used to improve PNC coverage for newborns. Further, since the MNR did not explicitly try to improve PNC, other evaluations of PNC-specific programs should be evaluated to understand how QI programs work to improve these outcomes. Finally, future evaluations should attempt to understand the isolated effect of facility-only approaches. This was not possible with the MNR as all districts had an intervention.

METHODOLOGICAL IMPLICATIONS

Chapter 2 is limited by the number of common covariates that are available from the DHS and MICS datasets. These surveys, though they are used in research, are not research tools. Instead, their main function is to support monitoring of key indicators at the country level. However, additional contextual variables on the pregnancy and birth should be included in these surveys to provide important information for research purposes as well as the provision of indicators for improving health programs.

One of the central issues in this dissertation is the difference in the levels of PNC in DHS surveys and MICS surveys. The DHS asks women about a "check" on their health as a means to measure PNC. Further work on elucidating what women identify as a "check" should be done. The MICS surveys use a different method of identifying PNC where more probing and detailed information is requested from respondents. In the case of the Ghana 2011 MICS and Zimbabwe 2014 MICS, levels of skilled birth attendance and PNC are similar which is expected, while the corresponding levels in DHS surveys are quite different. This may indicate that MICS data may be more appropriate to study PNC and that different questionnaire techniques may be causing these differences rather than differences in the actual levels of PNC coverage. Further examination on the quality of data from both surveys is warranted.

Chapter 4 provides novel data on the content of PNC. Five signal functions are examined in the study. Results indicate low levels of non-response and variability across different domains. Taken together, these are preliminary indications of good data quality. However, further work such as cognitive testing can be done to ascertain if indeed respondents understand the concepts and questions as they are intended. Additionally, many of the variables used to predict the signal functions were not significant except for skilled delivery. This may imply that studying these signal functions necessitates the inclusion of other variables that capture delivery and post-delivery characteristics such as provider type, place of service and timing of these services.

STUDY LIMITATIONS

In this dissertation, there are a number of limitations. The data used are cross-sectional in nature and examine associations between the outcome and main variables, PNC, and do not examine causal associations. A number of known covariates were not present in the datasets and as such, we were not able to control for these. For example, low birth weight is correlated with neonatal mortality though these data are not available for all newborns. The multi-level models increase the power for the analysis in the first two chapters. However, the results are at the aggregate level and cannot be generalized to the country-level. Further, early initiation of breastfeeding is usually measured by breastfeeding within one hour of birth. However, we were not able to examine this due to having very low levels of PNC within one hour. As levels of PNC rise in these countries, such analysis can be done. Dealing with sample sizes and weights is a challenge in chapters 2 and 3. Sample sizes are around 5000 women though Nigeria is more than twice this which means Nigeria may unduly influence the outcome of the models. DHS recommends to use de-normalized sample weights in multi-level models though data to do this are not publicly available. In chapter 3, the data do not indicate any information on the content of PNC. This is important as women who are counselled on breastfeeding and those who did not receive this kind of care are treated identically in the analysis. This can therefore be a source of bias in the models produced. Further, the DHS data used ask women about a ‘check’ on their health following birth. It is possible that women may not understand the term 'check' and also, may not comprehend when the birthing process ends, both of which may create a bias in responses.

In the fourth chapter, the evaluation could not examine causal linkages between the program and the outcomes. Trials, which randomize the intervention, are useful in this regard though not always feasible nor desirable in real world settings. While we are able to provide data on the signal functions of PNC, we can do so only for the Central region where the data were available at the time of analysis. This reduced the sample sizes for analysis and may imply that this part of the study is not sufficiently powered to detect statistically significant differences. Finally, results for the MNR program and outcomes may be diluted as the community approach used in the intervention areas was also used in the comparison areas to some extent, though this was not intended by the program. We are therefore unable to calculate the exact differences in outcomes due to the two approaches.

CONCLUDING REMARKS

This dissertation collectively shows the potential of PNC as a means to improve the survival and feeding practices of newborns in a large number of countries in sub-Saharan Africa. More nuanced analyses of this type are needed to further understand if the overall patterns seen in the aggregate exist at the individual country-level. Further, as PNC is being implemented in home visits, more research is needed to understand if these recommendations are being implemented and if they have any effect on key outcomes for newborns.

This dissertation has gone further to examine how PNC can be implemented programmatically through a QI intervention. The findings support the QI approach for improving PNC for the mother. The results also support the continued need to understand how programs function and to build the evidence-base around the PNC implementation as a means to improve future programming efforts.

REFERENCES

1. United Nations. Goal 3: Ensure healthy lives and promote well-being for all at all ages. http://www.un.org/sustainabledevelopment/health/. Updated 2015.

2. World Health Organization. *WHO recommendations on postnatal care of the mother and newborn.* World Health Organization; 2014.