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Faculty of Health Sciences

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(MPhil. MCH)**

**IMPROVING UTILISATION OF MATERNAL HEALTH RELATED SERVICES: THE
IMPACT OF A COMMUNITY HEALTH WORKER PILOT PROGRAMME IN NENO
MALAWI**

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DEDICATION

For Sofia and Ruth

You have brought a lot of happiness to me

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ABBREVIATIONS

ANC	Antenatal Care
CHWs	Community Health Workers
CI	Confidence Interval
CPR	Contraceptive Prevalence Rate
CrI	Credible Interval
DHIS	District Health Information System
EmOC	Emergency Obstetric Care
FP	Family Planning
HMHC	Healthy Mothers, Healthy Communities
HSSP	Health Sector Strategic Planning
LMICs	Low- and Middle-Income Countries
MDGs	Millennium Development Goals
MDHS	Malawi Demographic and Health Survey
MMR	Maternal Mortality Ratio
MoH	Ministry of Health
PIH	Partners In Health
PNC	Postnatal Care
PP	Percentage Point
RR	Relative Risk
SDG	Sustainable Development Goal
SRHR	Sexual and Reproductive Health and Rights

SSA	sub-Saharan Africa
TFR	Total Fertility Rate
UHC	Universal Health Coverage
WCBA	Women of Child Bearing Age
WHO	World Health Organisation

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DEFINITIONS

Women of child bearing age (WCBA): Women in reproductive age group from 15 to 49 years.

Community health workers (CHWs): ‘Members of the communities where they work, selected by the communities, answerable to the communities for their activities, supported by the health system but not necessarily a part of its organisation, and are trained shorter than professional workers’ (World Health Organisation (WHO), 2008,p.2).

Emergency Obstetric Care (EmOC): A set of indicators that should be available in a facility to ensure management of the most common direct obstetric complication possible. This list of indicators attempts to address equity and universal accessibility of emergency obstetric services (WHO, 2009).

Maternal death: ‘The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes’(WHO, 2011,p 156). Maternal death and maternal mortality is used synonymously.

Maternal Mortality Ratio (MMR): All maternal deaths per 100,000 live births (WHO, 2010) .

Maternal health services: Broad term that encompasses all sexual and reproductive health services including perinatal health (WHO,2018).

Perinatal services: The care given to women from conception, antenatal care, intrapartum care, and postnatal care to 42 days after giving birth (WHO,2018).

Antenatal care (ANC): Planned programme of education and intervention during pregnancy to ensure safe facility births. According to Malawian guidelines, all pregnant women must start ANC in the first trimester of pregnancy, and attend at least four or more ANC visits. Malawi's Ministry of Health has a defined package of care that should be provided at ANC clinics. The specific components of this package of care is beyond the scope of this thesis (Republic of Malawi, 2012).

Facility based Births: The number of pregnant women who gives births within a facility and excludes all women who give birth at home or on the way to the facility. According to Malawi's Ministry of Health, all women must give birth within the health facility. (Republic of Malawi, 2012).

Skilled facility births: The number of women who are assisted to give birth by qualified health personnel like doctors, midwives, nurses and mid-level health care workers. Qualified personnel are able to diagnose, manage and/or refer obstetric complications (WHO, 2001).

Postnatal care: All planned care given to mothers immediately after discharge from intrapartum care to 42 days after giving birth. Postnatal care and postpartum care are used synonymously (Republic of Malawi, 2012).

EXECUTIVE SUMMARY

Introduction: Malawi has one of the highest maternal mortality ratio (MMR) in sub-Saharan Africa (SSA). Despite investments in family planning and emergency obstetric care (EmOC), Malawi's Millennium Development Goal (MDG) target of reducing maternal deaths to 155 deaths per 100,000 live births was not met by the end of 2015. Between 2010 and 2015, Malawi was only able to reduce the MMR from 675 to 439 per 100,000 live births. Inadequate utilisation of perinatal services is the contributing factor to the MMR target not being achieved.

One approach for improving the utilisation of perinatal services is to invest in community health workers (CHWs). CHWs can be trained to: identify women of child bearing age (WCBA) who need perinatal services; provide community education; encourage timely referral of clients to the nearest health facility; and undertake community follow up for WCBA who are pregnant and/or have recently given birth. We evaluated changes in utilisation of antenatal care (ANC), facility based births, and postnatal care (PNC) after CHW deployment to conduct monthly home visits to WCBA for pregnancy identification and escorting women to ANC, labour and facility birth and PNC clinics in Neno district, Malawi. The CHW programme was implemented in two catchment areas from March 2015 to June 2016.

Methodology: We employed a retrospective quasi-experimental study design to evaluate the impact of CHWs on changes in the utilisation of ANC, facility based births, and PNC in Neno district, Malawi between March 2014 and June 2016 (pre-intervention period: March 2014 to February 2015, and post-intervention period: March 2015 to June 2016). Monthly outcomes were compared between a combined CHW intervention area and its synthetic control area using the synthetic control method. The synthetic control area (or synthetic counterfactual of the CHW)

was the control area that was created from multiple available control sites where the CHW programme was not implemented to allow the comparison of outcomes between the sites where CHWs were implemented and the sites where CHWs was not implemented.

Two hundred and eleven CHWs (128 existing CHWs plus 83 new CHWs from the community) were trained in maternal health and deployed to cover an estimated 5,132 WCBA living in a catchment area of about 20,530 people. The primary focus of the CHWs was to conduct monthly household visits to identify pregnant women, and then escort pregnant women to their initial and subsequent ANC appointments, facility births, and to PNC check-ups. As part of package of care, community mobilisation and improvements in services to achieve a minimum package of services at the local health centres were also added.

Using the synthetic control method, as developed by Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010) and a Bayesian approach of synthetic control developed by Brodersen (2015), a synthetic counterfactual of the CHW intervention was created based on six available public control facilities. The synthetic counterfactual trend was created to have similar pre-intervention characteristics as the CHW intervention trend. The impact of the CHW intervention was the difference between the CHW intervention site and its synthetic counterfactual

Results: CHWs in the intervention areas visited an average of 3,147 (range 3,036 – 3,218) of WCBA monthly, covering 61.0% of WCBA. During these visit 3.6% (97 women per month) of WCBA were suspected to be pregnant every month. Of those women suspected to be pregnant, 67.8% (66 women per month) were escorted to health facilities immediately every month. CHWs

visited an average of 254 pregnant women enrolled in ANC and 64 women in postpartum period monthly.

ANC and facility births utilisation in the CHW intervention site increased in comparison to the control site. Firstly, the number of new pregnant women enrolled in ANC per month increased by 18.0 % (95% Credible Interval (CrI) 8.0%, 28.0%), from 83 to 98 per pregnant women. Secondly, the proportion of women starting ANC in first trimester increased by 200.0% (95% CrI 162.0%, 234.0%), from 9.5% to 29.0% per month. Thirdly, the number of women attending four or more ANC visits increased by 37.0% (95% CrI 31.0%, 43.0%), from 28.0% to 39.0%. Lastly, the number of facility births increases by 20% (CrI 13.0%, 28.0%), from 85 women to 102 per month. However, there was no net difference on PNC visits between the CHW intervention site and its counterfactual unit (-37.0%, 95% CrI -224.0%, 170.0%).

Conclusions: CHW intervention significantly increased the utilisation of ANC and facility based births in Neno, Malawi. However, CHWs had no net difference on PNC utilisation.

CHAPTER 1: BACKGROUND AND INTRODUCTION

1.1 Background

Malawi had an estimated maternal mortality ratio (MMR) of 439 deaths per 100,000 live births in 2015 (National Statistical Office(NSO)[Malawi] and ICF, 2017). Among 46 countries in sub-Saharan Africa (SSA), Malawi was ranked as the country with the 25th worst MMR in 2013 (Kassebaum et al., 2014). Despite a decrease in the MMR from 675 in 2010 to 439 per 100,000 live births in 2015, Malawi fell short of its plan to reduce the MMR, in line with the Millennium Development Goal (MDG) MMR target of 75%, to 155 per 100,000 live births by 2015 (Ministry of Health, 2011; Malawi Government, 2017a). With the formation of the Sustainable Development Goals (SDGs) in 2015, the MMR global target has been reduced to 70 deaths per 100,000 live births by 2030 (United Nations General Assembly, 2015). Achieving this target requires not only maintaining Malawi's current strategies, but also adding new and innovative strategies to further accelerate the reduction in maternal deaths.

In 2010, Malawi developed a framework for accelerating the reduction of maternal mortality to achieve the MDG target by 2015. Firstly, the Health Sector Strategic Plan 1 (HSSP 2011-2016) was developed with the aim of achieving health equity. In the HSSP 1 (2011-2016), the high maternal mortality was identified as one of the challenges resulting from the lack of access to emergency obstetric care (EmOC) and the high total fertility rate (TFR) of 5.7 children per woman (NSO, 2011). Investments in increasing perinatal service utilisation, increasing the availability of family planning (FP), and improvements in EmOC were chosen as the main solutions for accelerating the reduction of the maternal deaths (NSO, 2011; Colbourn et al., 2013). The HSSP 2011-2016 was followed by a roadmap for accelerating the reduction of maternal and neonatal mortality and morbidity in 2012, which outlined key interventions that

could be scaled up to reduce the MMR. Health system interventions outlined in the roadmap included improving the utilisation of FP and EmOC services, as well as training health care workers to provide a continuum of care from the community to the facilities, including primary care facilities and referral facilities. These interventions were coupled with improvements in leadership and governance at the district and central level, improved partnerships, resource mobilisation, and improving systems for monitoring and evaluating maternal and child health outcomes (Republic of Malawi, 2012).

Between 2010 and 2015, Malawi made efforts to increase the number of facilities capable of providing full EmOC services. By 2014, the number of hospitals providing comprehensive EmOC increased from 42 to 45 hospitals and providing basic EmOC increased from 5 to 19 facilities (Republic of Malawi, 2010; Ministry of Health, 2015). Similarly, efforts were made to increase family planning with increasing availability of family planning commodities, training and mentorship to health care workers on family planning (Republic of Malawi, 2012).

By investing in these interventions, Malawi was able to reduce the MMR to its current rate. Additionally, some improvements in the utilisation of perinatal services were achieved. For example, by 2015 over 95% of pregnant women had attended at least one antenatal care (ANC) visit, facility births assisted by skilled staff increased from 70% to 90%, and the contraceptive prevalence rate (CPR) increased from 35% to 58% (NSO et al., 2017). In HSSP II (2017-2022), Malawi aims to reduce its MMR to 350 deaths per 100,000 live births by 2022 (Malawi Government, 2017a). To achieve this new target, new ways of increasing perinatal service utilisation should be implemented.

In low-and-middle income countries (LMICs) like Lesotho, Angola, Ethiopia, India, Bangladesh, Zambia and Ghana, where perinatal services utilisation was low, community health workers (CHWs) were introduced to improve utilisation of these services (Satti et al., 2012; Afework et al., 2014; Giugliani et al., 2014). Reviews of randomised studies provided evidence that community-based interventions in LMICs, interventions mainly by CHWs, were able to reduce maternal morbidity and mortality up to 25%, increased facility based births by up to 25%, and increased ANC visits up to 30% (Lassi et al., 2014; Lassi & Bhutta, 2015). In these studies, CHWs provided a unique channel for improving the utilisation of maternal health related activities by providing community education and mobilisation, as well as home visitation to screen for pregnancy and make referrals to perinatal health services. Additionally, some CHWs provide support when emergencies in the community arise.

CHW programmes are often designed and implemented with donor support and tend to be context-specific resulting in differences in care packages and service responsibilities of CHWs (Frymus et al., 2013; Schneider, Okello & Lehmann, 2016). For example, Haver (2015) documented the experiences of CHWs working in Rwanda, Afghanistan, Nigeria and Nepal in maternal and neonatal health programmes. Whereas CHWs in Rwanda were treating childhood illnesses, identifying pregnancies and referring to perinatal services, CHWs in Afghanistan were providing postnatal family planning only, CHWs in Nigeria were providing malaria prophylaxis and insecticide treated nets and CHWs in Nepal were providing misoprostol for treatment of postpartum haemorrhage. These differences in service packages resulted in differences in training, incentive packages, and selection as well as linkage systems to local health facilities. Consequently, CHW-based programmes are different from one setting to another, making replication in different contexts challenging. Despite these differences, the evidence supporting

the role of CHWs in perinatal service delivery are persuasive (Lassi et al., 2015). Introducing a CHW intervention, and evaluating the impact of the CHW programme in improving perinatal service utilisation in Neno is prudent and will add valuable lessons in the context of Malawi.

1.2 Introduction

Globally, maternal deaths involves the complex interaction of biological factors, health seeking behaviours, the availability and quality of health services, and the socio-economic wellbeing of the community (Alvarez et al., 2009). Some contributing factors to the high MMR in Malawi included a high TFR, a high unmet need for FP (19% of fecund women in a union or marriage, who want to limit or space their children have no access to contraceptives), high rates of female illiteracy (43%), poverty (51% and 25% of Malawians regarded as poor and ultra-poor respectively), a high HIV prevalence rate (8.8% HIV prevalence in the general population), and a high burden of communicable diseases (NSO, 2012; Malawi Government, 2017; NSO et al., 2017). Other determinants of maternal mortality in Malawi included inadequate health funding, persistent lack of facilities providing EmOC, lack of skilled staff and poor health system organisation (Colbourn, Lewycka, et al., 2013). Public health measures that reduce maternal death and improve maternal health outcomes have included the provision of quality maternal health services across the continuum of care: pre-pregnancy, pregnancy, labour and facility births, and PNC services (Campbell & Graham, 2006; Kerber et al., 2007). Even if this complete package of care is available universally, WCBA cannot benefit if they are unable to arrive at the health facilities. As such, the complete package of services within the perinatal care cascade cannot be achieved if women are not fully utilising the perinatal services.

Ensuring high utilisation of perinatal services is among the first steps of reducing maternal deaths and improving maternal health outcomes (Kerber et al., 2007). In Malawi, however,

utilisation of maternal health services remains very low. For example, although almost all women have some knowledge of family planning, there is about a 19% unmet need for FP in Malawi (NSO et al.,2017). Additionally, less than half of pregnant women complete four or more ANC visits and only 25% start ANC in first trimester. Although nine out of ten pregnant women deliver at health facilities, only half of the women return for follow-up in the postnatal clinics within six weeks of giving births (NSO et al., 2017).

Low utilisation of ANC, facility based births and PNC services are implicated as a contributing factor in maternal deaths in Malawi (Colbourn et al., 2013; Mataya, 2015; NSO, 2017). In a confidential enquiry of all maternal deaths audited between 2008 and 2012 and conducted in 27 of the 28 districts of Malawi, 16% of all pregnant women who died did not attend any ANC clinic. This is in contrast to the general population where only five percentage of pregnant women did not attend ANC clinics during pregnancy (Mataya, 2015). In the same report, 70% of deaths occurred in labour and the immediate postpartum period. About half of the maternal deaths were associated with delays in seeking care as they sought alternative ways of receiving care, struggles with decision making and/or challenges with transport to the nearest facility (Mataya, 2015). Elsewhere in Malawi, a cross-section study conducted in Mangochi reported that 38% of all maternal deaths occurred outside the health facility (Mgawadere, 2014) .

In the same confidential inquiry of maternal deaths, delays in receiving care once women arrived at the facility was the contributing factor to maternal deaths in 20-40% of the deaths. These delays included incomplete assessment by health care workers, inadequate resuscitation, and inappropriate patient management (Mataya, 2015). This suggest that reducing maternal deaths does not only depend on women successfully reaching facilities, but also prompt and appropriate treatment at the facilities.

The Malawian Ministry of Health (MoH) has emphasised on community-based interventions to increase utilisation of maternal health services (Ministry of Health, 2011). One of the key community based interventions involves the use of CHWs to increase the identification and enrolment of women into maternal health programmes. Between 2007 and 2014, CHWs have been working in Neno and have primarily focused on tuberculosis and HIV care. Neno is a rural, predominantly poor district in south-western Malawi. The main source of income is subsistence farming (NSO, 2012). In 2015, the district had about 150, 000 people (NSO, 2008). Neno is particularly hard to reach due to its mountainous terrain and a network of earth road throughout the district.

In an effort to reduce maternal morbidity and mortality in Neno, Partners in Health (PIH), in collaboration with the MoH, piloted a two-year project called “Healthy Mothers, Healthy Communities” (HMHC) from June 2014 to February 2016. The initiative, which was implemented in two catchment areas in Neno, had three main aims, namely: 1) to identify and train CHWs to increase utilisation of ANC, facility based births, and PNC by early identification and facilitated referral to maternal health services; 2) to engage the community through mass mobilisation events and community education; and 3) to strengthen the quality of maternal services at two pilot health facilities so that they offered the minimum required standard of care.

Two catchment sites in Neno district were chosen as the pilot intervention sites for the CHW programme. In the HMHC programme, CHWs expanded their roles beyond HIV/tuberculosis services to include household education; screening for women of reproductive age for pregnancy, sexually transmitted infections, HIV, and family planning; and referrals to health facilities for ANC, facility based births, and PNC.

1.3 Problem statement

In Malawi, the high MMR continues to pose a challenge as the country has one of the highest MMR in SSA. Despite investments in EmOC and the availability of FP, the progress made towards reducing the maternal deaths is slow as pregnant women continue to underutilise the maternal health services. Currently Malawi faces challenges with utilisation of ANC, intrapartum care and PNC. As shown above, as many as 75% of pregnant women are starting ANC after the first trimester, half do not complete the recommended ANC visits, as many as seven percentage still give birth outside the health facilities and only half of all women return to the health facility for PNC within six weeks after giving birth. Since delays in reaching the health facility, for perinatal care, has been shown to contribute to maternal deaths in Malawi, facilitating timely utilisation of perinatal services by women may be one method to address maternal mortality (NSO,2017). Using the HMHC pilot programme above, we hypothesise that CHWs can increase utilisation of perinatal health services by the identification of eligible women and the promotion of enrolment into ANC, facility based births, and PNC in Neno.

This study evaluated CHWs' contribution to increasing utilisation of ANC, PNC and facility based births between March 2014 and June 2016 in Neno, Malawi. It may be the first study in Neno District to demonstrate that 'lay community' members can contribute to mobilising and motivating WCBA to use perinatal health services. The results could potentially improve and expand the CHW programme in Neno and influence other maternal health managers to adopt the CHW approach in other districts in Malawi.

1.4 Objectives

The main study objectives were to examine service utilisation and determine changes in utilisation before and after CHWs were deployed to promote the identification and referral of

women from communities to facilities on three perinatal outcomes: 1) ANC 2) facility based births and 3) PNC

1.5 Summary

Chapter 1 discussed the introduction and background of the study. Chapter 2 provides a review of the literature on maternal mortality and the impact of CHWs on improving perinatal service utilisation, followed by the description of the methodology for the study in Chapter 3. Chapters 4 and 5 present the study results and the discussion of these results in the context of Malawi. The final chapter provides recommendations, policy implications, and the next steps for CHW programmes in Neno and Malawi.

CHAPTER 2: LITERATURE REVIEW

2.1 Objectives of the literature review

The aim of this literature review is to explore what is already known about maternal mortality, perinatal services and how effective are CHWs on improving utilisation of perinatal services in other contexts. The review therefore explored the global, regional and local burden of maternal mortality. Regarding the local burden of maternal mortality, the review explored the drivers of maternal mortality and strategies that have been implemented to reduce maternal deaths. Finally, the review explored global, regional, and national literature about other CHW programmes aimed at improving perinatal services utilisation, and reducing maternal morbidity and mortality. The strengths and potential gaps in CHW programmes were explored to justify why the current study could contribute to perinatal service delivery in Neno District, Malawi.

2.2 Search strategy

All relevant full publications from 2009 to 2017 were retrieved from PubMed, Google Scholar, and relevant Malawian government documents. For literature on maternal mortality, relevant literature that reported on maternal mortality, maternal deaths, maternal morbidity, reproductive health, and EmOC were included. We searched the Ministry of Health website and other sources to include all relevant health sector policies, strategies, and publications on health systems, maternal health, perinatal health, family planning, and obstetric care.

For CHWs, research studies that identified and trained CHWs to provide at least one of the following: community mobilisation, education, referral and follow-up were included. In these studies, one or more of the following primary outcomes were searched: ANC commenced at any gestation age, facility based births and PNC visits up to 42 days after giving births. As secondary

outcomes, studies that explored the impact of CHWs on maternal mortality and/or morbidity were also included. Studies that reported on the impact of CHWs on neonatal and/or child health outcomes only were excluded. The definitions of CHWs and any of the outcomes listed above were used. The following search terms were used in our search: perinatal services, maternal health services, ANC, facility based births, skilled births, intrapartum care, PNC, postpartum care, maternal mortality, maternal morbidity and maternal death.

2.3 Global, regional and local burden of maternal mortality

Globally, maternal mortality remains a significant concern, with over 275 million maternal deaths reported in 2015 (Kassebaum et al., 2016). The main causes of maternal mortality include maternal haemorrhage, maternal hypertensive disorders, complications of ectopic pregnancy and miscarriages and maternal sepsis. In 2015, the average MMR was 188 (Kassebaum et al., 2016).

The global MMR distribution is unequal with high income countries having the lowest MMR and LMICs having the highest MMR (WHO, 2015). For example, in 2015 the average MMR in high income countries was 17 per 100,000 live births, in contrast to LMICs where the average was 443 (Kassebaum et al., 2016). Interestingly, the use of perinatal services was inversely related with MMR with LMICs having the lowest utilisation of perinatal services (Kassebaum et al., 2014, 2016).

SSA countries have the worst MMR in the world and among the other LMICs outside this region. In 2015, the MMR in SSA averaged 546 per 100,000 live births and women in SSA had the highest lifetime risk of dying from maternal death (1 in 36 women) (WHO, 2015). The high MMR in SSA has been attributed to high HIV prevalence in this region, which has contributed to high indirect causes of deaths. Some estimates report that HIV has increased maternal deaths by

up to 11 per 100,000 live births (WHO, 2015). In addition to the HIV pandemic, some of the key drivers of maternal mortality in Africa include weak health systems, inadequate resources, especially financial resources, unavailability of quality perinatal services, and lack of essential health care staff (Alvarez et al., 2009; Garenne, 2015).

In Malawi, the MMR is still high, but has been declining since the early 2000s: from 984 deaths per 100,000 live births in 2004 to 675 deaths per 100,000 live births in 2010 (NSO, 2011; Republic of Malawi, 2012). From 2010 to 2015, the MMR was reported to be between 334 to 574 deaths per 100,000 live births in several studies (Colbourn et al., 2013; Kassebaum et al., 2014; Mgawadere, 2014; NSO, 2014; NSO et al., 2017). The most recent estimate of MMR from the 2015-2016 Malawi Demographic and Health Survey (MDHS) estimates the MMR to be 439 deaths per 100,000 live births (NSO et al., 2017).

2.4 Drivers of maternal mortality in Malawi in 2010

In 2010, it was postulated that the high MMR in Malawi was a result of the high TFR, lack of access to FP, lack of skilled health care workers, and a lack of access to EmOC (MoH, 2011; Republic of Malawi, 2012).

2.4.1 *High total fertility rate*

Every time women are pregnant, they are exposed to all pregnancy associated risks like obstetric haemorrhage, pre-eclampsia and ruptured uterus; and when these occurred they can lead to increased maternal morbidity and mortality. As a result, the high fertility rate increases the lifetime risk of woman dying during the perinatal period; the opposite is true: low fertility will reduce the lifetime's risks of woman dying from pregnancy related causes (Zureick-brown et al., 2013). With a total fertility of 5.7 in 2010, strategies for reducing the TFR so as to reduce the lifetime risk of dying during perinatal period were urgently needed (MoH, 2011).

2.4.2 *Early pregnancies*

Associated with the high TFR is early pregnancies in Malawi. Many women in Malawi start child bearing at an early age, with the mean age of child bearing at 19 years of age in 2010 (NSO, 2011). The young child bearing age predisposes women to a longer reproductive duration, and with the low use of family planning women are predisposed to high parity (Zureick-brown et al., 2013).

2.4.3 *Low contraceptive prevalence rate*

High availability and utilisation of family planning prevents unwanted pregnancies and allows spacing between children, thereby reducing the lifetime risk of women dying due to pregnancies (Jacobstein et al., 2013). In 172 countries in 2008, the provision of family planning alone reduced maternal deaths by 44%, with a possible 28% further reduction if all unmet family planning needs were met (Ahmed et al., 2012). Therefore, Malawi needed to increase family planning utilisation to address the low contraceptive rate of 35%; and this could potentially accelerate the reduction in maternal deaths (MoH, 2011).

2.4.4 Lack of skilled staff

In the perinatal period, adequate, well trained and well distributed health care workers are necessary to reduce maternal deaths (Bhutta et al., 2014). In Malawi, perinatal services are provided at three basic levels which are: primary, secondary and tertiary facilities (Chirwa, 2013). Primary facilities offer basic medical services mainly outpatient and maternity services. More complicated and high-risk cases are referred to secondary facilities which provide a higher level of care including obstetric surgeries and blood transfusions. If cases cannot be managed at secondary level, they are referred to tertiary level facilities where specialised perinatal services are available.

In many countries, the majority of health services are provided by nurses, midwives and other mid-level clinicians. These cadres of staff are regarded as the back bone of the health system. In Malawi, perinatal services are mainly provided by nurses and midwives with varying levels of training (either a 2-3 year diploma as auxiliary/nurse technicians or four year degree as registered nurses) and clinical officers, who are mid-level providers with three years of basic medical training (Department for International Development, 2010). In order to ensure good perinatal outcomes, these critical staff need to be adequately trained during pre-service and in-service years, then properly deployed to locations where maternal health services are needed.

Unfortunately, Malawi has a very high vacancy rate for these key clinical staff. In 2010-2011, the vacancy rate was 60%, 53%, 72% for nurse technicians, registered nurses and clinical officers respectively (Republic of Malawi, 2012). The high vacancy rate has been attributed to a low output of clinical staff from training institutions, low and demotivating salaries which perpetuates highly qualified staff to move to other countries, movement of staff from public to private facilities and rural to urban facilities and finally lack of resources in facilities

(Department for International Development, 2010; Chimwaza et al., 2014). Without adequate numbers of well-trained staff, it is difficult to provide good quality perinatal care

It is not only the quantity of the staff that impacts maternal mortality, but also appropriate deployment and on the job training. Although currently it is not possible to estimate the adequacy of distribution of all health care workers per facility in Malawi, it is known that tertiary facilities, which are located in cities, are well staffed and some are even overstaffed (Ministry of Health, 2018). The challenge of inappropriate deployment also affects nurses and midwives. In 2008, only 30% and 35% of doctors and nurses/midwives were serving 85 % of the population in Malawi respectively (Nove, 2011). As a result, women living in rural areas are served by few nurses and midwives, a scenario that perpetuates poor access to maternal care.

The nurses and midwives need to receive appropriate pre-service and in-service training; and this requires developing appropriate curriculum in training schools. Although the curriculum in Malawi have been developed in recent years, challenges have been raised on the appropriateness of the curriculum in addressing the prevailing challenges in rural areas where many of the nurses works (Bvumbwe & Mtshali, 2018).

To train all required nurses in Malawi, properly trained tutors needs to be identified and appropriately deployed to training colleges and health facilities. Although the need for more tutors is known, there are very few tutors to meet the tutor to students ratio in most colleges (Nove,2011; Malata et al., 2013). In 2008, the biggest nursing training college in Malawi called Kamuzu College of Nursing, had a ratio of 1 tutor to 15 students, with other classes having up to 50 nurses. This is against a standard ratio of 1 to 10 as set by Malawi MoH (Malata et al., 2013). These tutors also need to receive appropriate up-to-date training to enable them to effectively

mentor nurses and midwives. This continues to be a challenge in Malawi. For example, in 2010, about half of midwife tutors did not receive appropriate and up-to-date training on EmOC (Republic of Malawi, 2010).

2.4.5 Lack of emergency obstetric care

In 2009, WHO developed a handbook outlining what should be provided at EmOC classified health facilities (WHO, 2009). The EmOC classification has nine signal functions. Facilities classified as basic should provide the following services: parenteral antibiotics, parenteral oxytocics, parenteral anticonvulsants, neonatal resuscitation, assisted vaginal births, manual removal of the placenta and removal of retained products of conception. If facilities offer two additional services, namely caesarean sections and blood transfusions, they were classified as comprehensive (WHO, 2009). Malawi adopted EmOC signal functions and requires all primary facilities that provides intrapartum care to offer the seven core functions and secondary and tertiary facilities to offer all nine functions (MoH, 2015). According to the 2014 report, Malawi should have 156 EmOC facilities to achieve equity (defined as five EmOC facilities in a population of 500, 000), but the country only had 64 full EmOC facilities. Furthermore, in primary facilities where most perinatal care is provided, only 7% had all seven signal functions of EmOC. This is in contrast to hospitals where Malawi met the target for comprehensive EmOC facilities (MoH, 2015). Therefore, Malawi needed to step up in its effort to provide EmOC by targeting primary facilities so that they offer basic EmOC (MoH, 2015).

2.5 Strategies used to accelerate the reduction of maternal deaths from 2010 to 2015 in Malawi

Due to the challenges that contribute to high maternal deaths in Malawi, the government of Malawi developed a road map for accelerating the reduction of maternal and neonatal mortality

and morbidity in 2012 (Republic of Malawi, 2012). In the roadmap, key health system interventions were formulated as discussed below.

2.5.1 Improving availability, utilisation, and accessibility of family planning

A specific focus aimed at increasing the availability, utilisation, and accessibility of FP methods to reach a CPR of 60% by 2015, through increasing the availability of long-term FP, improving the skills of health care providers, integrating FP services with other services and improving the supply chain of FP commodities (Republic of Malawi, 2012). Immediately after labour and facility births, up to 61% of women have the highest unmet need for family planning and meeting this need would reduce unwanted pregnancies and ensure better birthing interval (Moore et al., 2015). Motivating women during antenatal period and labour is therefore essential, as this is the time when women are in contact with the health services many times and can be motivated to start family immediately after giving births. As such, one effort of increasing CPR in Malawi would include the promotion of family planning messaging during antenatal and labour and provision of postpartum family immediately after or within six weeks after giving births (Republic of Malawi, 2012).

2.5.2 Improving the quality of comprehensive perinatal care at health facilities

In Malawi, perinatal services are structured as a continuum of care from the community to the facility. At the district level, comprehensive EmOC is provided mainly by midwives and clinical officers working in available hospitals (Republic of Malawi, 2010). Additionally, the district health management team offers leadership, guidance, supportive supervision, resource mobilisation and allocation towards perinatal services. The district also provides core support services that include support for communications, maintenance of facilities, drugs and equipment, health information systems and transport to and from primary facilities (Chirwa,

2013). The coordination of activities between district health management teams, support services and clinical services is essential as weak coordination could lead to poor coordination of district-wide perinatal services and lead to poor maternal health outcomes (Salam et al., 2014).

Beyond district hospitals, primary facilities offer perinatal services within smaller catchment areas; Neno's population per catchment area ranges from 4,000 to 20,000 people. If complications arise, women are referred to hospitals for comprehensive EmOC. Depending on the setting, district level teams conduct integrated outreach clinics once a month in difficult-to-reach areas. Although not universally available, CHWs have a role in the community by providing disease prevention and health promotion activities. In perinatal health, CHWs provide education and mobilise women to attend ANC, deliver at health facilities and PNC (Malawi Government, 2017b).

In the roadmap, Malawi planned to expand the comprehensive provision of perinatal care by placing specific emphasis on ensuring all facilities offering ANC, improving utilisation of ANC by community mobilisation and the use of CHWs, improving the package of care provided in ANC, doubling the number facilities offering EmOC from 20% to 40%, improving infrastructure at health facilities to allow smooth operation of perinatal services, and promoting audits of perinatal services at all facilities (Republic of Malawi, 2012).

2.5.3 Improving the quality and quantity of skilled staff in perinatal care

With only 28-47% of established posts filled by nurses and clinical officers, who are the backbone of the Malawian health service, Malawian target was to almost double the recruitment of all these cadres by 2015 (Republic of Malawi, 2012). This meant proposing an increase in intake into the existing training programme by training 558 nurses and 156 clinical officers by

2015. Additionally, training was proposed for 5,000 community midwives who would offer community-based perinatal services. The new proposed nurses were supposed to be deployed to primary health facilities to achieve the current staffing norm of at least two midwives per primary facility (MoH, 2015; Republic of Malawi, 2010). Clinical officers were supposed to be mainly deployed to hospitals to help provide comprehensive EmOC. Furthermore, it was proposed that all nurses and clinical officers working in facilities would be trained in integrated management of maternal and neonatal health, a course that provides basic training in perinatal care (Republic of Malawi, 2012).

2.5.4 Strengthening continuum of care from community-to-facility and facility-to-facility referral systems

As maternal health can be compromised due to referral delays from community clinics to secondary facilities, as well as from secondary to tertiary facilities, a strategy was developed to mitigate these delays. To improve communication from primary to secondary health facilities, the provision of functioning two-way radios, mobile communication devices, and ambulances could reduce maternal deaths. In communities the proposal was adopted to increase community-based interventions (including community mobilisation and use of CHWs) that would ensure the continuum of care from communities to health facilities (Republic of Malawi, 2012).

2.5.5 Strengthening other sexual and reproductive health and rights services

Malawi recognises the need for providing comprehensive sexual and reproductive health and rights (SRHR) to all its citizens in accordance with the programme of action adopted at the international conference on population and development held in 1994 and the African Union Maputo action plan developed in 2006 (African Union, 2006). This declaration promote universal coverage of SRHR in every country as pre-requisites for universal health coverage and human development. In line with these key declarations, Malawi developed a national policy on

SRHR in 2009 (Republic of Malawi, 2009). The policy defined 11 key strategies to ensure universal coverage of reproductive health services: improvements in maternal and child health (perinatal services are included in this section); FP; young people's sexual and reproductive health; prevention and management of HIV and sexually transmitted diseases; detection and management of reproductive cancers; elimination of harmful cultural practices around reproductive health; prevention and management of infertility; management of obstetric fistula; male involvement in SRHR; improving human resources; and strengthening systems for delivery of SRHR (Republic of Malawi, 2009).

Although perinatal services has been the main focus in this paper, the perinatal services are among the package in SRHR services (Republic of Malawi, 2009). Therefore in an effort to improve maternal health, reduce maternal deaths and achieve universal coverage of SRHR, the roadmap promoted improving perinatal services together with other SRHR services (Republic of Malawi, 2012). These SRHR services included strengthening utilisation and availability of integrated HIV/sexually transmitted infections/FP with perinatal services, increased availability and utilisation of adolescent friendly health services and male involvement in sexual health.

2.5.6 Strengthening governance and leadership on perinatal services

The other four strategies for accelerating the reduction of maternal mortality involved the improvement of governance and leadership towards perinatal services. Strategies included improving district planning so that resources were allocated towards perinatal services, improved resource mobilisation at the ministry and local level, strengthening partnerships at the local level and finally strengthening monitoring and evaluation of maternal health services (Republic of Malawi, 2012).

2.6 Progress towards reducing maternal mortality ratio from 2010 to 2015 in Malawi

The progress of reducing the MMR to the 2015 level can be attributed to improvements in access to skilled attendance during facility births (from 7 out of 10 to 9 out of 10 in 2010 and 2015, respectively), high ANC coverage (over 95% of pregnant women attended at least one ANC in 2010 and 2015), reduction in TFR (from 5.7 in 2010 to 4.4 in 2015), and increases in CPR (35% to 58% in 2010 and 2015, respectively). (National Statistical Office, 2011; National Statistical Office(NSO)[Malawi] & ICF, 2017). Furthermore, although the interaction between the MMR and HIV is complex; improved access to HIV services including increased availability of antiretroviral therapy is considered to have played a significant role in reducing the MMR (Colbourn et al., 2013). HIV may contribute to high maternal deaths by increasing conditions that directly contributes to maternal death, and pregnancy itself may accelerate HIV associated deaths leading to increase in the number of maternal deaths among women of reproductive age (Kassebaum et al., 2014). Additionally, the HIV epidemic imposes an increased workload on an already overburdened health system, diverting resource mobilisation away from perinatal services, and in other cases reducing the number of staff working in perinatal services due to HIV associated deaths (Colbourn et al., 2013).

Although the MMR has been declining, Malawi did not meet the 2015 MDG target of reducing the MMR to 150 deaths per 100,000 live births (Malawi Government, 2017a). Some of the challenges that exist include lack of facilities that provide EmOC, the high unmet need for family planning, and shortage of well-trained staff. The new target of reducing MMR to 350 per 100,000 live births by 2022 requires extra efforts in addressing these challenges and perinatal service utilisation is one of the main challenges that should be addressed urgently (Malawi

Government, 2017a). Additionally, women need to start perinatal services earlier, and timely attend all required visits to benefit from complete package of care in the perinatal care cascade.

Health services utilisation in general, and maternal health services in particular, is a challenge in Malawi. According to the MDHS 2015-2016 (2017), 70% of women in Malawi experience one or more barriers to utilising perinatal health services. Over half of the women reported long distances to health facilities and fees required by some health facilities as significant barriers (NSO et al., 2017). Although 95% of women attended at least one ANC visit during pregnancy, only one in four women started ANC in the first trimester and only half of these completed four or more ANC visits as currently recommended by the Malawian government. Seven percent of women continue to give birth outside of health facilities and about half of these women do not come to the facility for postnatal check-ups within 42 days of giving births (NSO et al., 2017). In Malawi, there have been reports of many maternal deaths that occur among women who did not attend perinatal services. Poor ANC attendance could have an impact on maternal deaths, as up to 30% of maternal deaths occur during the antenatal period in Malawi (Vink et al., 2013; Mgawadere, 2014). Additionally, challenges in utilising intrapartum care, as well as PNC services, also contribute to the high number of maternal deaths. For example, in community and facility audits of maternal deaths in Mangochi District, Malawi, between December 2011 and November 2016, approximately 38% of maternal deaths occurred before the woman arrived at the hospital, and over 90% these deaths occurred at home (Mgawadere et al., 2016). In three studies conducted in Lilongwe, Kasungu, Salima and Mangochi districts of Malawi, 39-63% maternal deaths were associated with delays in utilising services during pregnancy, labour, and facility births (Kongnyuy, Mlava & van den Broek, 2009; Vink et al., 2013; Mgawadere, 2014). Comparison of utilisation between urban and rural areas and the three regions of Malawi (North,

Central and South) showed lower utilisation rates among the rural communities and in the southern region of Malawi for ANC, facility based births, and postnatal care (NSO et al., 2017). Since no data could be found from Neno district during the review, the district likely has a low utilisation rate, as it is a rural, southern-region district of Malawi. Neno has over 150,000 people, with about 65% of people living in poverty (50% higher than the average poverty rate in Malawi) (NSO, 2012).

2.7 Impact of community health workers on utilisation of perinatal health services: global evidence

Since the utilisation of perinatal services is one of the main challenges of maternal health in Africa, and Malawi in particular, community-based strategies that improve the utilisation of perinatal services were implemented in many settings in recent years in attempt to achieve the MDG target for maternal health (Schneider, et al., 2016). These strategies, defined as maternal health service provision at community, village or household level by using community action groups, CHWs and/or different community mobilisation strategies, aim at delivering perinatal services at women's 'doorsteps,' even in the remotest areas (Bhutta et al., 2014). The use of CHWs as key community based strategy has increased since 2005, with over 600 reported CHW-implemented programmes in LMICs of which 35% have been implemented with the main aim of improving maternal and child health services (Schneider et al., 2016).

CHWs have been advocated as drivers of increased perinatal service utilisation in many ways. Firstly, CHWs provide community, village and household-based education of perinatal health services. For example, in a quasi-experimental study conducted in two districts in Tanzania, CHWs were trained to provide birth preparedness and lifesaving skills to pregnant women; in comparison to control sites, rates of utilisation of ANC and facility based births increased by

25% and 11% respectively. Additionally women's knowledge on danger signs during emergencies and their ability to prepare for facility births improved (August et al., 2016).

Secondly, CHWs promote early identification of perinatal cases in the community. For example, in a large CHW study conducted in two urban districts of Dar es Salaam in Tanzania designed to identify women who may be pregnant by enquiring on who had missed at least one last normal menstrual period, CHWs identified over 2,000 pregnancies; about 70% of all pregnancies identified were enrolled in local health facilities in 16 months. More importantly, the CHWs found pregnant women earlier as the average number of pregnant women starting ANC decreased from 21 weeks at the beginning of the intervention to 16 weeks at the end of the intervention (Lema et al., 2014). Although this may be beyond normal scope of CHWs, about 1,600 CHWs in Nepal were trained to screen for pregnancy and conduct urinary pregnancy tests in the community. By the end of eight months over 80% of the CHWs were competently able to test for pregnancy and they had found 53% of women to be positive after testing for pregnancy (Andersen et al., 2013).

Thirdly, CHWs provide facilitated referrals to perinatal health services (Darmstadt et al., 2010). In this role, CHWs ensure that women understand the importance of seeking help as soon as possible and promote compliance to referral, monitor the referral by recording and following what happens after the referral was made and assist with financial and/or physical barriers to ensure women reach the facilities where they are referred. In a CHW programme aimed at identifying and escorting women to health facilities as well as referral to maternity waiting homes in one health centre of about 25,000 people in Lesotho in 2009, 55% of all facility based births were women who were admitted in the waiting home to wait labour prior to labour and they were escorted to the facility by CHWs (Satti et al., 2012).

Lastly, some CHWs have provided some curative services in the community. This is common in neonatal and child health services where CHWs manage community clinics where CHWs provide malaria diagnosis and treatment among other service (Paintain et al., 2014). In perinatal services, CHWs have also been used to provide misoprostol, a medication that is normally administered by facility based health care workers (Smith et al., 2013). In this method, CHWs distributes misoprostol during antenatal period to pregnant women to keep at home. The misoprostol is taken by the mother during labour and facility births when the woman develops complications. This is very helpful in LMICs where misoprostol is easily available at the health facility when it is needed, when the woman develop bleeding on the way to the facility and/or during giving birth at traditional birth attendant, another type of CHW (Haver et al., 2016; Smith et al., 2013).

A recent meta-analysis of 26 randomised and quasi-experimental studies which evaluated the impact of community outreach workers, mainly CHWs, on improving utilisation of maternal and neonatal mortality and morbidity, showed a possible effect of community-based maternal and child health services on reducing maternal mortality, and significant effects on reducing maternal morbidity, as well as perinatal and neonatal mortality (Lassi et al., 2015). The review, which included studies from 1991 to 2013, evaluated the effect of additional training to community outreach workers on the provision of maternal and child health services, preventive services, behavioural change services and community mobilisation strategies. The community outreach workers were defined as members of the community trained to provide service and included all CHWs and community midwives. In this review, almost all the studies were conducted in Asia and Africa, with only one study in Europe (Greece). Overall, the review showed that community-based maternal services provided by outreach workers increased utilisation of facility based

births by 20% (Relative Risk (RR): 1.20; 95% Confidence interval (CI): 1.04 to 1.39).

Furthermore, the review also showed a possible 20% reduction in maternal mortality (RR: 0.80; 95% CI: 0.64-1.00), as well as 25% significant reductions in maternal morbidity (RR: 0.75; 95% CI: 0.61 to 0.92) and neonatal mortality (RR: 0.75; 95% CI: 0.67 to 0.83). However, the authors also note that despite community-based strategies showing a possible effect on reducing maternal mortality, the results may not be reflective of true effect as they only analysed eleven studies and the sample size may not have been large enough to detect a meaningful impact on maternal mortality. The effect of these community-based strategies on reducing maternal morbidity is an added advantage towards reducing maternal mortality deaths. However the review did not include ANC and PNC as outcomes (Lassi et al., 2015).

A systematic review of 43 randomised and non-randomised studies explored the value of community-based interventions – specifically home visitation and referrals, shifting responsibilities normally done by health care workers to community health workers, additional training, and community mobilization—on improving utilisation of maternal health services (Lassi et al., 2014). This review found that home visits by CHWs increased ANC visits up to 33% (RR: 1.33; 95% CI: 1.20-1.47), increased successful referrals for women to perinatal services (RR: 1.4; 95% CI: 1.19-1.65), and reduced maternal morbidity by 25% (RR: 0.75; 95% CI: 0.61-0.92). However, the authors did not explore the CHWs' contribution towards changes in utilisation of postnatal care and facility based births. The authors concluded that interventions that combine community mobilisation with task shifting and home visitations appear to have substantial impacts on reducing maternal morbidity (25% reduction) and neonatal mortality (24% reduction) (Lassi et al., 2014).

Many individual studies conducted in developing countries have explored the roles of CHWs on improving utilisation of ANC, facility based births and PNC. Studies in Pakistan, Ethiopia, Lesotho, Tanzania, and Bangladesh have found over 20% increases in utilisation of at least one ANC visit and/or four or more ANC visits when CHWs are used to improve utilisation of ANC and facility based births (Darmstadt et al., 2010; Satti et al., 2012; Afework et al., 2014; Lema et al., 2014; Memon et al., 2015; August et al., 2016). For example, in a cross-sectional study in two districts Ethiopia where CHWs conduct home visits during the perinatal period, women had three times and two times higher odds of completing four or more ANC visits and delivering at a health facility respectively, if the women received a home visit at least once by a CHW (Afework et al., 2014).

In general, most studies have shown that CHWs are associated with an increase in facility based deliveries, although in some studies the increase was not statistically significant. For instance, a CHW cluster randomised study in Bangladesh conducted to determine changes in utilisation of perinatal services as well as neonatal mortality found a 10% increase in facility based births in women who had a CHW home visit, with the difference being significant in comparison to control sites (Darmstadt et al., 2010). In this study, CHWs were identifying pregnancies during household visits, conducted two home visits in first trimester and third trimester where they provided education and birth preparedness sessions and four home visits in postnatal period (Darmstadt et al., 2010). However, in another cluster randomised study conducted in Ghana where CHWs were conducting two home visits during pregnancy and three visits when women gave births, the CHWs increased the facility based births in the intervention site but the increase was not significant in comparison to the control sites (Kirkwood et al., 2013) .

Among the studies reviewed here, few studies report on facility PNC changes as result of CHWs, but rather report CHWs conducting postnatal home visits. For example, in a study conducted in Bangladesh by Darmstadt et al. (2010), CHWs visited up to 60% of women during the first two weeks after giving birth. A cross sectional study on impact of CHWs in Ethiopia who conducted home visits during perinatal period found no impact of their CHWs on PNC (Medhanyie et al., 2012).

2.8 Impact of community health workers on utilisation of perinatal health services: evidence from Malawi

In Malawi, four studies in the past seven years reported community-based interventions for improving maternal health service utilisation. Colbourn et al., (2013) reported a randomised control trial where community volunteers formed women participatory groups in three districts in central Malawi. The community interventions included an initial training on obstetric emergencies to members of women participatory groups. This was followed by several cycles of meetings consisting of the following: maternal and neonatal problem identification, planning and implementing solutions with the communities to address the problems and evaluation of their successes. In this study, in sites with women community participatory groups, the neonatal mortality rate declined (16% lower in intervention sites than control sites) during the intervention period, but there was no net effect on reducing maternal mortality (Colbourn, et al., 2013).

Furthermore, no significant effect on facility based births was observed. This study did not directly explore the effect of the community interventions on improving ANC or PNC utilisation.

Lewycka et al., (2013) applied the same participatory model described above in another district in central Malawi and measured the effect of these participatory groups on maternal and neonatal mortality. In this study, women's participatory groups had no significant effect on the reduction

of maternal or neonatal mortality, but after adjusting for parity, wealth status and social-demographics, the reductions in maternal and neonatal mortality was significant (74% and 41% decrease in MMR and neonatal mortality rate respectively). In this same study, the women participatory groups showed a 50% increase in uptake of at least one ANC visit. However, the intervention had no effect on four or more ANC visits, facility based births, or PNC visits. Both Lewycka et al., (2013) and Colbourn et al., (2013) conducted studies in the central region of Malawi, in areas that are socio-economically and culturally different from Neno District.

Callaghan-Koru et al., (2013) evaluated a package of community-based maternal and neonatal care which involved using government hired CHWs to mobilize the community, conduct home visits and educate pregnant and postpartum women in three districts in Malawi. A before-and-after comparison of the study showed that only 36 % (n=342) and 11% (n=90) of the 900 women interviewed had received a home visit by a CHW during pregnancy and PNC respectively. Overall, there was a 21% increase in facility based births (from 71% to 92%) and about six percentages (from 89% to 95%) increase in at least one ANC visit in the three districts where the study was conducted. Since the study did not have a comparison site, it was difficult to attribute the change to CHWs only or other community interventions applied in the study. This study did not provide outcomes in changes in PNC, four or more ANC visits, or ANC visits in the first trimester.

2.9 Summary of studies reviewed

Although CHW programmes examined in this literature review were aimed at improving utilisation of perinatal services, some differences existed among the design of CHW programmes, the interventions used by the CHWs, the outcomes reported and the results obtained in the intervention. Firstly, the CHWs interventions were driven by different priorities

in different countries, hence differences in CHW composition and their roles. Secondly, most of the studies reviewed did not evaluate utilisation of all three components of perinatal services namely ANC, facility based births and PNC. Thirdly, most of the studies did not explore the role of CHWs on early attendance to ANC. Lastly, the effect of CHWs on utilising perinatal services differs within countries and between countries.

2.10 Role of this study in Neno, Malawi

In light of the highlighted differences and challenges explored in the studies reviewed, the rationale and the design of the CHW programme in Neno aimed to address the following: 1) there is no CHWs model that fits all contexts between and within countries. As the role of CHWs on changing the utilisation of ANC services, facility based births and PNC services is not consistent across studies, it is necessary to explore the roles of CHW on these key outcomes in a different setting in Malawi. 2) At the time of this review, few studies in Malawi explored the role of community interventions, especially CHWs, on perinatal services in Malawi. The few studies in Malawi used different cadres of CHWs, were conducted in parts of Malawi other than and different from Neno and the results on utilisation of perinatal services have been inconsistent. As a result, there is a great need to add more evidence to the literature on the role of CHWs on changing utilisation of perinatal services in other areas of Malawi. 3) The studies in Malawi did not explore the effect of CHWs on ANC, PNC, and facility based births as a continuum of care within perinatal services. They focus on one or more of these outcomes of interest. This study will provide evidence across all three key services of perinatal care. 4) The study also directly addresses the Malawian MoH proposed recommendations for addressing maternal mortality burden by focusing on new and innovative community-based interventions.

CHAPTER 3: METHODOLOGY

This chapter discuss the study type, site, duration, inclusion and exclusion criteria, data analysis plan and measures of quality of the study.

3.1 Type of study

This was a retrospective quasi-experimental study evaluating changes in the utilisation of ANC, facility based births, and PNC services between a CHW intervention area and its own comparative control area. Month-to-month comparison of longitudinal data from pre-intervention and post-intervention periods between the CHW maternal health intervention area and its control was used to measure the differences in utilisation of services using a synthetic control method approach.

3.2 The synthetic control method

Originally used in political sciences, the synthetic control method has been used to assess the effect of interventions between a ‘treated or intervention site’ and a comparative control site when it is not possible to randomise participants between treated and non-treated groups (Abadie & Gardeazabal, 2003; Abadie, Diamond & Hainmueller, 2010). In order to assess the effect of an intervention, it is essential to know what would have happened had the intervention not been implemented, that is the counterfactual outcome, which is not observed. The synthetic control method aims to estimate this counterfactual outcome using a weighted average of control sites (called a synthetic control unit) designed to replicate the pre-intervention trend observed in the ‘treated’ site. This synthetic unit is defined as ‘the time-invariant weighted average of available control units, which prior to the intervention had similar pre-intervention characteristics and outcome trajectory to the treated unit’ (Kreif et al., 2016 p.215). The synthetic unit is created

using a data driven method: it is created from available control areas where the intervention was not conducted (combined ‘untreated’ areas), thus the synthetic unit is created using predictors of the outcome of interest, and is created to have similar characteristics as the ‘treated unit’ before the intervention (Lepine, Lagarde & LeNestour, 2015). Since the ‘treated’ and synthetic unit have similar characteristics in the pre-intervention period, there are minimal differences between the ‘treated’ and synthetic control unit – an effect achieved by randomisation in experimental studies (Craig, 2015). The effect of the intervention in the synthetic control method is the difference in outcomes between the ‘treated’ and its synthetic control unit after implementation of the intervention.

The synthetic control method originally developed by Abadie et al., (2003) and Abadie et al. (2010) was modified using the Bayesian implementation of synthetic control. The synthetic control method makes use of four sources of information for estimation of the post-intervention counterfactual of a time series: 1) the pre-intervention time series; 2) other control time series; 3) external covariates; and 4) prior knowledge of effect size. The synthetic control method as discussed by Abadie et al., (2003) and Abadie et al. (2010) requires the first three for their implementation. The external covariates or ‘time varying predictors’ are factors that are known to influence the outcomes of interest in both the intervention and the control sites. Therefore, they can be used to create the synthetic unit time trend prior to intervention. Normally, these covariates are chosen based on rigorous evidence collected locally. In this study, we did not conduct a study to identify these co-variates. In the absence of time varying predictors in this study, the method as explained by Abadie et al., (2003) and Abadie et al. (2010) was not used. Instead, the Bayesian implementation of synthetic control as described by Brodersen et al. (2015)

was applied, which does not require time-variant predictors to create the counterfactual time series trend.

3.3 Study period

Data were obtained from all eligible health facilities in Neno district for the period between March 2014 and June 2016. The pre-intervention period consisted of 12 periods corresponding to 12 months: March 2014 to February 2015. The post intervention was a period of 16 months extending from March 2015 to June 2016. Therefore, the total observation period was 28 months. The pre-intervention period was chosen because 12-month data allowed for seasonal variability in maternal health utilisation across all facilities and was long enough to allow for retrospective data collection if any data element was missing.

3.4 Study area

The study was conducted in Neno district which had a population of about 150,000 people in 2015. Neno is the newest district which was created in 2002, and is located in south western zone of Malawi. This rural district has about 65% of its inhabitants living in poverty (50% higher than national average), 80% of the inhabitants depend on subsistence farming, only 4% of the people are formally employed and 4% of the people use electricity as an energy source (NSO, 2012). Most people in Neno district belong to the Ngoni tribe.

The district had two hospitals, which were both constructed in the past 10 years, and 11 primary facilities in 2015. In terms of ownership, the facilities were grouped into three groups: 1) One private facility 2) four facilities owned by faith based organisations 3) Eight facilities owned by Malawian government. Services were free at government facilities only, but patients had to pay

user fees for private and faith based owned facilities. Accessibility to health services is a challenge due to its mountainous terrain as well as poor infrastructure.

In this study, facilities were grouped as either intervention or control sites. The intervention sites ('treated sites') were two catchment sites where the CHW intervention was implemented (Chifunga health centre and Lisungwi community hospital). The rest of the public health facilities (six facilities) in Neno acted as comparison sites (see Figure 1 and Table 1).

3.5 Sample size, inclusion, and exclusion criteria

The study is a retrospective study and uses archival medical records to look at the changes in utilisation of perinatal services between 2014 and 2016. The data used in this study was originally intended for reporting purposes within the CHW programme and facility perinatal health programmes. The data was therefore fixed by the number of women that utilised perinatal services and the choice of facility clusters. Therefore, the study included all WCBA that utilised ANC, facility births and/or attended a PNC clinic at the CHW intervention and control health facilities in Neno districts. As a confirmation that the women utilised the services, their appointment visits and any interventions done during the visits were recorded in the appropriate maternal health registers and reported in monthly reports.

Observations from Chifunga health centre and Lisungwi community hospital were summed into one group: the CHW intervention group (treated unit). Chifunga is a public facility which had a catchment population of 10,900 in 2015. The facility provided outpatient department services, as well as maternal health services including ANC, FP, HIV, intrapartum services, PNC, and under-five services. Women with high-risk pregnancies within the last three weeks of their pregnancy, and all women in labour, were admitted at the facility. Lisungwi is a 72-bed community hospital

that provides primary and some secondary medical services. In addition to many outpatient department services, it provides in-patient admissions for male, female, and paediatrics, as well as acting as a referral facility for five health centres including Chifunga. Lisungwi community hospital exclusively provides outpatient and perinatal services to its immediate surrounding villages, a primary catchment area of 9,360 people. For other health facility catchment areas, patients must be referred by their health centres to access outpatient and perinatal services. In total, the CHW intervention catchment area had a combined population of 20,530, with 5,091 WCBA estimated to be eligible for the CHW intervention.

A synthetic control unit was created from the health facility catchment areas that did not receive the CHW intervention (see Table 1). Facilities that had user fees in 2015 were excluded, since there is evidence of lower utilisation of some services in facilities charging user fees in Neno (Watson et al., 2016). After removing five facilities that charge user fees, the remaining six facilities were used for the creation of the synthetic control unit: Zalewa, Midzemba, Ligowe, Magaletta, and Luwani health centres, as well as Neno district hospital (see Figure 1).

Table 1: Adjusted population of Neno health facilities in 2015 (Projected from 2008 Malawi national census).

Facility Name	2015 Projected Population	2015 Number of Households
Chifunga*	10,900	2,180
Ligowe**	11,345	2,269
Lisungwi*	9,360	1,926
Luwani**	4,567	913
Magaleta**	8,267	1,653
Matandani***	9,961	1,992
Matope***	16,739	3,348
Midzemba**	12,913	2,583
Neno District Hospital**	18,927	3,785
Neno Parish***	6,129	1,226
Nkula***	2,047	409
Nsambe***	14,141	2,828
Zalewa**	11,066	2,213

NB: 1) *Intervention site 2) ** Public facilities used for creating synthetic control 3) ***

Facilities with user fees

3.6 Community health workers intervention

The three-delays model originally conceptualized by Thaddeus & Maine (1994) and modified by Gabrysch & Campbell (2009), was used to understand how CHWs improve maternal health services utilisation. In this model, successful prevention of maternal deaths and improvement of maternal health outcomes can be achieved by promoting a decision to seek maternal health services, the identification of care needed and individual travel to health facilities to access health care, and timely treatment when the women are finally at the health facilities.

The hypothesis of this pilot intervention is that CHWs would improve perinatal health service utilisation by addressing the first two barriers: promoting timely and appropriate decision making towards maternal health services and early identification and referral of women to health facilities that offer perinatal services. Specifically, CHWs will directly contribute to increasing utilisation of ANC, facility based births, and PNC services firstly by physically escorting women suspected to be pregnant to health facility, all pregnant women to all ANC visits, intrapartum care, and PNC visits. Secondly, CHWs will continuously give education and counselling during monthly household visits.

In this study, CHWs were planned to be assigned to households with an average of one CHW to 20 households. This was a shift from how CHWs were assigned prior to this intervention as they were assigned based on number of patients with one CHW looking after 5-8 HIV/tuberculosis patients. The shift from patient to household approach necessitated to adjust the number of CHWs with an addition of 83 new CHWs to bring the number of CHWs in the intervention area to 211.

CHWs were selected by the communities in consultation with local leaders based on pre-designed protocols. The protocols emphasised that CHWs should know how to read and write the local language, should have good behaviour and should reside where they will work. Upon selection of CHWs by communities, they received a simple test to see if they know how to read and write. Upon passing this exam, CHW received a 5-day perinatal care training.

The 5-day CHW training consisted of pre and post examination, and covered topics around home visits, counselling, education and referral to perinatal services for pregnant and postnatal women. Upon finishing the training, they received a certificate of attendance. Due to large numbers of CHWs that needed training, CHWs were trained and deployed between February and May 2015.

All CHWs received a stipend equivalent to \$20 USD in 2015 by PIH and were provided with household registers, writing materials, and other tools for use in the community. Supervision was provided at three levels. Firstly, a group of senior CHWs was selected among the CHW group. Each senior CHW received an extra 2 days training on supervision and mentorship. Senior CHWs supervised a maximum of 10 CHWs in addition to an average of 10 households assigned to themselves. Secondly, two facility level supervisors were hired to provide supervision and mentorship of the senior CHWs. Finally, a dedicated CHW officer and monitoring and evaluation officer were hired to for overall management of the CHW programme.

The CHWs were deployed to specifically provide the following services in addition to HIV and TB work:

- 1) Conduct monthly household census among WCBA and ask questions on who might be pregnant. If they found a woman who is likely to be pregnant, CHWs physically escorted the woman to health facility for pregnancy confirmation and enrolment.
- 2) Physically escort pregnant women to all scheduled (a minimum of one visit per trimester) and emergency ANC visits, escort women to facility for labour and facility births and escort women two times to postnatal care (at one and six weeks post giving births).
- 3) Visit pregnant women once every month during the household visit to provide education on perinatal health service and birth preparedness.

Data from CHWs were aggregated at community level before they were aggregated at facility level. The data were used for improvement within the CHWs programme and was also shared with the local facilities every month.

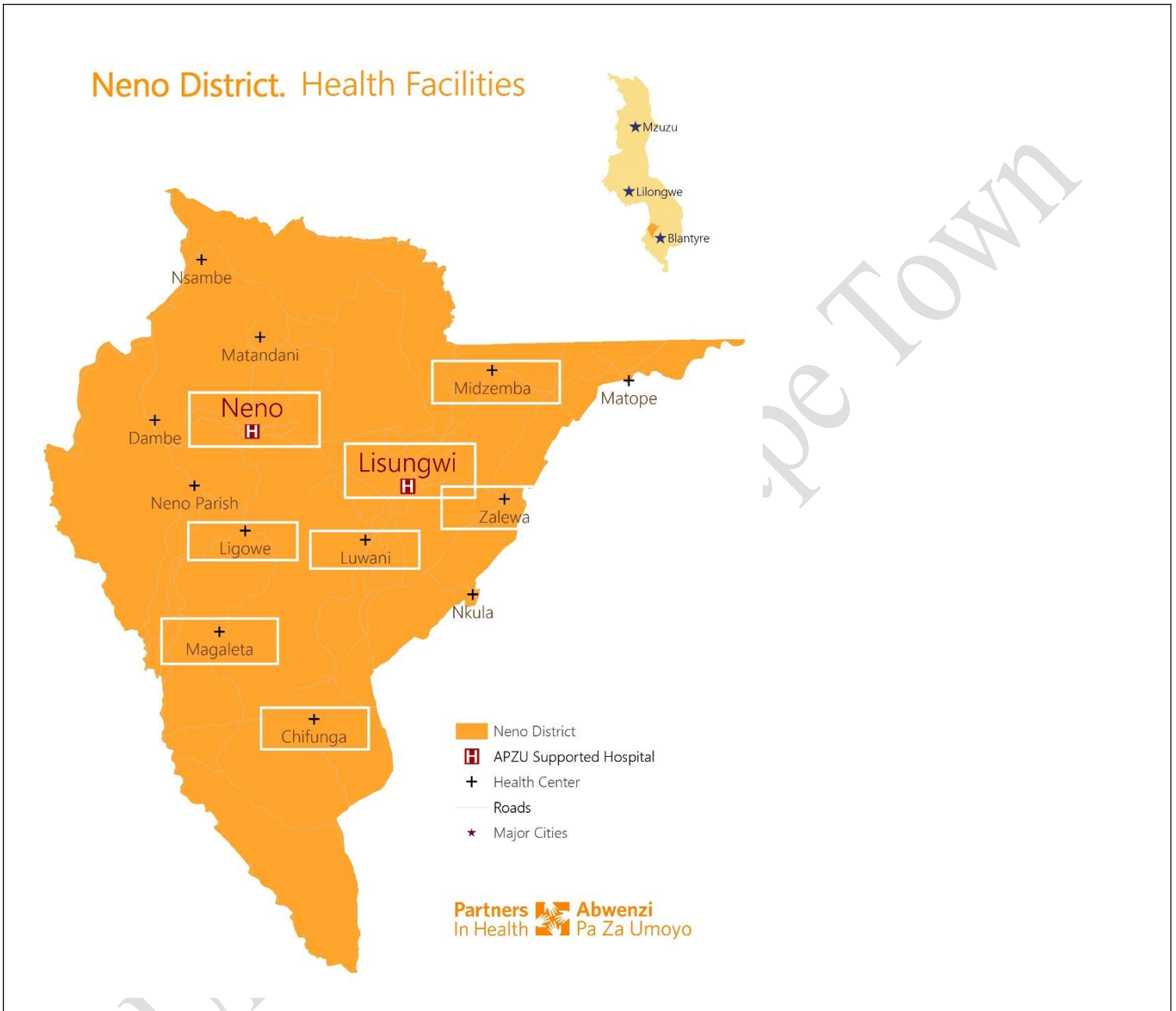
To ensure that facilities in intervention site were able to effectively manage pregnant women during perinatal clinics, the two facilities received some additional support to meet minimum standards. Both facilities benefited from a construction of maternity waiting home to allow pregnant women who live very far to await labour two to three weeks before labour. Depending on needs every month, the facilities received extra medical supplies from MoH and PIH to ensure they provide EmOC services. Due to acute shortage of nurses, Chifunga health facility received an extra nurse who was hired by PIH. At the request of communities, the two facilities received 23 bicycle ambulances to ease transportation from community to facility during an obstetric emergency. Two community awareness campaigns per quarter were also conducted in the CHW catchment areas.

3.7 Outcome and measurements

The differences between the CHW intervention unit and the comparison synthetic control unit was measured for the following outcomes:

1. ANC: ANC data were collected routinely from all pregnant women who began ANC at a specific facility using a standard MoH ANC register. These registers record information on all visits and interventions that were done during the antenatal visits. This data was routinely aggregated on a monthly basis using a standard MoH aggregating forms and entered into the District Health Information System (DHIS) 2. The monthly reports were a cohort analysis examining outcomes for women who were expected to give birth that month. From the monthly reports, the following specific outcomes were extracted:
 - a. New ANC visits: The total number of new ANC visits;
 - b. Early ANC Initiation: The proportion of pregnant women who started ANC in the first trimester. This proportion was calculated as women who attended ANC in the first trimester in relation to the total number of women in the cohort for that specific month's report;
 - c. Complete ANC: The proportion of pregnant women who completed four or more ANC visits. This was measured as all women who attended four or more ANC visits in comparison to the total number of pregnant women in the cohort for that month;
 - d. Facility based births: Total monthly facility births at each facility; and
 - e. PNC visits: Total monthly PNC visits per month for each health facility.

Figure 1: Map of Neno showing the health facilities (Community health worker intervention and control facilities are in the box)



3.8 Data collection and analysis plan

During the implementation phase, monthly CHW data were collected, aggregated, and stored in a special database. The data, obtained from CHWs, included the number of women screened per month, pregnancies identified, and women accompanied and/or referred to the health facility.

The data were analysed using summary statistics such as frequency, mean, and percentage.

For the key outcome indicators – ANC visits, facility based births, and PNC visits – aggregated monthly reports were obtained from the DHIS 2.

All the information in the DHIS 2 and the CHW registers were extracted and stored in a database created and maintained by PIH. This database was updated monthly during the CHW implementation phase, and contained both CHW and facility based data. Permission to use this data was granted by both PIH and the MoH. During the data cleaning and analysis process, all missing data on the perinatal outcomes were collected by cross-checking with a copy of the facility's monthly reports compiled at the MoH local data office. If no data were found, local health facilities were asked to reproduce the report from the source register. If the facility could not produce a monthly aggregated report for that month, or if part of the report was missing, only missing aggregated number was excluded from our analysis.

Bayesian formulation of Brodersen et al. (2015) that permits dynamic covariate effects, seasonal effects, and local linear time trends was used to show a causal effect. A slab and spike prior was used for the model coefficients that effectively let the data choose which coefficients to include in the model to create the counterfactual time series prior to and after the intervention.

The Bayesian method also facilitated inference, which is difficult under other approaches that use 'placebo tests.' Using observed pre-intervention data, we simulated posterior predictive

distribution over the counterfactual time series and computed the posterior prediction of point wise impact from the posterior predictive samples, and hence credible intervals at 95% for the treatment effects were simply estimated. Credible intervals rather than confidence intervals were used because in Bayesian approach to the synthetic control method, we were estimating an outcome (which is treated as random) based on the observed data (which is fixed). Therefore, 95% credible interval meant, given our observed data, the value of the outcome parameter lied within a 95% fixed credible region. This is in contrast to frequentist approach which uses confidence intervals and measures the certainty that the true parameter falls within a 95% region given parameter (fixed in this case).

All data were aggregated and cleaned using Stata version 14, produced by Stata Corp, USA. The outcomes and causal effect were analysed using both Stata version 14 and R (R core team).

3.9 Bias

As a quasi-experimental study, the study may have been affected by performance bias which cannot be corrected by the synthetic control method (Viswanathan et al., 2013). In this type of bias, pregnant women in control sites may have been using the facilities in the CHW intervention to benefit from the perceived better care at the CHW intervention sites.

3.10 Generalisability

The study was conducted in only two health facilities in Neno. These sites may be different to other health centres. Additionally, other areas in Malawi and beyond may be contextually and culturally different from our CHW intervention sites. Therefore, the study may not be generalisable to other settings. However, broad lessons can be drawn from this study and applied to CHW programmes in other settings.

3.11 Validity and reliability

In quantitative research, the extent to which a research tool or instrument measures an outcome is defined as validity (Heale & Twycross, 2015). Although we did not pilot the monthly reporting data collection tools, the data collection tools for our outcomes (i.e. ANC, facility based births, and PNC) were designed by the MoH and were used nationally in Malawi. From experience with other data collection tools designed nationally, the tools are routinely piloted and reviewed as necessary before they are adapted for use. Additionally the synthetic control method has been used in many studies and validated against other methods for causal effect and shows valid results in comparative studies (Kreif et al., 2016). Other authors have argued that the synthetic control method is one of the most important innovations for evaluating causal impact in the absence of randomisation as it has a stronger method for creating the comparison site (Athey & Imbens, 2016).

Reliability measures the consistency of the results if the study is repeated in a different context (Heale et al., 2015). This study depended on designing a CHW programme with clear and specific job description of CHWs on perinatal care services. Additionally, the intervention was coupled with improvements in health facilities to ensure facilities have a minimum package of perinatal care. Therefore, if a programme is designed similar to this study but in a different context, the results can be replicated. However if the CHW and supporting intervention are different, the results may be not be reliable.

3.12 Ethical considerations

Although the study did not actively involve humans, ethical principles were adhered to, as described in the Declaration of Helsinki (World Medical Association, 2013). The aggregated data used in this study was already anonymised when the monthly reports were written. In an

effort to maintain confidentiality and avoid harm to patients, all data were kept confidential in password-protected documents, and were made accessible only to study investigators. The study used routinely collected data, and informed consent from patients was not obtained. Ethical approval to evaluate clinical programmes implemented at PIH was obtained from the National Health Sciences Research Committee (reference #1216), a regulatory body that approves all studies within Malawi. Additionally, approval to conduct the study was obtained from the University of Cape Town Human and Ethics Committee and the local MoH.

3.13 Risks and benefits of the study

The use of routinely collected and disaggregated data poses minimal risks to patients as the information cannot be linked to individuals. The CHWs will potentially increase the number of women enrolled in ANC and promote early timing to ANC. Additionally, women will be encouraged to deliver at facilities and complete PNC care. These changes will ensure women obtains all necessary care at the health facilities whether they present routinely or have complications. The successful management at local health facilities will improve pregnancy outcomes and reduce maternal morbidity and mortality. Finally, the study may guide implementation of similar CHW programmes in the rest of Neno, the rest of Malawi and globally.

4. CHAPTER 4: RESULTS

This chapter presents the key CHW performance indicators within the first year of the CHW programme implementation (March 2015 to February 2016), changes in perinatal services in the CHW intervention area and changes in utilisation of ANC, facility based births and PNC using the synthetic control method.

4.1 Data completeness

All data for the CHWs' performance during the first year were completely retrieved. Among the six available facilities for creation of synthetic control unit, we removed one facility, Midzemba, because almost all data for our outcomes were not available as the facility was not providing these services during the duration of the study.

Data on ANC and PNC was obtained from all five sites and were used to create synthetic control unit for ANC and PNC outcomes. All data during the study duration was available for new pregnant women enrolled in ANC, pregnant women completing four or more ANC visits and PNC from all five control sites. However, for pregnant women starting ANC in first trimester, we excluded one facility (Ligowe) in creation of synthetic unit and used the remaining four sites as Ligowe had a missing value for November 2015. All attempts to retrieve this value failed and source registers could not be found. There was no missing data for all outcomes in the CHW intervention sites during the study duration.

4.2 Community health workers' performance indicators

A total of 211 CHWs were identified and deployed in the CHW intervention area (Chifunga and Lisungwi catchment areas). In this intervention site, 20,530 people were living in 4,106

households based on the actual census by CHWs at the beginning of the intervention. Applying the 2008 Malawi national census estimates that 25% of population are WCBA, it was estimated that about 5,132 WCBA were living in the intervention site. However, based on CHW household registers and at full implementation of the programme, the average number of WCBA reported by CHWs was 3,147 with a range from 3,036 to 3,218. If the WCBA national census estimate is true, CHWs covered approximately 61.0% (3,137 women out of 5,132) of WCBA living in the intervention site every month. Although it was not possible to confirm the actual number of WCBA during the CHW intervention period, it is possible that the actual number of WCBA in CHW intervention area was within 3,036 and 3,218. It was not possible to ascertain the numbers at first because the study used the Malawi nation census estimates for WCBA, estimates commonly used by MoH to project population catchment areas in Malawi.

Each month, CHWs reported on suspected pregnant women. These were WCBA who had missed their last normal menstrual period at least once and women that have declared themselves to be pregnant and are not yet enrolled in ANC clinic. In the first year of intervention, an average of 97 WCBA (representing 3.6% of WCBA screened per month) were suspected to be pregnant and were immediately referred to the nearest facility. The number of referrals for pregnancy confirmation and enrolment to ANC clinic were highest in the first four months of the CHW intervention, averaging 131 women per month (5.6% WCBA per month). To ensure no delay in enrolment to ANC clinics, CHWs were required to escort WCBA who might be pregnant immediately to the nearest facility. Among the 97 suspected pregnant women per month, over two thirds (67.8% or 66 women per month) agreed and were successfully escorted to the facility for pregnancy confirmation and/ or enrolments to ANC clinic.

CHWs also reported on pregnant women who were already enrolled for ANC and postnatal women within the first six weeks after giving birth. Every month, CHWs visited an average of 254 pregnant women in their households. Additionally, CHWs visited an average of 64 postnatal women in their households every month and among these women, 44 women were successfully escorted to PNC clinic every month.

4.3 Changes in utilisation of perinatal services in the community health workers intervention site

During the first 16 months of the CHW intervention (March 2015 to June 2016), a total of 1,563 new pregnant women were enrolled in ANC clinic in the CHW intervention area. In comparison to the previous 12 months before the CHW intervention, the total number of pregnant women in an ANC cohort irrespective of gestation age increased from 79 to 103 women per month. With regard to timing, the number of women starting ANC in first trimester increased from 10 to 29 women per month. In an effort to standardise the number so that they are applicable and comparable to other areas, the proportion of pregnant women completing four or more ANC was calculated as the number of pregnant women starting ANC in first trimester over the total pregnant women in the cohort. The proportion of women starting ANC in first trimester increased from 13.1% (10 out of 79 pregnant women in ANC cohort per month) every month to 28.6% (29 out of 103 women in an ANC cohort every month), an 118% change from 12 months prior to CHW intervention.

The number of pregnant women completing at least four ANC visits also increased in comparison to 12 months prior to CHW intervention. The number of women completing four or more ANC increased from 22 to 40 pregnant women per month in the ANC cohort. Calculated over the total ANC women in cohort, the proportion of women completing four or more ANC

visits every month increased from 28.5% (22 out of 79 women per month) to 39.0% (40 out of 103 women per month), a 27% change from baseline.

Finally, the number of women delivering at the health facility increased by 20% (from 85 to 102 facility based births per month), and the number of women attending PNC increased by 14% (from 44 to 50 postnatal visits per month).

4.4 Impact of community health workers' intervention by using synthetic control

In order to ascertain whether the results were not due to chance, we used the synthetic control method to compare changes in the intervention site with the counterfactual synthetic unit (created from available control sites in Neno) to determine the net difference and significance of CHW intervention. As can be seen from the figures 2a, 3a, 4a, 5a and 6a, the CHW intervention trend (black continuous line) matched the synthetic unit before the intervention shown by the CHW intervention trend staying within the 95% credibility region (blue region) of the synthetic unit time series trend (dotted blue line). After intervention (after February 2015), the CHW intervention time series trend mostly deviates above the synthetic unit time series trend as the CHW are deployed. Figures 2b, 3b, 4b, 5b, 6b shows the point wise intervals of the outcome allowing the temporal changes of outcomes of interest. Except for figure 6a, the point wise estimate has values mainly near zero pre-intervention and above zero after intervention signifying positive changes in our outcomes after CHW intervention. Table 2 summarises the percentage change in outcomes of interest between the CHW intervention and the counterfactual synthetic unit.

Table 2: Results of main outcomes after community health worker intervention

Outcome (average per month)	Synthetic unit outcome	Community health worker intervention outcome	Percentage change (% ^a , CrI ^b)	P value ^{##}
Number of new pregnant women enrolled in antenatal care	83	98	18.0 (8.0,29.0)	0.001*
% of pregnant women starting antenatal care in first trimester	9.5	29.0	200.0 (162.0, 234.0)	0.001*
% of pregnant women completing 4 or more antenatal visits	28.0	39.0	37.0(31.0,43.0)	0.001*
Number of monthly facility based births	85	102	20.0 (13.0, 28.0)	0.001*
PNC visits	79	50	-37.0 (224.0, 170.0)	0.21

^a Percentage,

^b Credible interval

* Significant results

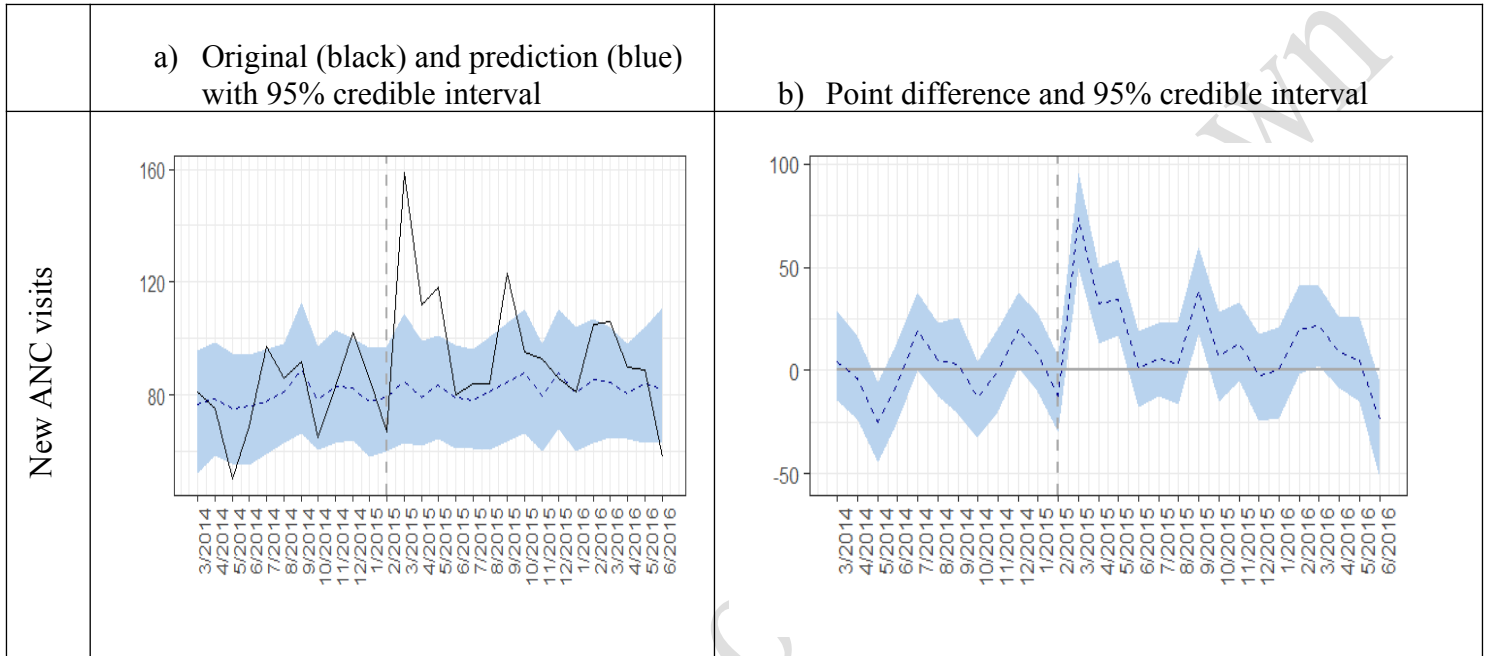
[#]p value signifies that the probability of getting the intervention effect between intervention and its counterfactual site by chance is very small.

4.4.1 Community health workers' impact on antenatal care visits

Figure 2 shows the time series for the CHW intervention site and predicted counterfactual synthetic control unit response. As can be seen from the trend, the CHW intervention had the effect of initially rapidly increasing the number of pregnant women enrolled in ANC within the first four months before returning to its pre-intervention level. The number of new pregnant women enrolled in ANC increased from 83 women per month if we did not have the CHW

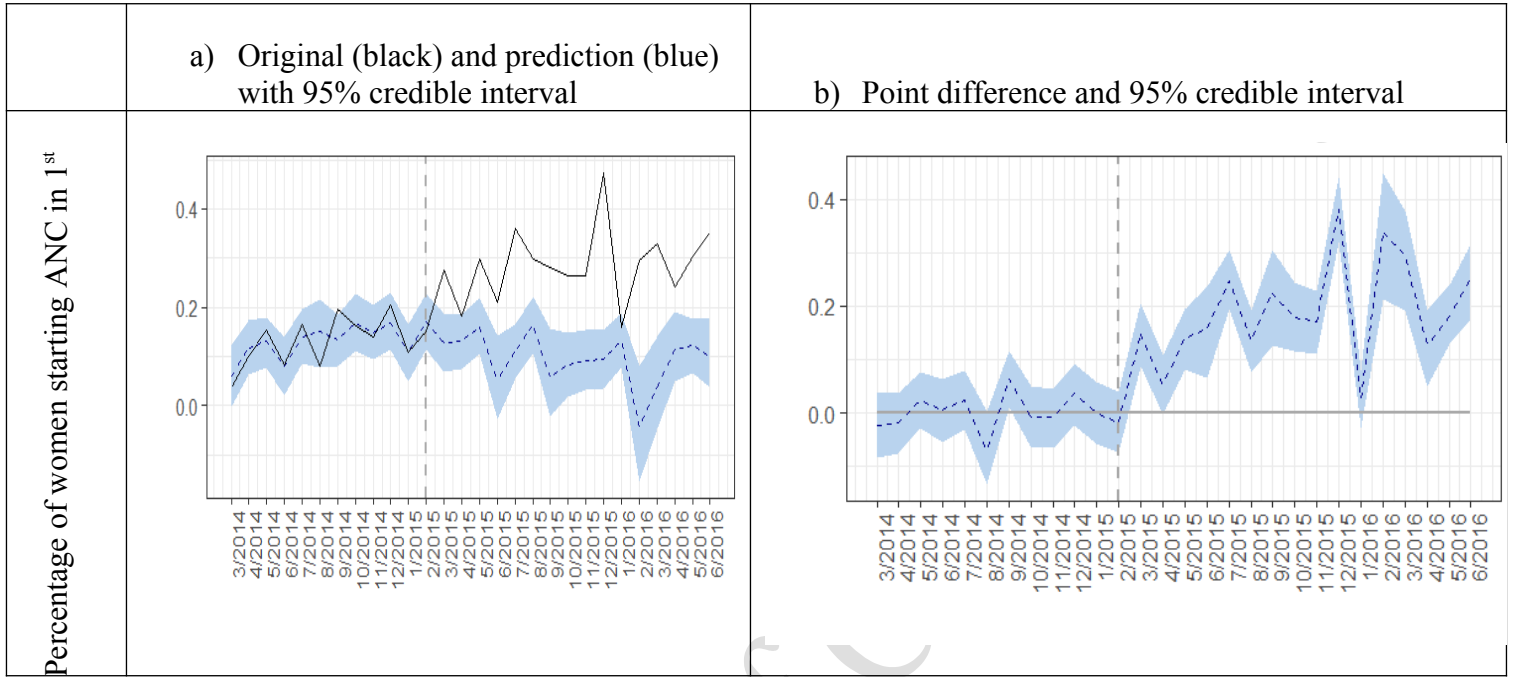
intervention to 98 women per month with the CHW intervention, representing an 18.0% [95% CrI: 8.0%, 29.0%] increase in new ANC enrolments.

Figure 2: Number of pregnant women newly enrolled in antenatal care between the community health workers' intervention site and its synthetic control between March, 2014 and June, 2016.



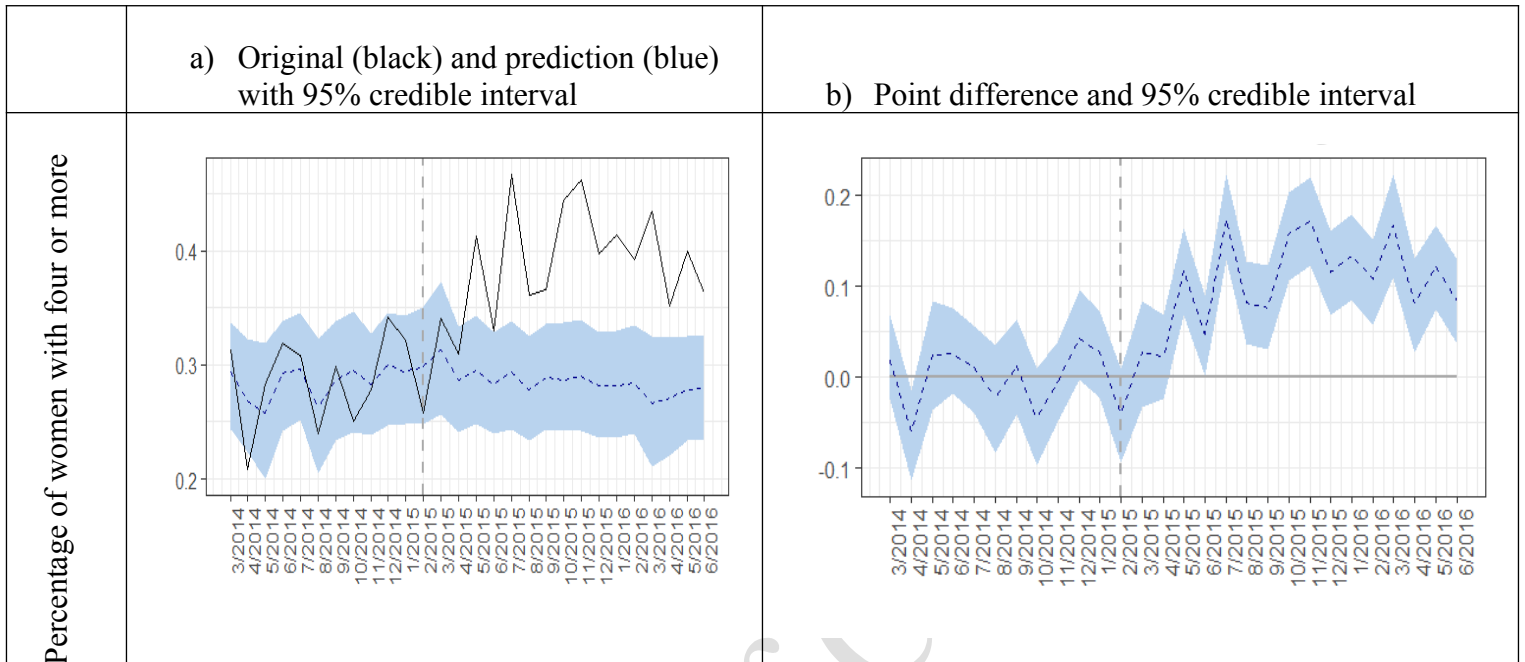
CHWs did not only increase the number of new pregnant women starting ANC, but also increased the proportion of pregnant women starting ANC in the first trimester and completing four or more ANC visits. The CHW intervention increased ANC visits in the first trimester by 200.0% (95% CrI 162.0%, 234.0%) from 9.5% per month without the intervention to 29.0% with CHW intervention (Figure 3). Proportion of pregnant women completing four or more ANC visits increased by 37.0% (95% CrI 31.0%, 43.0%) from 28.0% without the intervention to 39.0% with CHW intervention (Figure 4).

Figure 3: Percentage (%) of pregnant women starting antenatal care in first trimester between the community health workers' intervention site and its synthetic control between March, 2014 and June, 2016.



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Figure 4: Percentage of pregnant women completing four or more antenatal care visits between the community health worker intervention site and its synthetic control between March, 2014 and June, 2016

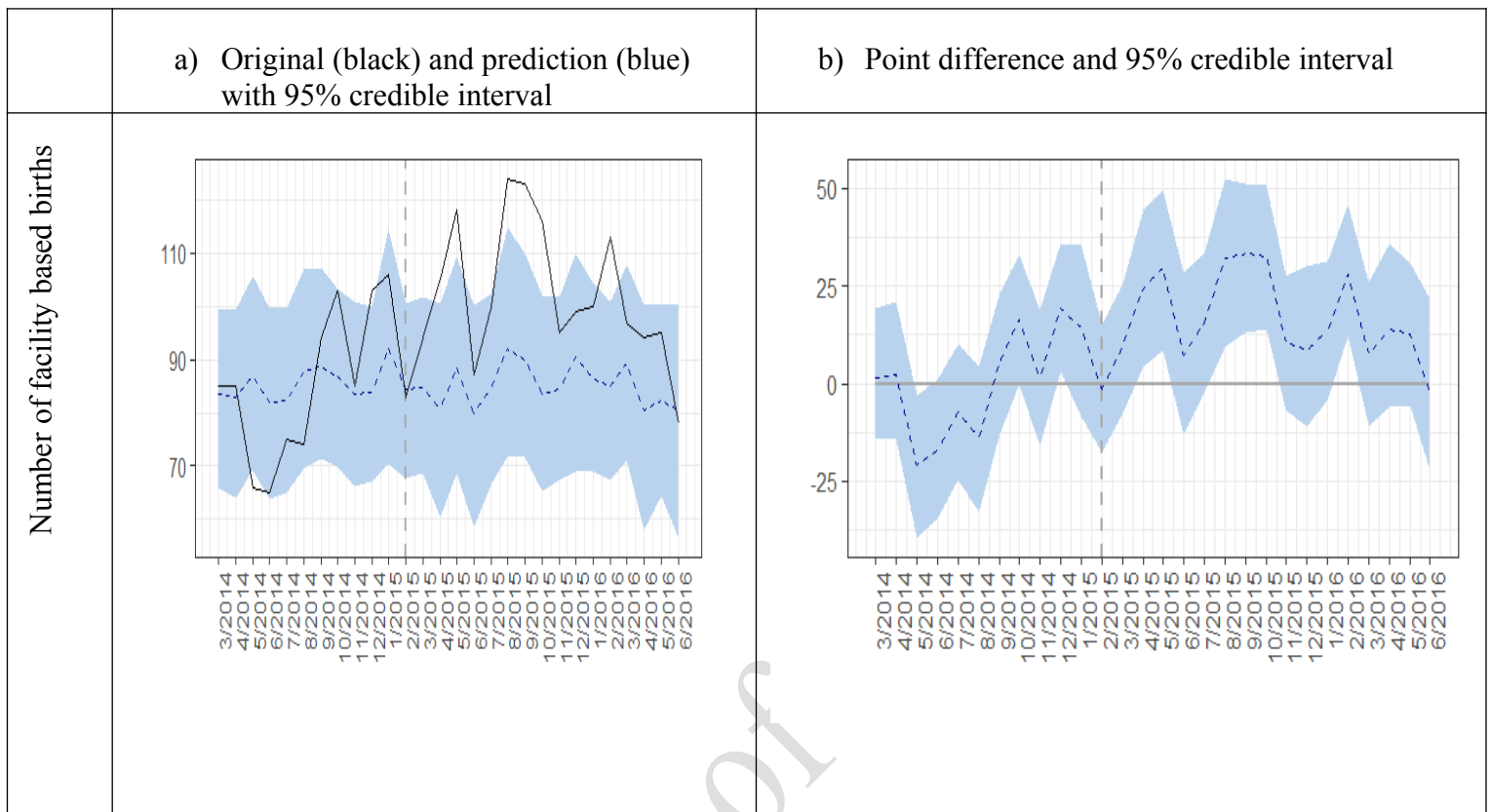


4.4.2 Changes in facility based births

As seen in Figure 5, CHWs increased the number of women giving births within the facilities.

The average post-intervention number of facility based births was 20.0% [95% CrI 13.0%, 28.0%] higher than the expected synthetic control outcome of 85 [95% CrI 79, 91] births per month (Figure 5).

Figure 5: Number of facility based births between the community health worker intervention site and its synthetic control between March, 2014 and June, 2016

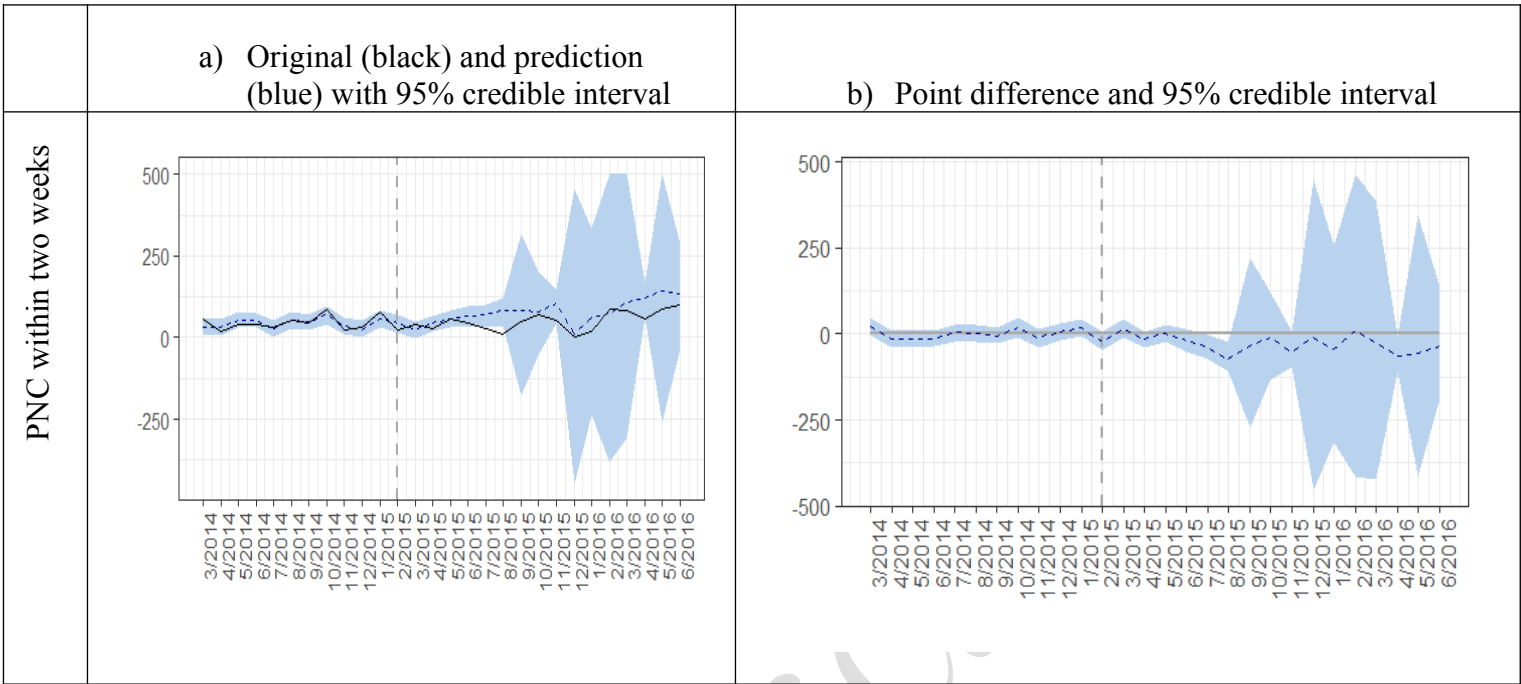


4.4.3 Community health workers effect on Postnatal care

The net effect of the CHWs on PNC was -37.0% (95% CrI -224.0%, +170.0%) (Figure 6).

Therefore, there was little evidence that the CHW intervention had an effect on the number of women receiving PNC within two weeks after giving births.

Figure 6: Utilisation of postnatal care between the community health worker intervention and its synthetic control between March, 2014 and June, 2016.



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5. CHAPTER 5: DISCUSSION

This study was conceived to address the challenges of inadequate utilisation of perinatal services in Neno district, Malawi using CHWs. More specifically, the study examined the changes in utilisation of new pregnant women enrolled in ANC clinic, pregnant women starting ANC in first trimester, pregnant women completing four or more ANC visits, facility based births and women utilising PNC.

CHWs reached as high as 60% of estimated WCBA living in the catchment area every month. However this number is an estimate based on the 2008 Malawi national census, which assumes stable population growth and similar proportions of WCBA by 2015. By using 211 CHW registers at full implementation, the total number of WCBA in the two intervention areas ranged from 3,036 to 3,218. As CHWs made a full household census of WCBA at least once a month, it was possible that they could not find all WCBA in their households every month. Due to consistency of reporting within this range by CHWs, it is possible that the number of WCBA was within this range rather than the Malawi national census estimate. Sustained efforts by well-trained members of the community, the CHWs, may have reinforced the positive behaviour of WCBA towards perinatal services. By visiting each household every month, CHWs were providing sustained community education and mobilisation, and identifying women that were pregnant based on screening questions (Lehmann, Friedman & Sanders, 2004). Additionally, the CHW community intervention did not only provide the services closer to the whole community, but also brought equity in the distribution of maternal health services in Neno (Carroli & Rooney, 2001; Lassi et al., 2014).

5.1 Community health workers and antenatal care utilisation

The multi-purpose advantages of ANC in reducing maternal deaths, including facility based health education as women interact with the health system multiple times, screening and treatment of pregnancy related conditions, screening and treatment of other SRHR, demonstrate how critical it is to improve utilisation of ANC if MMR is to be reduced (Carroli et al., 2001; Campbell & Graham, 2006). In this study, the CHW intervention site had a significant increase in women enrolled in ANC, women starting ANC in the first trimester and women completing four or more ANC visits in comparison to the counterfactual site. The CHW community based changes mirrored facility based changes in ANC utilisation.

The highest number of women were enrolled in ANC within the first four months, with an 18.0% increase (from 83 to 98 new women per month) in new women enrolled in ANC, a 200.0% increase in the proportion of women attending ANC in first trimester (from 9.5% to 29.0%) and a 37.0% increase (from 28.0% to 39.0%) of women completing four or more ANC visits. The increase in ANC enrolment is similar to a quasi-experimental study in Pakistan where CHWs increased ANC utilisation by 16% in comparison to control sites. In this study, ANC enrolments at least once was reported, with no division of ANC by gestation age (Memon et al., 2015). Similarly, a CHW intervention in Bangladesh increased at least one ANC visit to a health facility by 20% higher than the control sites (Darmstadt et al., 2010). Other studies in Lesotho and Tanzania also showed increases in one or more of the ANC outcomes measured in this study (Afework et al., 2014; August et al., 2016; Lema et al., 2014). However, the increases in ANC enrolment is not uniform across studies, as shown by a study in Ghana. In this cluster randomised study between CHWs intervention and control sites without CHWs, there was no significant change in women completing four or more ANC visits between intervention and

control sites (Kirkwood et al., 2013).

In this study, the increases in total ANC visits, ANC in first trimester, and four or more ANC visits may have been achieved by CHWs in many ways. Firstly, the CHW intervention resulted in identifying women that were pregnant before they presented to a health facility. As has been shown in Tanzania, CHWs were successfully used to identify pregnancies and over 75% of new pregnant women enrolled in ANC clinic were first identified by CHWs (Lema et al., 2014).

Although the context, culture, and health systems may be different, the concept of community identification of pregnancies by CHWs was also feasible in Neno, Malawi as CHWs suspected about 3.6 (97 women per month) of WCBA to be pregnant every month and referred over two thirds to nearest health facility.

Secondly, the impact of the CHW intervention was immediate as the highest number of identified and enrolled women to ANC clinics were within the first four months of the intervention. In the first four months, about 131 women were referred for ANC every month; higher than an average of 96 women per month throughout the intervention period. CHWs may have found a lot of pregnant women that had not yet started ANC and may have referred these women to care. By making households visits, CHW may have addressed the challenges of distance to formal health facility, ignorance of existing services and provided rationale for utilising health services early.

Thirdly, CHWs found pregnant women earlier, as reflected by the changes in the number of women starting ANC in first trimester. In Malawi, over 90% of women attend ANC at least once during pregnancy. Although there is almost universal ANC coverage, many pregnant women start ANC late (NSO et al., 2017). In Malawi, women avoid disclosing their pregnancies due to

fear of witchcraft, possible embarrassment if the pregnancy occurs out of wedlock or within adolescent years and in general, to avoid gossip in fear that the pregnancy may not come to term if disclosure is made early (Pell et al., 2013). As trusted community members, CHWs may have addressed these challenges and encouraged women to start ANC early.

Lastly, the CHW intervention had one of the highest linkages to care for ANC, where almost seven out of ten women were immediately escorted to a health facility. One of the main barriers to attending ANC clinic is the long distance to health facilities, which may have been resolved by encouraging and escorting women to care (Benti Tefera & Kuti, 2015; Creanga et al., 2017). Although the study did not explore which method of referral was better than the other (for example, referral letter versus escorting patient to health facility), escorting the patient to the health facility may have provided a direct link to ANC clinics. Further studies can explore which method of referral is more effective in rural Malawi.

5.2 Community health workers and facility based births

Utilisation of facilities for intrapartum care by skilled staff is one way of addressing MMR as many deaths occur in and around this period (Campbell et al., 2006). Therefore, skilled attendance during child births in health facilities has been advocated as one of the best ways of reducing maternal deaths as emergency interventions can be provided when women develop unexpected complications during labour and after giving births (Campbell et al., 2006). In Malawi, this strategy could help reduce as many as 71% of maternal deaths that occur during facility births and postnatal period (Mataya, 2015). Encouraging women to give birth at the facility is therefore the first step in Malawi as many barriers, including distance, prevent women from utilising facilities for giving births. In this study, facility based births increased significantly (by 20% above counterfactual synthetic site). The increases in facility based births

is impressive, considering that in Malawi over 90% of women are reported to give birth within health facilities – hence, the margin of improvement may have seemed small at the beginning of the CHW intervention (NSO et al., 2017). Similar improvements have been shown in other studies in LMICs (August et al., 2016; Darmstadt et al., 2010). In this study, utilisation of facility based births may have been achieved by CHWs promoting birth preparedness during pregnancy and escorting women to maternity waiting homes, as well as maternity units.

5.3 Community health worker intervention and postnatal care

Improvements in utilisation of PNC should be strengthened. This is important as pregnant women and newborns are more likely to develop complications and die in and around labour and usually within the first week after giving birth (Sines et al., 2007). Additionally, PNC provides opportunities for promoting essential maternal and newborn interventions including breastfeeding support, depression support, prevention of mother to child transmission of HIV, promotion of immunisation, growth monitoring and adoption of early postpartum FP (Kerber et al., 2007). However in this study, the CHW intervention was not associated with changes in PNC utilisation. This is not uncommon, as evidence of CHWs' impact on PNC has not been uniform across studies. For example, in Bangladesh, CHWs had an impact on improving PNC utilisation, while in Ethiopia there was no significant improvements in PNC utilisation (Darmstadt et al., 2010; Medhanyie et al., 2012). Understanding the importance of PNC, reasons why CHWs did not have an impact on PNC utilisation in Neno should be investigated. However, from clinical experience, PNC data capturing system was one of the most neglected perinatal system in Neno during the implementation phase. Whereas ANC and facility based births had dedicated monthly reports, PNC did not have its own monthly report apart from one indicator in the DHIS 2. In

contrast to ANC and facility based births, no standard register, clinic schedule, or package of care for PNC were available in most facilities during the CHW implementation stage.

5.4 Strengths of the study

The study has three main strengths. Firstly, the use of synthetic control method enabled rigorous analysis of the effect of the CHW intervention. Although the implementation of the CHW programme was not randomised, creating a synthetic unit allowed the analysis to be conducted as if randomisation was achieved. In addition, the synthetic unit strengthened the robustness of the choice of comparative site: the synthetic site had similar pre-intervention characteristics as the CHW intervention unit, making the process similar to matching in classic case studies. All eligible and available control sites are used, hence removing bias in selecting control sites. Using multiple control sites was better than one control site, and the control unit was created using observable data (Lepine, et al., 2015; Kreif et al., 2016; Pieters et al., 2016). As a form of quasi-experimental study design, comparative case studies using the synthetic method also allowed for seasonal changes in outcomes of interest to be accounted for, and allowed for unobserved differences in units to vary over time during the duration of the study (Kreif et al., 2016).

Secondly, by applying the Bayesian method, the study was able to demonstrate inference, something that the synthetic control method, as described by Abadie and Gardeazabal (2003), requires sensitivity tests to demonstrate inference.

Lastly, the study strengthened perinatal service provision, record keeping and monitoring and evaluation mainly in the intervention area. In an effort to ensure the services were available as CHWs mobilised women, strengthening of available supplies was essential. As the facilities were interacting with changes in the communities by CHWs, the ability to notice and act to challenges

were improved resulting in positive feedback to health care workers towards improving the quality of care, record keeping and monitoring and evaluation.

5.5 Limitations of the study

The study had several limitations. The study has mainly focused on increasing utilisation of perinatal services and has shown increases in these services. However, the attendance of these services does not necessarily mean WCBA received better quality care, as some facilities may not have the capacity to provide comprehensive perinatal services.(Creanga et al., 2017). With support to facilities, we believed that facilities were able to provide quality care, although a formal evaluation of the quality of care at the intervention sites may be prudent.

As part of the intervention, community mobilisation and some facility improvements were done to ensure the intervention facilities provide a consistent minimum standard of care. This would have confounded the impact of the CHW program as this would increase the utilisation of the perinatal services due to perceived better quality of care. However, the changes were necessary as it would have been unethical to identify pregnant women and refer them to a facility that did not have the capacity to properly manage the referred women.

This study was a retrospective study, and as a result we relied on data routinely collected and aggregated by different health care workers at different facilities. Although we performed data quality checks on CHW and facility data in our intervention site, we did not perform quality checks at sites used for creation of synthetic control. For facility based data, we relied on health care worker clinical assessments on utilisation and report writing. We obtained all the data except the missing ANC in first trimester data that excluded one facility from creation of synthetic control of ANC in first trimester. This may have an effect on the magnitude for

outcome for ANC of first trimester.

As far as it known, this is the only CHW intervention that was happening in Neno during the study duration. However, we cannot completely rule out other interventions that were happening that may have had an impact on perinatal services.

In this study, it was assumed that women from the CHW intervention site were not getting care from the non-intervention sites and vice versa but in practice some women may have been moving from one catchment area to another. As one of the area where CHWs were deployed received referrals from other facilities as a hospital, contamination likely occurred which may have had an effect on the outcomes.

Finally, the study investigated and responded to challenges that were contributing to high maternal deaths until 2015. However, between 2015 and 2018, new challenges in addition to current challenges has been identified and needs to be addressed. One of the main challenges that has been identified is the challenge of high maternal mortality in adolescents mainly due to high teenage pregnancies (45% of all births occur in adolescents), low contraceptive prevalence rate and high abortion rate in this group (Malawi government, 2017). It would be important to see if the CHW intervention explored in this study can be developed to address the challenge of high maternal deaths in adolescents.

6. CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Well-trained and well-supervised CHWs – working in programmes that aim to conduct household visits and refer women to first and subsequent ANC visits, as well as maternity and postnatal care – have shown significant improvements in perinatal care utilisation. In comparison to control areas, CHW intervention areas are related to an increase in the number of women starting ANC earlier and completing ANC, as well as women delivering in health facilities. Although not statistically significant, PNC utilisation also increased pre and post-intervention in the CHW intervention sites. These changes were made possible by the important role of CHWs by providing sustained community education, addressing barriers to utilisation of maternal health and acting as WCBA advocates towards the importance of utilising perinatal services.

In an effort to accelerate the reduction of maternal mortality to achieve SDG targets, Malawi should adopt a CHW programme similar to this programme if it would like to improve perinatal services utilisation.

6.2 Recommendations

6.2.1 Local

In Neno district, the design of the CHW programme in this study resulted in several improvements to the design of CHWs. Firstly, it was shown that it was possible to extend CHW tasks beyond tuberculosis and HIV activities. Secondly, lessons were learnt about the equitable distribution of CHWs at household level. Key programme changes, including extra supervision by senior CHWs and structured and supervised data collection system were seen as enabling factors to the positive changes in the utilisation of perinatal services. Based on these local lessons, the following recommendations are made:

1. The study demonstrated the feasibility that CHWs can work on increasing the utilisation of perinatal services, if given maternal health focused training, supervision and data collection tools. Currently this programme was conducted on two out of the 13 facilities in Neno. Therefore, the CHW programme should be changed to include perinatal services and should be scaled to all the areas of Neno facilities.
2. The CHW programme in Neno should be re-designed based on the number of households rather than number of patients as this would ensure all households have a CHW coverage.
3. As part of their work, CHWs should assist with household census every month. This would provide the district with more accurate population estimates in the catchment areas.

6.2.2 *National and international*

In this pilot, CHW community-based packages have been shown to increase the utilisation of perinatal services. In Malawi, where accessibility to services is a challenge, results generated in this study will add evidence on the impact of CHWs on improving utilisation of perinatal services. Therefore, as Malawi will be developing strategies and road maps for improving maternal health and reducing maternal deaths, this research highlights the strategic role and impact of CHWs.

The CHW design, and accompanying package of care, can be adopted in its entirety from Neno to another district in an effort to produce similar lasting results. However, due to differences in funding, context, and purpose of the CHW design, it may not be possible to replicate everything.

However, lessons from some aspects, for example supervision structure, can be adopted and piloted in other contexts.

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8. APPENDICES

8.1 Evaluation of clinical programmes in Neno District approval letter

Telephone: + 265 789 400
Facsimile: + 265 789 431

All Communications should be addressed to:
The Secretary for Health and Population



In reply please quote No.
MINISTRY OF HEALTH AND POPULATION
P.O. BOX 30377
LILONGWE 3
MALAWI

9th December, 2016

Luckson Dullie
Partners in Health
Neno

Dear Sir,

RE: PROTOCOL # 1216: EVALUATION OF CLINICAL CARE IN NENO DISTRICT, MALAWI

Thank you for the above titled proposal that you submitted to the National Health Sciences Research Committee (NHSRC) for review. Please be advised that the NHSRC has reviewed and approved your application for continuation of the above titled study.

- **APPROVAL NUMBER** : 1216
- The above details should be used on all correspondences, consent forms and documents as appropriate.
- **APPROVAL DATE** : 9/12/2016
- **EXPIRATION DATE**

This approval expires on 8/12/2017. After this date, this project may only continue upon renewal. For purposes of renewal, a progress report on a standard form obtainable from the NHSRC Secretariat should be submitted one month before the expiration date for continuing review.



- **SERIOUS ADVERSE EVENT REPORTING:** All serious problems having to do with subject safety must be reported to the NHSRC within 10 working days using standard forms obtainable from the NHSRC Secretariat.
- **MODIFICATIONS:** Prior NHSRC approval using forms obtainable from the NHSRC Secretariat is required before implementing any changes in the protocol (including changes in the consent documents). You may not use any other consent documents besides those approved by the NHSRC.
- **TERMINATION OF STUDY:** On termination of a study, a report has to be submitted to the NHSRC using standard forms obtainable from the NHSRC Secretariat.
- **QUESTIONS:** Please contact the NHSRC on telephone number +265 1 726 418 OR 0888344443 or by email on mohdoccentre@gmail.com
- **OTHER:** Please be reminded to send in copies of your final research results for our records (Health Research Database).

Kind regards from the NHSRC Secretariat.

For: **CHAIRPERSON, NATIONAL HEALTH SCIENCES RESEARCH COMMITTEE**
Office of the Chairperson, National Health Sciences Research Committee
Ministry of Health and Population, Lilongwe, Malawi

Executive Committee: Dr B. Chilima (Chairperson), Dr B. Ngwira (Vice-Chairperson)
Registered with the USA Office for Human Research Protections (OHRP) as an International IRB
IRB Number IRB0003905 FWA00005976

8.2 University of Cape Town Human Research Ethics committee approval

 **UNIVERSITY OF CAPE TOWN**
Faculty of Health Sciences
Human Research Ethics Committee 

Room E52-24 Old Main Building
Grootes Schuur Hospital
Observatory 7925
Telephone [021] 404 7682
Email: nosi.tsama@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

14 November 2017

HREC REF: 647/2017

Ms J Shea
Paediatrics & Child Health
Child Health Unit
Room 3.17
3rd Floor ICH Building
Red Cross Children's Hospital

Dear Ms Shea

**PROJECT TITLE: IMPROVING THE UTILIZATION OF MATERNAL HEALTH RELATED SERVICES:
THE IMPACT OF A COMMUNITY HEALTH WORKER PILOT PROGRAM IN NENO, MALAWI
(MPHIL CANDIDATE - C KACHIMANGA)**

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30th November 2018.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)


We acknowledge that the student C Kachimanga will be involved in this study.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval before the research may occur.

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Yours sincerely



PROFESSOR M. BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

8.3 Neno District Health Office Approval letter

Telephone: + 265 432 355
Facsimile: + 265 432 264

*All Communications should be
addressed to:
The District Health Officer:*



In reply please quote No

Ministry of Health,
Neno District Hospital
P.O. Box 52
Neno

20th November 2017

Chembekezo Kachimanga
Partners in Health, APZU
PO Box 56
Neno, Malawi

Dear Dr C. Kachimanga,

Re: Request to conduct a study on impact of Community Health Workers (CHWs) on perinatal services in Neno, Malawi.

I acknowledge receipt of your request dated 15th November 2017. I am granting you permission to obtain and analyse the requested data. I hope the findings will improve clinical care for pregnant women in Neno, Malawi.

Yours Sincerely,

A handwritten signature in black ink, appearing to read 'L. Nazimera'.

Dr. Lawrence Nazimera (MBBS, GH Fellow)
District Health Officer

