ABSTRACT

The Effectiveness of a Community Health Worker Program in Sigoti, Kenya

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Women from the Luo tribe have the highest HIV prevalence of any ethnicity and gender category in Kenya (22.8%). Due to the high prevalence of HIV, it is important that these women deliver their infants in health care facilities that provide antiretroviral treatment as a means to decrease the rate of mother to child transmission. In addition, the presence of skilled personnel during delivery can avert between 13 to 33% of maternal deaths. Volunteer community health worker programs have been created in many developing nations in order to increase the use of maternal health services. However, the effectiveness of many of these programs has not been established. The purpose of this study is to examine whether a community health worker program in Sigoti, Kenya increased the use of maternal health services from January 2009 through May 2012. Data from the maternal registry at the Sigoti Health Center was analyzed in order to determine if utilization rates changed after the institution of the community health worker program. Data was divided into non-intervention and intervention time frames for comparisons. The number of facility-based deliveries increased from an average of 38 in the non-intervention time frames to 60 in the intervention time frame. This increase was statistically significant ($p=0.014$). However, increases in the risk profile of the women ($p=0.119$), the number of HIV-positive women ($p=0.102$), and mean birth weight ($p=0.100$) were not statistically significant. These findings show that community health worker programs can be used to increase the number of facility-based deliveries. Through such programs, developing nations can potentially increase the number of pregnant women receiving antiretroviral treatment and thereby reduce the rate of mother to child transmission of HIV.

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THE EFFECTIVENESS OF A COMMUNITY HEALTH WORKER PROGRAM IN SIGOTI, KENYA

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To the people living on the Nyakach Plateau for the improvement of their health.

CHAPTER ONE

Introduction

There is a dramatic shortage of healthcare workers around the world, especially in sub-Saharan Africa. Particularly in rural areas, this shortage has decreased accessibility to proper medical care. Kenya has grown to become a leading nation in Africa in the geopolitical realm but lags behind many African nations in several health related factors. Currently, Kenya is one of the most populous countries in Africa and has maintained a relatively stable democratic government despite its presence in the volatile region of Eastern Africa. Despite its geopolitical importance, compared to the rest of the world, and even many sub-Saharan countries, Kenya falls short in health system performance. Some of the barriers to adequate health care include lack of funds, poor health care services, distant health facilities, lack of understanding in how to use the health care system, and a shortage of human resources (Adamu 2002; Byford-Richardson 2013; Hodgkin 1996; Van Eijk 2006). These barriers result in higher mortality rates and lower life expectancy (Byford-Richardson 2013; Van Eijk 2006).

In fact, several health outcomes in Kenya have worsened over the past two decades. For example, life expectancy dropped six years between 1990 and 2008, from 60 to 54 (WHO Kenya Health Statistics Profile 2010). In addition, maternal mortality for the past decade has been on the rise. In 2003 there were 414 maternal deaths per 100,000 live births; however, in 2008 this rate increased 17.9% to 488 maternal deaths per 100,000 live births. In addition, the adult mortality rate for

females in every age group over 35 increased between 2003 and 2008. Despite these worsening statistics there have also been signs of hope. Both infant mortality rates and under five mortality rates have dropped since 2003. Infant mortality has dropped by 32% and under-five mortality by 36% (Kenya DHS 2003; Kenya DHS 2008-2009).

The worsening statistics have multiple causes. Some of the stagnant health statistics have been partially attributed to the government's response. According to the WHO's country brief on Kenya: "This stagnation [of the maternal mortality rate] is attributable to the high disease burden due to existing, and new conditions, and an inadequate response to manage the disease burden" (WHO Kenya Brief 2009). The government's decreasing prioritization of health is evident in the distribution of its expenditures. In 2000, 11% of government expenditures went to health care. In 2007, only 7.8% of total government expenditures were spent on health care (WHO Kenya Health Statistics Profile 2010). In addition, half of total health expenditures are spent on care for either HIV or malaria, creating a further shortage of resources in treating other medical conditions (Kenya National Health Accounts 2009-2010). However, in a developing country like Kenya where the gross national income per capita is $820, which is below the sub-Saharan average of $1,258, not many people are able to afford the costs of health care, especially as food prices have continued to rise over the past few years (World Bank Kenya at a Glance 2011).

When examining the health of Kenya, one finds a deep disparity in the quality of health care that citizens receive. Gender, socio-economic standing, ethnicity, and geographic setting are influential in determining the quality of health care

(Schellenberg 2003; Feikin 2011; Kenya DHS 2008-2009). Rural areas do not contain the infrastructure, wealth, medical equipment, medicines, or medical personnel equivalent to that of urban areas. In addition, Kenyan demographics reveal that a substantial number of people live in rural areas as compared to urban centers. A little over 31 million Kenyans, or 78% of the population, live in rural areas (WHO Kenya Health Profile 2010). To many this means no running water, no electricity, little means of transportation, and the closest hospital being many miles away. These factors often hinder women from giving birth with skilled personnel present. Of women living in rural Kenya, 36.8% gave birth with the aid of skilled personnel, whereas in urban Kenya 74.8% of women gave birth with the aid of skilled personnel (Kenya DHS 2008-2009). Immunization levels also reveal a lack of equity between rural and urban areas (WHO Kenya Health Profile 2010).

In addition, the distribution of health care services is disproportionate between provinces in Kenya. In the Nyanza Province, one of the poorest regions, the ratio of population to health facilities is 8963:1, while in the Central Province, the wealthiest region, the ratio is 4194:1 (Wamai 2009). In addition, mortality rates differ greatly between provinces. The Nyanza Province contains the highest rate of infant and under-five mortality. In the Nyanza Province, the infant mortality is 95 deaths per 1,000 live births, while in the Eastern Province the infant mortality is 39 deaths per 1,000 live births (Kenya DHS 2008-2009). In the Nyanza Province, 1 out of 7 children die before age five, while in the Central Province 1 out of 20 children die before age five (Kenya DHS 2008-2009). Despite the disparity between the Nyanza Province and other wealthier provinces, both infant and under-five

mortality have decreased greatly in the past decade. From 2003 to 2008, infant mortality in the Nyanza Province decreased 28.6% and under-five mortality decreased 27.7% (Kenya DHS 2003; Kenya DHS 2008-2009).

Though an individual Kenyan citizen may experience financial barriers to health care, a far different picture is seen on the national level in terms of money available for health care. The immediate concern in the delivery of health care for many sub-Saharan countries is not a lack of financial resources but the translation of those funds into human resources (Kober 2004). As enormous sums of money have been donated to achieve the millennial goals set forth by the WHO in financially strained countries, the major barrier has now switched from the availability of funds to the problem of human resources to deliver care (World Health Report 2006). It is estimated that in order for the Health Millennium Development Goals to be reached, sub-Saharan Africa would have to triple the current health care workforce (Van Damme 2008).

Sub-Saharan Africa contains 3% of the world's health care workforce and 24% of the world's disease burden (WHO Scaling Up, Saving Lives 2008). However, this ratio is worsened when factoring in that the majority of health care providers are located in the urban centers while the majority of disease burden is among the rural populace (Feikin 2011). Physicians are largely unwilling to move to rural areas, especially when urban centers and developed nations provide larger salaries, more security, and more opportunity for advanced training. A study incorporating final-year medical students in six sub-Saharan countries (including Kenya), revealed that only 4.8% were interested in rural medicine (Ihekweazu 2005). In addition, the

flocking of African-trained physicians to developed countries has especially hurt nations such as Kenya where the ratio of doctors to population is below average compared to the rest of Africa (WHO Kenya Health Profile 2012).

Not only does Kenya lack practicing physicians, the total health workforce is greatly diminished. The WHO states that to achieve minimal health standards the minimal number of health workers required is 2.5:1000. In Kenya's healthiest and most affluent district, Central Province, the ratio is 1.89:1000 (Wamai 2009).

Due to the varying challenges in each of the Kenyan provinces, there has been a recent push to decentralize the Kenyan health system. The Health and Life Sciences Partnership Institute (HLSP Institute), and the Kenyan Ministry of Health published a report saying:

> "At present, human resources are managed by the central Ministry of Health. There is a strong case for granting greater autonomy to districts and provinces to manage their own staff - they are in the best position to understand local health needs and to provide the appropriate staff to meet them. This is one of the recommendations of NHSSP II. The catchment and staffing "norms" do not allow for the variation in demand and morbidity patterns, and should be reviewed urgently" (HLSP Institute 2006).

Greater decentralization would allow for each of the provinces to provide specialized solutions to their specialized needs.

The WHO has encouraged nations struggling with adequate numbers of health workers to establish community health workers (CHWs) as a resource in the medical field (WHO Task Shifting 2008). Community health workers are an integral part of the WHO's millennial goals in reducing various mortality rates and efficiently increasing access to health care. Maternal mortality rates, infant mortality rates, and

under five mortality rates are heavily dependent upon the density of health care workers in the region (Anand 2004).

Community health workers (CHWs) have proven to be unique assets in bringing cheap and effective healthcare to resource poor countries. Whereas professional healthcare workers flee rural areas for more opportunities elsewhere, CHWs have shown resilience in remaining in the communities from which they come. These programs have also shown that they can maintain high retention rates when the CHWs are incentivized, properly trained, properly supplied, and when the community is supportive of their work. There have been several programs instituted throughout Kenya over the past few decades (Kelly 2001; Kisia 2012).

Community health workers deliver healthcare in a variety of ways; for example, they can deliver health care directly by diagnosing malaria and giving medicine for treatment. However, more frequently CHW's affect community health indirectly through referring ill community members and giving health education. By their work, CHWs have reduced morbidity, mortality, and the prevalence of certain diseases in their communities.

One specific way in which CHWs have been used is to increase the utilization of maternal health services, particularly the number of facility-based deliveries (Satti 2012; Medhanyie 2012). Studies have shown that increasing the number of prenatal care visits reduces maternal mortality (Magadi 2001). In addition, several studies have revealed that the presence of skilled personnel at delivery and delivering at a non-comprehensive primary health facility both reduce maternal mortality (Mengesha 2013; Koblinksy 1999; De Brouwere 1998). Despite the better

outcomes associated with delivering in a health facility, only 36.8% of women in rural Kenya give birth with the aid of skilled personnel (Kenya DHS 2008-2009). In some parts of rural Kenya, the percent of deliveries with the aid of skilled personnel are as low as 5.4% (Cotter 2006). In the Nyanza Province, 45.5% of women deliver with the aid of skilled personnel (Kenya DHS 2008-2009).

Another important reason for increasing the use of maternal health services is because of the high prevalence of HIV in many developing countries. Health care facilities in Kenya are equipped with antiretroviral drugs (ARVs). These drugs slow the progression of HIV and reduce the rate of mother to child transmission. Without the use of ARVs during pregnancy, the WHO estimates the rate of mother to child transmission of HIV to be between 15-45%; another study estimates the rate to be about 25% (Connor 1994) while yet another states it to be at 20% (Cooper 2002). However, with the use of ARVs, the rate of transmission can be reduced to 0.8% (Townsend 2008).

It is also important for HIV-positive women to be administered ARVs throughout the pregnancy and afterwards during breastfeeding in order to prevent transmission (Peltier 2009). The Kenyan government encourages HIV-positive mothers to breastfeed due to the greater risk of the infant becoming malnourished. However, because of this decision, the mother to child transmission of HIV increases due to the presence of HIV virus in breast milk. Through the use of CHWs, more HIV-positive women have had access to ARVs during pregnancy, delivery, and breastfeeding, thereby, reducing the rate of mother to child transmission.

Community health workers are important to reduce the impact of HIV because they help to bring women to the health facility for prenatal care, encourage women to deliver at the health facility, and provide follow up to ensure that HIV-positive breastfeeding mothers continue taking ARVs. At each of these three steps it is possible to reduce the rate of mother to child transmission through ARVs. Therefore, CHWs play an important role in alleviating the burden of HIV.

Despite the many success stories of CHW programs, variability in effectiveness exists; therefore, it is necessary to evaluate the effectiveness of newly introduced CHW programs. Two previous studies that analyzed the effectiveness CHW programs in increasing the use of maternal health services include Satti (2012) and Medhanyie (2012). The former study examines a CHW program attached to the Bobete Health Center in Lesotho. The latter study examines health extension workers in Ethiopia.

Satti reviewed a CHW program that was trained by the nonprofit organization *Partners in Health* to increase the number of prenatal care visits, facility-based deliveries, and the amount of pregnant women receiving ARVs. The study took place in a setting similar to the Upper Nyakach Division, a highland region of Lesotho where 77% of the population is rural and many villages are only accessible by horse or foot. In addition, the adult HIV prevalence of Lesotho (24%) is similar to that of Luo women (22.8%). Due to several factors, including the large presence of traditional birth attendants and inaccessible terrain, Satti states that most births do not occur in primary care facilities or hospitals, as is the case with the Upper Nyakach Division. Differences in Satti's study from this study include the

catchment area of the Bobete Health Center (25,000 vs. 8,000 at the Sigoti Health Center), the number of CHWs (100 vs. 30 at the Sigoti Health Center), and that the CHWs trained by *Partners in Health* were incentivized through a graded pay scale based on performance. The results of Satti's study show that their CHW program increased the number of deliveries at the Bobete Health Center from 46 in the year preceding the study to 178 in the year after the study. The Bobete Health Center had the added advantage of having a "lying-in" center where women near their expected due date could stay.

Medhanyie reviewed the effects of a new cadre of CHWs called health extension workers that were established by the Ethiopian government in 2003. More specifically, this study examined the effects of health extension workers in the Tigray region of Ethiopia. Like the Upper Nyakach Division, the Tigray region has a historically low rate of facility-based deliveries (8.6% in 2006) and a largely rural population (80% in 2007). At the time of the study, there were approximately 2 health extension workers for every 5,000 people in the Tigray region and each health extension worker was paid a uniform monthly salary. One of the main purposes of the health extension workers was to increase the number of facility-based deliveries. The results of Medhanyie reveal that, whereas the usage of antenatal care and family planning increased, the proportion of women delivering at a health facility did not change after the institution of the health extension workers. Reasons mentioned by Medhanyie for this stagnation include the low number of health extension workers per population, the distance of health facilities from households, and the population's lack of trust in health extension workers.

Community Health Workers in Western Kenya

There is a long-term plan to build a new clinic in an acutely underserved area of the Nyanza Province and to bring in health professionals who are currently being trained in Kenya. Those who have been directly involved with these efforts and with CHW programs have described the history and the challenges of effectively utilizing CHW in multiple conversations with the author (Personal Communication, May 2012). A Nyanza Province regional health care expert and a public health officer from Kisumu, the capital of the Nyanza Province and the fifth largest city in Kenya, talked about the importance of CHWs in the overall health care delivery system in this region of Kenya. Because residents on the plateau realized the need for training more health workers, CHWs have been used there sporadically for a number of years.

In western Kenya, public health officers often act as administrators and trainers of CHW programs. They also act as the link between CHWs and the health facilities. However, there are a variety of CHW programs in Kenya and not all fall under the administration of public health officers.

Though CHWs are an important part of the health care delivery system in western Kenya, it has been difficult to lower their turnover rate. Unrealized promises of pay and increasing workloads have disincentivized many workers, stated both the public health officer and regional health care expert. However, through offering incentives and through encouraging the workers, many choose to continue. By allowing the communities to take ownership of their own health, many

communities have realized the importance of CHWs and fostered the progress of these programs.

The main tasks of CHWs working under public health officers include: monitoring the health of community members, reporting weekly to the public health officer, participating in community dialogue days, and participating in community action days. Each CHW is given a specific list of households for which they are responsible. The workers visit the households weekly, record who is ill, and refer if necessary. While visiting the households, CHWs will often provide health education. At the end of the week they debrief with their public health officer. Community dialogue days are planned events where communities gather to discuss important health issues. Often during these gatherings a plan will be enacted to carry out a specific intervention, such as a mass vaccination. The days on which the intervention occurs are called community action days.

The public health officer also discussed the role of CHWs in decreasing maternal and infant mortality rates in Kisumu. Before the institution of the CHWs, these rates were much higher. She stated that the main reasons for the decreasing mortality rate include: the increasing rates of facility-based deliveries, prenatal care, and child immunizations. She also stated that now nearly all women living within her district deliver in the health facilities instead of at home or with a traditional birth attendant.

The main cause for referrals in Kisumu is malaria. The public health officer estimated that in the rainy season, up to 80% of the patients in Kisumu hospitals are seeking treatment for malaria. In the dry season, she estimated that this number

drops to 50%. In addition, HIV health services also play a major role in the delivery of health care in Kisumu.

One of the foremost barriers in the delivery of health care that both the public health officer and regional health care expert mentioned is the shortage of health care professionals. They both stated that particular shortages exist in the number of technical staff, such as physicians, nurses, and pharmacists, but that there are also shortages in support staff. However, CHWs are helping to alleviate the problems that arise from a shortage of health care personnel.

Shortages also exist in effective pharmaceuticals. The Kenya Medical Supplies Agency (KEMSA) is in charge of distributing medicines to public health facilities. However, as the public health officer stated, KEMSA often runs out of necessary supplies. In addition, city councils have the responsibility of purchasing necessary medical supplies for municipal health facilities. However, the city councils often do not adequately stock these municipal health facilities. Another barrier to health care delivery in Kenya is the perception among the people that quality health care cannot be received in the public health facilities. The regional health care expert stated that some will not seek treatment in public health facilities because of shortages in both supplies and health care professionals, and on the other hand, they will not seek treatment in private clinics because of the expense. Due to this, some are reluctant to seek timely treatment.

Case Study: Community Health Workers on the Nyakach Plateau in Rural Western Kenya

One of the areas of Kenya with the highest disease burden is the rural and remote Nyakach Plateau in western Kenya. This steep, rocky plateau is accessible only on poorly kept dirt roads or narrow trails. The vast majority of people travel only by walking or occasionally by hiring a motorcycle taxi. The Luo tribe lives in scattered villages amid clusters of 1 to 5-acre plots of land where subsistence farming provides most of the food. There are no industries or manufacturing sites, and this is largely because the plateau did not have electricity until less than two years ago. Despite the introduction of electricity, other types of infrastructure are still lacking, such as sewage systems and water pipelines. Therefore, in order to obtain water people must walk to the closest well or spring. Often, wells and springs go dry during severe droughts. When droughts occur, shortages of food exist and starvation becomes a true threat. In addition, the prevalence of orphans and widows who lack the ability to support themselves has greatly increased due to the HIV epidemic. The Luo tribe has the highest HIV prevalence among any ethnic group in Kenya (20.2%). The next highest HIV prevalence among an ethnic group in Kenya is the Maasai (7.9%).

The Sigoti Health Center

The Sigoti Health Center in Kenya is a government operated health facility located in the village of Sigoti, a rural but highly populated area on the upper part of the Nyakach Plateau (officially known as the Upper Nyakach Division). There are

approximately 8,000 people in its catchment area, though people often travel from more distant locations in order to seek treatment. The health center provides a variety of in-patient and out-patient services, including: HIV counseling and treatment, prenatal care, basic emergency obstetric care, immunizations, and tests for various diseases. There are 12 ward rooms where patients can stay overnight and a delivery ward with two delivery beds. The Sigoti Health Center, as well as the World Health Organization, recommends that women attend at least 4 prenatal care sessions (WHO Antenatal Care). Every woman who attends prenatal care or delivers a baby there is tested for HIV. There are no physicians at the health center, but a clinical health officer comes to see patients for a few days of every week. The other staff members include nurses and a lab technician. Both the nurses and the clinical health officer help deliver infants.

When the Sigoti Health Center is not equipped to handle a case, the health center will refer the patient to either Nyabondo Mission Hospital or health facilities located in Kisumu. Nyabondo Mission Hospital is located approximately 6 km from the Sigoti Health Center while Kisumu is approximately 64 km from the Sigoti Health Center. The most common reasons for referral are fractures, injuries needing blood transfusion, cases needing oxygen, and patients requiring surgery. The KEMSA provides drugs and medical supplies for the Sigoti Health Center, but often there are shortages, especially of malaria medicines. The head nurse stated that for some supplies, the government only provides enough for 3 to 4 months a year. The most common shortages occur with malaria medication, gauze, and

gloves. The Kenyan Ministry of Health provides the salaries for the Sigoti Health Center staff.

On average the Sigoti Health Center treats or counsels 20-30 patients daily. The main reasons why patients come include: HIV counseling, immunizations, prenatal care, and general treatment for illnesses. Costs include a 20 shilling payment ($0.24) and additional fees for various lab tests. If a patient is able to pay, then they will cover the costs of additional supplies that were used in the treatment, such as gauze and gloves. HIV testing, treatment, and counseling is free of charge. The cost of delivering a baby is 500 shillings ($5.89). Compared to the Nyabondo Mission Hospital, the Sigoti Health Center has cheaper but not as extensive services. As is the case with hospitals in Kisumu, malaria is the most common illness.

Some of the health center's needs include: obtaining pads for women instead continuing to use rags, modern delivery beds, heaters for newborns, and money to pay CHWs for their services. The health center also would like to see more assistance in treating patients and help with educating the surrounding area on health related topics. The head nurse stated that the lack of qualified health professionals in the region is presently a larger problem than the lack of facilities.

Koguta East Community Health Worker Program

The Koguta East CHW Program was created by the Sigoti Health Center and began operating in September 2011. Originally there were 30 CHWs that were trained, but as of May 2012 only 22 were active. The reason mentioned for the decrease was an unfulfilled expectation of a salary.

According to both the head nurse at the health center and the chair of the CHW program, the responsibilities of the workers include: tracking former patients for check-ups, bringing HIV-positive patients to the health center who have not been regularly taking antiretroviral therapy (ART), health education, and identifying and referring ill community members. They were trained not to treat but only to refer patients. However, the chair of the CHW program stated that a few were trained to deliver certain drugs such as malaria medications and pain killers. He stated that the distribution of these drugs was highly controlled by the health center.

The training of the CHWs was accomplished by the head nurse and a public health officer. The International Center for AIDS Care and Treatment Programs (ICAP) at Columbia University's Mailman School of Public Health provided both funding and training materials. The training lasted two weeks and covered topics including: immunizations, household mapping, prenatal care, common diseases, prevalence data, and the referral system. The CHWs also receive yearly follow up training. The criteria for becoming part of the Koguta East CHW Program include: having at least a fourth grade education, being a respected community member, and being part of the community in which you work.

The CHWs are not paid, but the health center provides incentives that encourage the workers to remain and be productive. Such incentives include meals, refreshments, and the opportunity to use a bicycle. In a place where food is often lacking, the incentive of having a meal or refreshments can be powerful. Twenty-nine of the 30 CHWs originally trained are female. This is largely because men spend much of their time providing income and food for the family and do not have

the excess time to become involved in a large, unpaid commitment. Another reason is because a CHW is viewed as a caregiver, a role that only women play in traditional Luo society, and it is rare for men to cross this social boundary.

Community health workers work an average of 2 to 3 hours a day. They each refer up to 5 patients per day. According to the chair of the CHW program, the main causes of referral include: signs of malaria, signs of tuberculosis, and illnesses associated with HIV.

Though the concept of a CHW sounds promising, the reality is that often the workers in actual practice are ineffective. The charge nurse stated that CHW programs become ineffective when the workers begin treating patients for illnesses that they are not trained to treat. Most CHWs are not trained to treat diseases, but all are trained to give first aid. Other factors mentioned that make CHWs ineffective include: the misuse of confidential information, poor management, and lack of communication among the workers and the health center. In addition, during the rainy season it is difficult for CHWs to accomplish their tasks because they are not equipped with rain gear. The problems of rough terrain and poor transportation are also barriers preventing the workers from carrying out their tasks. Another barrier in the delivery of health care that was mentioned by the chair of the CHW program is the high prevalence of malnutrition in the community. He mentioned that many patients will discontinue taking their prescriptions because they blame the side effects of malnutrition on the treatment they receive. The scarcity of food is often more devastating to the health of the patients than the actual illness. Often it is

more important for CHWs to help households find food rather than refer them to the health center.

Despite these barriers, the head nurse stated that without the use of CHWs, the health center's goals are unattainable. Through community mobilization and education, the Sigoti Health Center has placed their confidence in CHWs to help better the health of the Upper Nyakach Division.

CHAPTER TWO

Review of Literature

What is a community health worker?

In 1978 at the Alma Ata Conference the World Health Organization (WHO) saw a need for the establishment of another health cadre composed of community health workers (CHWs). At the conference they established the role of a CHW and came up with a widely accepted definition: "Community health workers should be members of the communities where they work, should be selected by the communities, should be answerable to the communities for their activities, should be supported by the health system but not necessarily a part of its organization, and have shorter training than professional workers." In view of this broad definition, there are many types of CHW programs. These programs can be paid or volunteer, government managed, managed by an NGO, managed by a private health institution, or managed by the community where they live. Often, CHWs are called by different names in different countries and have different specified tasks based on the areas where they serve. Some countries such as China, Brazil, Ethiopia, and Iran have undertaken nationwide training programs for CHWs while other countries contain a myriad of autonomous small-scale programs.

Community health workers are not professional health care providers, nor are they traditional healers. Physicians, clinical officers, nurses, and other formally trained health providers are not included as CHWs.

Are community health workers effective?

Community health workers around the world have proved to be effective in several set tasks and have been shown to lower mortality and morbidity rates. However, a large portion of the impact CHW programs have cannot be measured. For example, patient satisfaction and the effects of community health education are not always easily quantifiable (Crispin 2012; Ordinioha 2010). The nature of the care delivered by CHWs is of two types: direct health care delivery and indirect health care delivery. Whereas in some programs CHWs can directly treat a variety of illnesses and injuries, give basic medications, provide environmental sanitation, and supply clean water, the overall effect of CHWs goes well beyond the physical treatment of an ailment. For example, CHW programs also are often designed to educate the community about basic sanitation, refer certain patients to nearby hospitals and clinics, provide counseling for patients struggling with TB and HIV, and to strengthen family planning programs (Community health workers: What do we know about them? WHO Report 2007). The effects of indirect health care delivery are not always easy to calculate, and therefore, studies cannot always show the entirety of a CHW program's impact.

Though morbidity, mortality, and prevalence data cannot completely reveal the effectiveness of CHWs, it is important to examine the quantifiable changes that occur after the beginning of such interventions. From 2006-2009, a volunteer CHW program was established in 116 Ugandan villages (Brenner 2011). All of the CHWs in the villages were trained in the same way by the same two individuals. There was

a 10.8% decrease in prevalence of diarrhea, 5.8% decrease in prevalence of fever associated with malaria, and in the first 18 months of implementation there was a 53% reduction in deaths of children under the age of five. One meta-analysis discussed the effects of CHW programs on neonatal care (Gogia 2011). This study analyzed 13 different CHW programs and revealed that reductions in neonatal mortality rates were statistically significant. Another study examined a CHW program in the rural Gadchiroli district of India (Bang 2005). This program helped reduce neonatal morbidity by 50%, neonatal mortality by 70%, and infant mortality rate by 57% between 1993 to 2003. In Ethiopia from January to December of 1997 a case-control study was completed in order to see the impact on mortality rates when village mothers were taught to recognize malaria in their children and to treat them promptly with chloroquin (Kidane 2000). This approach proved successful as the percentage of deaths of children under-5 due to malaria was lower in the intervention areas. In the intervention areas 19% of deaths were due to malaria compared to 57% in control areas. Community health workers have also been shown to increase both immunization use and the number of positive outcomes for patients with acute respiratory infections (Lewin 2005). Programs implementing CHW into the health workforce not only have positive impacts in resource poor countries, but they are also shown to improve health in developed nations. In the United States, CHWs increased access to health services, increased overall knowledge of health, and promoted behavior change among ethnic minority women (Andrews 2004).

One of the major benefits of instituting CHWs into the workforce is that they serve in areas where many health care professionals are unwilling to serve. In view of the shortage of health care professionals in rural areas, CHWs are used to create more efficient health care delivery systems where shortages exist. They do this through the shifting of tasks from the clinic to the community. Trained CHWs can perform many simpler tasks which are currently the responsibility of nurses (WHO Task Shifting 2008). Because CHWs work in the community, they increase the amount of time and resources that clinic patients receive by meeting many needs out in the community. Through this type of intervention, CHWs preserve clinic resources for sicker patients. One study in rural western Kenya revealed that the implementation of a community based program to treat patients with HIV reduced clinic visits in half (Selke 2010). Several HIV-positive patients who were receiving ART regularly were enrolled in a CHW program. The workers were trained to record the patient's symptoms, adherence, and vital signs, and then to dispense a month's supply of HIV medications if the patient did not require further treatment at the clinic. This intervention was measured against a control group whose patients continued to be administered ART monthly at the local clinic. There were no significant differences in the clinical and laboratory outcomes between the patients in the intervention and control groups. The researchers reported: "Our study demonstrated that task-shifting can decrease the number of clinic visits, thus helping to decongest the clinic and increase the number of patients receiving care with fixed clinic resources."

How do community health workers aid in delivering health care?

The WHO defines task shifting as a process in which "specific tasks are moved, where appropriate, from highly qualified health workers to health workers with shorter training and fewer qualifications in order to make more efficient use of the available human resources for health" (WHO Task Shifting 2008). The implementation of CHWs is a form of task-shifting in which tasks previously performed in the clinic are now accomplished in the community. Because they are a part of the community and its culture, the connection they share with the community is quite different than an outside professionally trained physician. Their knowledge of the community and its way of life gives them particular insight. In addition, they are able to communicate and influence the members in their community more effectively than outsiders. This enables them to deliver necessary health care in situations where traditional beliefs about western medicine could lead to the patient rejecting care or choosing a type of traditional health care that is detrimental to their health.

In rural western Kenya one of the predominant tribes is the Luo. Traditional beliefs are powerful and pervasive in this ethnic group. Their beliefs concerning malaria-related anemia and convulsions act as barriers to effective health care delivery. Eighty percent of the Luo mothers interviewed in the district of Kilifi considered convulsions unpreventable, and of the 20% who thought convulsions were preventable, 19% believed amulets provided the necessary prevention (Mwenesi 1995). This is an example of an educational and cultural issue that could

be effectively addressed by CHWs who can communicate medical knowledge within their own community persuasively and inoffensively.

Sometimes, medical professionals or CHWs who are from one tribe or group feel as if they cannot work with another tribe or group. When diversity in the community is not modeled in the CHW program, then differences in CHWs and those they serve can diminish the effectiveness of the program. One example of this occurring was the implementation of a health education program in Kenya. One researcher stated:

> "A community nurse told us that although he was fully qualified and able to diagnose and prescribe, he belonged to the Masai tribe. In his view, this disqualified him from working with other tribal groups, e.g. the Kikuya. Likewise, a Kikuya nurse would not feel able to work with the Masai" (Hoy 1992).

Community health workers are especially effective since they live in the same village and are a part of the ethnic group for which they deliver health care. Due to their understanding of local customs and previous acceptance by the community, their delivery of education and health care has a greater probability of being accepted and practiced. This is important because a patient's understanding of a treatment is correlated with their adherence to that treatment. Adherence to anti-malarial medicine in the Kenyan districts of Garissa and Bunyala was shown to be most strongly correlated to their knowledge of the treatment (Lawford 2011). In addition, through education CHWs can be used to lower the spread of communicable diseases and improve knowledge of proper sanitation techniques to prevent parasites. Community health workers aided by the Carter Foundation have played an integral part in the reduction of Dracunculiasis infestations around the world

(WHO Dracunculiasis 2013). In 1986 there were an estimated 3.5 million cases. In 2012, there were only 542 cases spread across four countries. Education on nutrition is also important, as resource-poor areas often lack proper amounts of vitamins and minerals such as iodine in their diet. Household care of diarrhea in Kenya is insufficient largely because of the lack oral rehydration solution. Community health workers have been highlighted as a possible means to distribute the solution and empower caregivers to utilize it (Olsen 2011).

The array of tasks that a CHW can perform is quite broad. The tasks vary among nations and provinces based on laws governing the delivery of medicine and regional health needs. In much of the literature CHWs are trained in order to deal with a specific problem, such as malaria or HIV. Through this, their training can be more specialized. The impact they have can be quantified through prevalence or mortality rates or through laboratory results that are associated with the particular illness. Because of the myriad of health delivery laws and needs, the purposes of CHW programs vary from place to place.

> "CHWs perform a wide range of tasks: home visits, environmental sanitation, provision of water supply, first aid and treatment of simple and common ailments, health education, nutrition and surveillance, maternal and child health and family planning activities, TB and HIV/AIDS care (i.e. counseling, peer and treatment support and palliative care), malaria control, treatment of acute respiratory infections, communicable disease control, community development activities, referrals, recordkeeping and collection of data on vital events. These tasks are performed in many different combinations and with different degrees of breadth and depth" (Community health workers: What do we know about them? WHO report 2007).

Another aspect of a CHW is that they are almost always connected to another health institution or clinic. They act as an extension of the clinic into the community

and are able to refer patients to that clinic. Because their training is not extensive, they are not able to treat complex cases and must have a connected health institution to which they can refer. Sometimes, as mentioned before, CHW programs are nationwide programs. However, in many cases they are much smaller in scale.

When are Community Health Workers Most Effective?

Successful CHW programs share certain elements. Community health workers must be properly selected. This means that they should be selected from the community that they will serve. It also means that the community should select its own CHWs. This gives the community more control over the program and allows them to select candidates they trust, respect, and believe will do an excellent job in providing health care to the entire community. Giving the community a large portion of the decision-making and planning allows the community to mobilize and take ownership of their health. This broad mobilization is important before a CHW program begins because it allows the community to prioritize health concerns. It is important for the community to provide the energy and support needed to sustain the program for any extended period of time (Community health workers: What do we know about them? WHO report 2007).

Community health workers must be properly trained in order to carry out their job. This training is more likely to be successful when the CHWs are given a specified job description with a limited amount of tasks. The training should be focused on the individual tasks and reveal if the potential CHW is competent in the tasks before continuing. Also, the initial training should have a proper duration

based on the tasks that the CHWs will be performing. Increasing the amount of time spent in hands-on practice of the necessary skills is important. Initial training alone does not suffice, as certain skills used less often by the CHWs might be forgotten or might be carried out wrongly as time progresses. Therefore, it is important to have reoccurring training sessions (Abbat 2005).

In their training it is important for the CHWs to understand the medical importance of their tasks. Not only does this incentivize them to continue doing their work well, it also enables them to communicate the importance of medications and nutrition to their village. When inadequate or contradictory information is spread in a community, it may lead to a decrease in adherence to medications or important therapies. In a Kenyan refugee camp, CHWs were given the task to distribute micronutrient powder. However, due to inadequate and contradictory communication to the refugees about the importance of the powder, rumors spread about its effects, causing a decrease in its consumption (Kodish 2011).

A nation's government plays a critical role in a CHW program's success or failure. Governments can provide a helpful environment and necessary resources for the program's success, or they can dismantle a program if it does not fit into the agenda of that nation. Governments play an important role in establishing either a friendly or hostile environment to CHW programs.

Supervision is also vital for the effective use of CHWs. Empowering administrators who provide practical evaluations of the CHWs are important for a program's success. Supervisors are also vital for maintaining constant supply lines in order for the CHWs to be properly equipped. In addition, evaluations on the

quantifiable effects of the program should be disseminated to community leaders in order for them to know the progress being made. Also, the size of a program plays a role in its effectiveness. Not having enough CHWs hampers the effectiveness of the program while having too many CHWs wastes resources. Small scale CHW programs generally will have an easier time securing the needed financial resources, medicines, instruments, and other materials needed to carry out their job (Community health workers: What do we know about them? WHO report).

What are the incentives for CHWs?

In order to create an effective CHW program with a high retention rate, incentives should be implemented. Incentives for CHWs vary. One effective incentive is a performance-based financing system where the more referrals a CHW achieves, the larger the monetary reward. This incentive system has helped increase the use of maternal and child health services in Rwanda and Lesotho (Basinga 2011; Farmer 2013; Satti 2012). Other government operated CHW programs provide a uniform monthly salary (Medhanyie 2012). However, more often than not, resource-poor countries do not have the money or the willingness to create nationwide salaried CHW programs, especially when the programs are mostly established for rural, low priority areas. Therefore, incentives in poor, rural communities generally come from nonmonetary means. In certain cultures, the value of community and participation in the betterment of that community is the basic incentive (Adamu 2011-2012). Community and tribal ties are often much stronger in developing nations than in developed nations. When health care is prioritized within a community, CHWs are given a place of respect because of their

important role. This recognition within their community is an important incentive. Both the acquired skills gained through training and the ability to effectively treat patients can be incentives (Puett 2012). Preferential treatment within the community and a personal sense of accomplishment are also incentives. Many CHW programs also provide meals for their workers and a mode of transportation, such as a bicycle. Each of these forms of incentives has been used to lower turnover rates (Community health workers: What do we know about them? WHO report 2007).

The Gap

The Sigoti Health Center established the Koguta East CHW Program in September 2011 in order to improve the health of the region through a community-based approach. Thirty community health workers were initially trained by the head nurse and a clinical health officer. By May 2012, twenty-two were still active. The CHWs worked in a region known as East Koguta. The East Koguta sub-location is one of the two main sub-locations located within the Sigoti Health Center's catchment area and has a population of 7,360 (KNBS Population Census 2009).

One of the main reasons for the creation of this program was to increase the number of facility-based deliveries. According to the head nurse, the goal of the health center is that 30% of all births occurring within the catchment area happen at their facility, rather than at home without the presence of skilled personnel. Community health workers were actively working to encourage every pregnant female in their community to deliver at the health center due to better health outcomes that are achieved when compared to deliveries at home or with the aid of a traditional birth attendant. The local community health professionals strongly

believed that the program has been successful in increasing the number of facility-based deliveries.

High-risk women were targeted by the community health workers and were especially encouraged to deliver at the health center. Because pregnant women with certain risk factors are at an increased likelihood of having a bad outcome during the delivery process, the CHWs were acutely aware that it is important to have these women deliver in a facility staffed with professional health care workers.

In particular, HIV rates are high in East Koguta, and special effort is made to encourage HIV-positive women to deliver at the health center. Luo women have the highest HIV prevalence rate (22.8%) of any Kenyan ethnic and gender category (Kenyan DHS 2008-2009). Due to East Koguta being comprised of predominately Luo men and women, the importance of testing pregnant women for HIV and administering ART to HIV-positive women is increased. When HIV-positive women are given ART throughout their pregnancy, the probability of mother to child transmission is greatly reduced.

One of the important roles of a CHW is to give health education. Through educating pregnant women about what to do and not to do while pregnant, bringing them to prenatal care visits, and encouraging them to deliver at the clinic, it is assumed that better health outcomes, such as infant birth weight, will be achieved.

These professionals believe that their program has been achieving such results. It is also believed that the intervention has resulted in better pregnancy outcomes. In spite of these high hopes and confident assertions of success, no data has been analyzed to see if there has been an increase or if an increase had paid off

in bringing in higher-risk women. In an effort to support and quantify these conclusions for the purpose of directing the program in the future, it became apparent that the next step was to look at the evidence. With the goal of understanding what strategies work in this particular community and how they can be improved, this study analyzed available clinic records to see what impact the CHW intervention has had over a nine-month period.

In the tradition of community-based research, this study attempts to apply sound epidemiologic methods and the findings of prior research for two purposes. One goal is to evaluate this particular program in which the author is involved and invested. The other purpose is to generalize when it is appropriate to other similar settings and to contribute to the scientific literature about the effectiveness of community health workers.

CHAPTER THREE

Hypothesis

With the general objective of investigating the effectiveness of a community health worker program this study hypothesizes that the community health workers in the traditional, rural Kenyan community of East Koguta will increase the utilization of maternal health services and improve pregnancy outcomes.

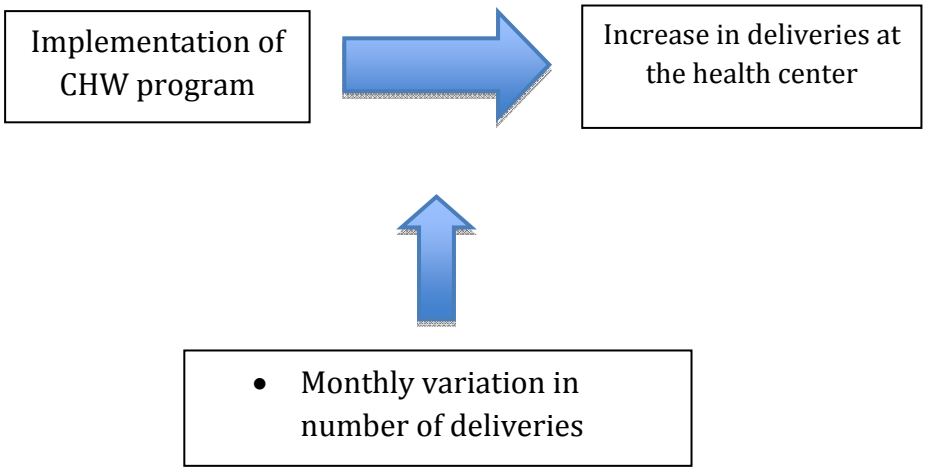
Research Questions

Primary Research Question

Will the implementation of the Koguta East Community Health Worker Program increase the number of pregnant women who delivered at the Sigoti Health Center?

Hypothesis: The community health worker program will increase the number of women delivering at the health center when compared to the same time period in the previous two years.

Null Hypothesis: There will not be an increase in the number of deliveries at the health center after the institution of the community health worker program compared to the same time period in the previous two years.

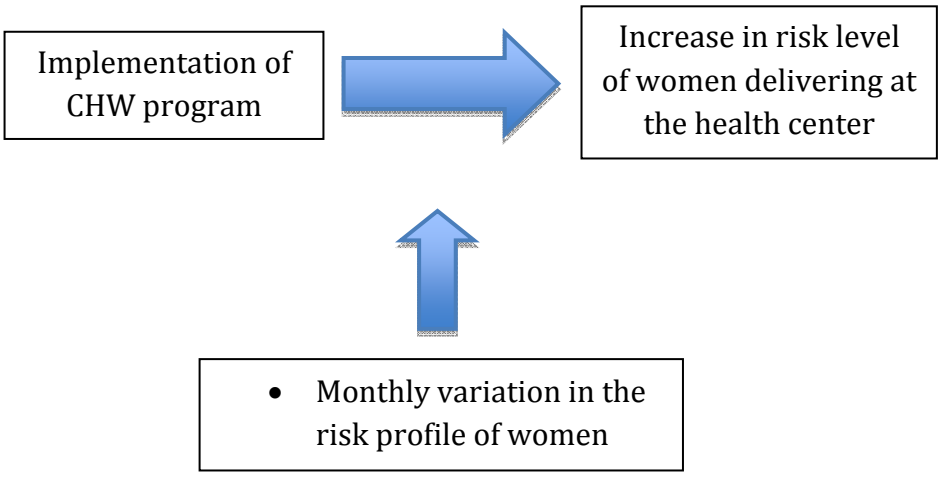

Implementation of CHW program
Increase in deliveries at the health center
Monthly variation in number of deliveries

Second Research Question

Will the Koguta East Community Health Worker Program bring in higher risk women to deliver at the Sigoti Health Center?

Hypothesis: The women who deliver at the health center after the institution of the community health worker program will be at higher risk than women who delivered in the same time period during the previous two years.

Null Hypothesis: There will not be an increase in the risk profile of women who deliver after the institution of the community health worker program compared to the risk profile of women in the same time period in the previous two years.

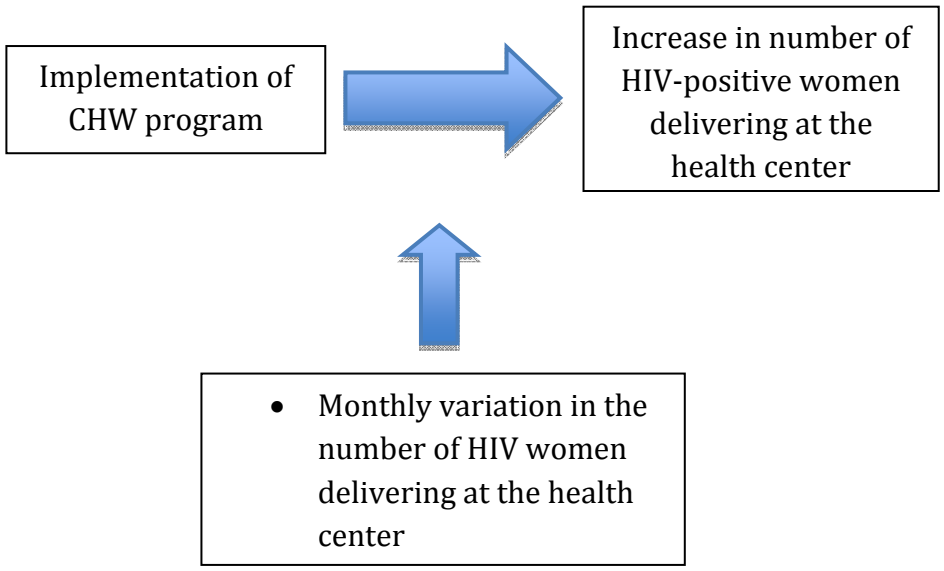


Third Research Question

Will the Koguta East Community Health Worker Program increase the number of HIV-positive women who deliver at the Sigoti Health Center?

Hypothesis: The Koguta East Community Health Worker Program will increase the number of HIV-positive women who deliver at the health center compared to the same time period in the previous two years.

Null Hypothesis: There will not be an increase in the number of HIV-positive women who deliver at the health center after the institution of the community health worker program compared to the same time period in the previous two years.

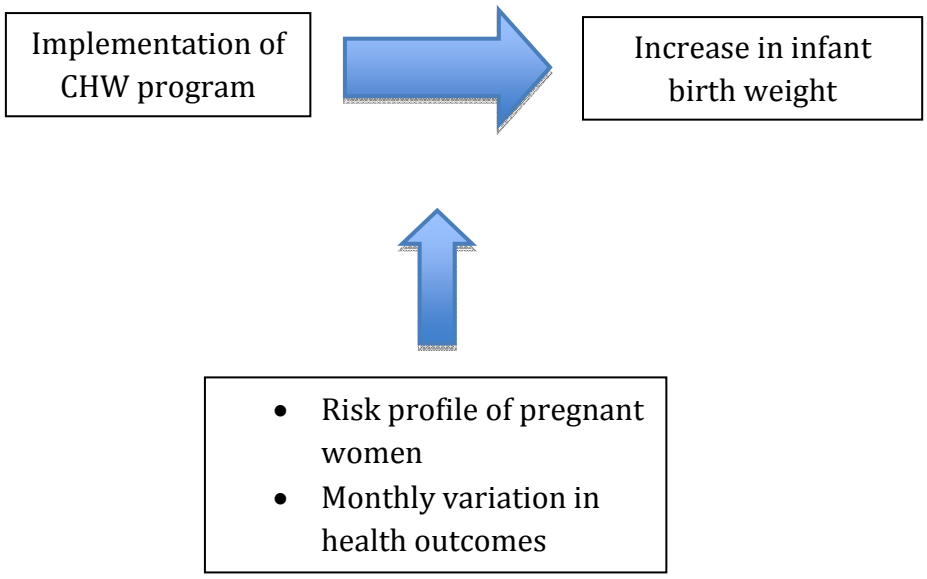


Fourth Research Question

Will the Koguta East Community Health Worker Program result in an increase in infant birth weight after adjusting for the mother's risk profile?

Hypothesis: The community health worker program will increase the mean infant birth weight when adjusting for the mother's risk profile compared to the same time period in the previous two years.

Null Hypothesis: There will not be an increase in infant birth weight after the institution of the community health worker program compared to the same time period in the previous two years.



CHAPTER FOUR

Methods

Population

This study was conducted in the village of Sigoti in the Upper Nyakach Division in the Nyanza Province of Kenya. Data was collected from the Sigoti Health Center from the beginning of January 2009 through the first week of June 2012. Nurses and clinical officers working in the health center provide medical services, including maternal care, for the surrounding area. The main catchment area of the Sigoti Health Center is comprised of approximately 8,000 people from the Ramogi and East Koguta sub-locations, though many patients come from more distant areas as well. This study focuses on the data collected from women coming to the Sigoti Health Center for labor and delivery services. The main tribe composing the Nyakach Division of Kenya is the Luo and it is safe to assume that either all or almost all women delivering at the Sigoti Health Center are Luo. The Sigoti Health Center serves a rural, agricultural region.

All women who delivered at the health center from January 2009 through the first week of June 2012 were included in the study, though most of the data analysis focuses on the women living in the sub-location East Koguta. Data was collected by the nurses and clinical officers both before and after the deliveries. Nearly all women had attended at least one prenatal care visit at the health center, and therefore some data, such as HIV status, was collected at prenatal visits. The

subjects enrolled in the study were all of the women who delivered at the Sigoti Health Center during this time period.

Exclusion Criterion

Information about one mother and the twins she delivered was excluded from the statistical analysis involving infant birth weight. This was done due to growth differences of twins and their normally lower birth weights as compared with single gestational fetuses in the womb.

Research Design

This study was a retrospective study that examines the maternity data from the Sigoti Health Center. The focus of this study was to determine if the implementation of a CHW program improves access to medical care and creates better health outcomes. More specifically, this study sought to understand which health factors CHWs are most effective at improving, especially by looking at the number of facility-based deliveries, the risk profile of the women delivering, the number of HIV-positive women delivering, and birth weights. In order to test the hypotheses of this study, only maternal data from women living in the sub-location East Koguta were included in the data analysis. This is because the CHW program attached to the Sigoti Health Center only referred women living in East Koguta. However, maternal data from all sub-locations were included and displayed as summary statistics in order to show health care statistics of the region and to compare East Koguta with the surrounding sub-locations. The clinic director, provided data from the Sigoti Health Center Maternal Registry that was photocopied

in June 2012 and subsequently transferred to electronic form by the principal investigator. The data was double-entered into a computer, and both data sets were compared to correct any discrepancies that might have occurred during data entry. The primary outcome of interest was whether more women from East Koguta delivered at the health center after the implementation of a CHW program.

Study Site

The Sigoti Health Center is located in the Upper Nyakach Division in western, Kenya. This region is located in the larger administrative region of the Nyanza Province, which lies next to Lake Victoria and the Tanzanian border. The Upper Nyakach Division also has been the site of a temporary medical clinic that is set up annually through the nonprofit organization *Straw to Bread*, led by Dr. Lisa Baker. Through this organization, many Americans have been able to serve in the Upper Nyakach Division in a variety of ways by providing: medical expertise and treatment, health education in primary and secondary schools, micro-enterprise funding, agricultural education and development, rainwater harvesting and filtering systems, a new school building, and clinical research. It is through the partnership *Straw to Bread* has maintained with the Luo community on the Nyakach Plateau that this study was made possible.

Sample Size

The number of mothers recorded in the Sigoti Health Center's maternal registry from January 2009 through the first week of June 2012 is 522. This number includes all mothers who began delivering at the Sigoti Health Center. Because of

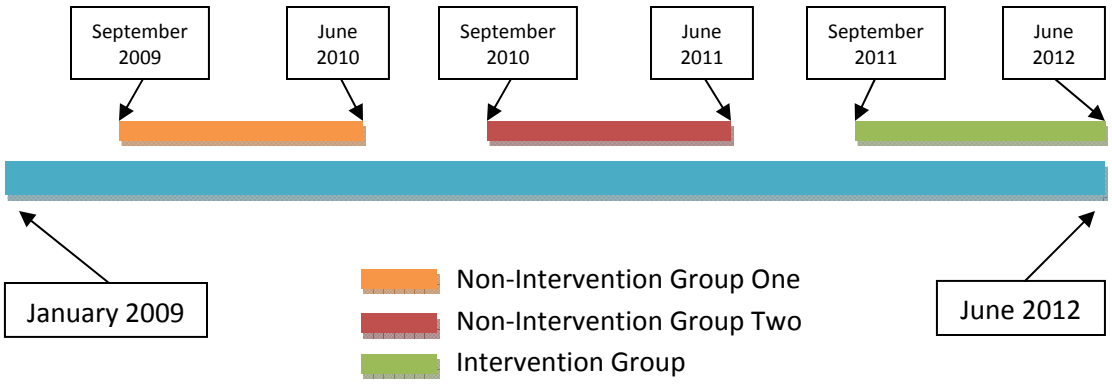
the occasional referral of women to other nearby health facilities during the delivery process, the number of completed deliveries at the Sigoti Health Center is smaller. The number of live infant births excluding one set of twins was 506.

Data Analysis

Data collected from the Sigoti Health Center was divided into specific time frames. This was done in order to adjust for monthly variation when comparing women and infants after the intervention with women and infants before the intervention. Because some months on average contain more deliveries, it was decided that, in order to obtain comparable data, the comparisons would have to be made between the same ranges of months each year. There were nine complete months of data after the beginning of the intervention. These included all the months from September 2011 through May 2012. Because the maternal records began in January 2009, only two respective time frames could be constructed to match the intervention time frame of September 2011 through May 2012. These respective time frames were September 2009 through May 2010 and September 2010 through May 2011 (See *Figure 1*).

Figure 1

Time Frame of Non-Intervention and Intervention Groups



Risk Score

In order to test the hypothesis that mothers coming to the Sigoti Health Center after the institution of the CHW program had more risk, each mother was given a risk score based on four factors: parity, age, marital status, and HIV status. For parity, risk was determined to be present in nulliparous women and women who had given birth more than three times. In this traditional, tribal culture, a single woman giving birth is considerably more vulnerable and less supported than a married woman. Thus, for marital status, risk was determined to be present in single, divorced, widowed, or separated women. For age, risk was determined to be present in women 15 years old and younger or 35 years old and older. For HIV status, risk was determined to be present in women who were known to have tested positive for HIV. Each risk factor was weighted differently depending on the potential negative impact on a woman's health. Parity was given the lowest risk score weight. If risk due to parity was present in a woman, then one point of risk

was added to her overall risk score. Both age and marital status risk factors were weighted the same at two risk points. Finally, HIV status was weighted the heaviest with four risk points added to women who were HIV-positive. Therefore, risk scores had a possible range of 0 to 9 in which women with no risk factors present had a score of 0 and women with every risk factor present had a score of 9. These weights were determined by the investigators, of whom one was an experienced physician who had practiced medicine in the area and was aware of the risks in this cultural context.

Statistical Analysis

All statistical analyses were done through the statistical software SAS 9.3 by SAS Institute Inc. (Cary, North Carolina) and R version 2.15.3 by the R Foundation for Statistical Computing (Vienna, Austria). Univariate, bivariate, and multivariate statistics were used in the analysis. Univariate statistics were used to describe the distribution of all pertinent variables. Bivariate and multivariate statistics were used to test relationships among the variables and to test the four hypotheses to determine if differences in the intervention and non-intervention groups were statistically significant. Alpha was set at 0.05.

Hypothesis 1

The first hypothesis was that the CHW program would increase the number of women delivering at the Sigoti Health Center after adjusting for monthly fluctuation. In order to analyze this hypothesis, the test for equality of proportions was used. In this bivariate analysis, proportions are compared to each other in

order to determine if the difference in the proportions is statistically significant. To test the hypothesis, proportions were created for the first non-intervention group, the second non-intervention group, an average of the two non-intervention comparison groups, and the intervention group. The numerator of each proportion was equal to the number of women in that comparison group. A common denominator was used for each of the proportions. This denominator was equal to the estimated number of women that deliver in East Koguta over a nine-month period, the length of time of each comparison group. Therefore, the proportions created were equal to the proportion of women in East Koguta that delivered at the Sigoti Health Center during the respective time frame. The common denominator was created by multiplying the crude birth rate (CBR=birth rate per 1000 population) by one thousandth of the population of East Koguta and then multiplying this product by 0.75 (Kenya DHS 2008-2009). Therefore, the equation {denominator=[CFR*(Pop/1000)]*0.75} was used to estimate that on average 194.856 women deliver in East Koguta over a nine-month period. The population and crude birth rate data were from the year 2009. The first, second, and average non-intervention proportions were tested against the intervention proportion using the test for equality of proportions. This was done in order to determine if increases in the number of deliveries were statistically significant. The comparison between the average non-intervention proportion and the intervention proportion was used to determine if the null hypothesis was rejected.

Hypothesis 2

The second hypothesis of this study was that the women delivering at the health center after the institution of the CHW program would have higher risk than before when adjusting for monthly fluctuation. In order to test this hypothesis, a one-way analysis of variance was used in order to determine if the average risk scores were significantly different between the first non-intervention group, the second non-intervention group, and the intervention group.

Hypothesis 3

The third hypothesis of this study was that the CHW program would increase the number of HIV-positive women who delivered at the clinic after adjusting for monthly variation. As in the primary hypothesis, the test for equality of proportions was also used for this hypothesis. Proportions were created for the first non-intervention group, the second non-intervention group, an average of the two non-intervention groups, and the intervention group. The numerator of each proportion was equal to the number of HIV-positive women in that comparison group. Additionally, a common denominator was used for each of the proportions. This denominator was equal to the estimated number of HIV-positive women that deliver in East Koguta over a nine-month period. Therefore, the proportions created were equal to the proportion of HIV-positive women in East Koguta that delivered at the Sigoti Health Center during the respective time frame. The common denominator was created by multiplying the common denominator of the primary hypothesis by the HIV prevalence rate of Luo women in Kenya, 22.8% (Kenya DHS 2008-2009).

Therefore, the equation {denominator=[CBR*(Pop/1000)]*0.75*0.228} was used. These final proportions were then inputted into the test for equality of proportions. Each non-intervention group proportion and the average non-intervention group proportion were compared with the intervention proportion in order to determine if increases in the number of HIV women were statistically significant. The comparison between the average non-intervention proportion and the intervention proportion was used to determine if the null hypothesis was rejected.

Hypothesis 4

The fourth hypothesis of this study was that the CHW program increased infant weight after adjusting for monthly variation and the mother's risk profile. In order to adjust for the mother's risk profile, a two-way analysis of variance was used. Infant birth weights of both non-intervention groups were combined and compared to the intervention group's infant birth weights. A two-way analysis of variance was used to determine if there was a significant increase in infant birth weight in the intervention group.

Infant birth weight was the only outcome used in the analysis of hypothesis 4 but was not the only health outcome recorded in the maternal registry. Infant deaths, maternal deaths, and referrals to other health facilities were too few in number to be considered in the analysis of this hypothesis. Gestational age could have also been used as a health outcome measure. However, this variable proved to be unreliable. In this study, there were two sets of gestational ages for every infant, and each set represented a different method. One set was composed of gestational ages recorded in the Maternal Registry by the nurses at the Sigoti Health Center.

The other set was calculated by figuring the time elapsed between the date of last menstrual period and the date of delivery. The gestational age listed by the nurses rarely matched the calculated gestational age. Infant birth weight was regressed on each set of gestational ages in order to determine which measure was more reliable. Gestational age recorded by the nurses predicted 0.84% of the variability of infant birth weight while the calculated gestational age predicted 1.41% of the variability of infant birth weight. Normally gestational age can predict approximately 40% of infant birth weight. Due to these large discrepancies, both sets of gestational age were deemed as unreliable.

CHAPTER FIVE

Results

Maternal Statistics

Number of Deliveries

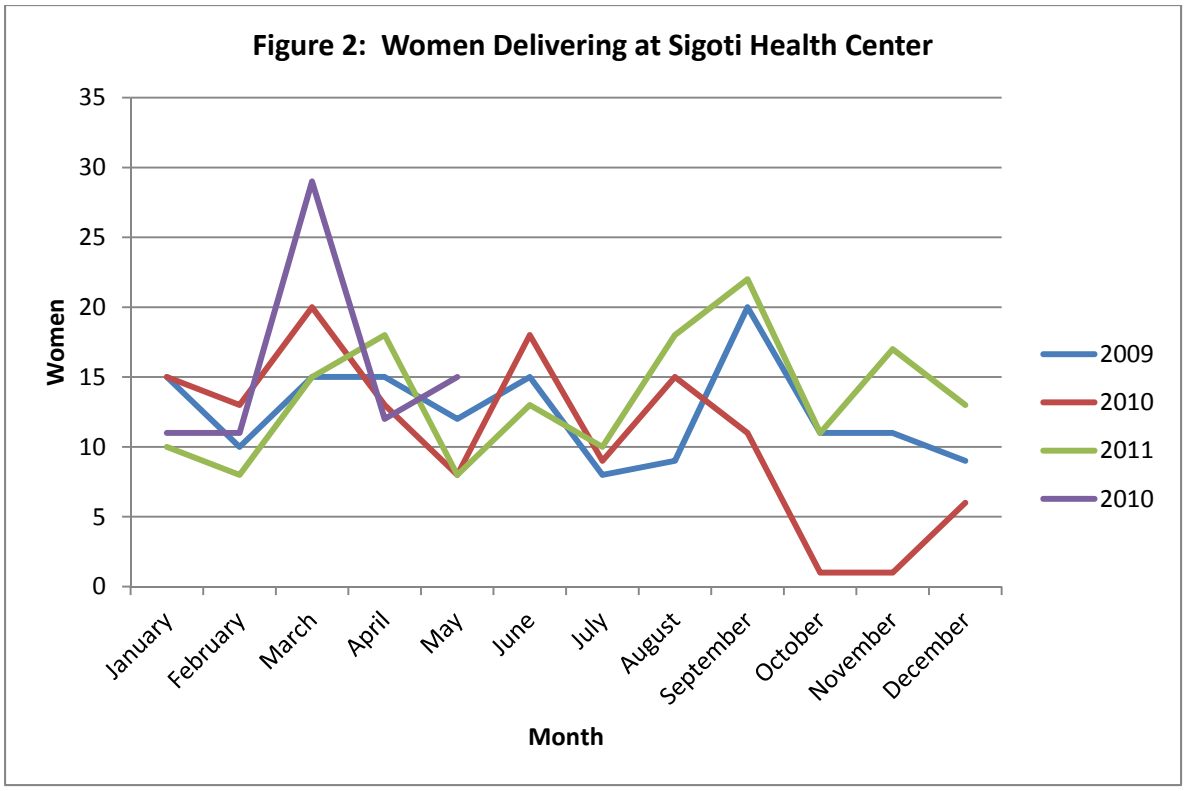
All Sub-Locations. Over the three and a half year period in which data was collected, 522 pregnant women came to the Sigoti Health Center in order to deliver. Of the 522 women who delivered, most came from one of two sub-locations: East Koguta and Ramogi. From East Koguta there were 211 women (41.7%), and from Ramogi there were 148 women (29.3%).

From September 2011 through May 2012, the time frame of the intervention, 142 mothers delivered at the health center. Before the intervention, 380 mothers delivered. In 2009, 150 women delivered. In 2010, 130 women delivered. In 2011, 163 women delivered. In addition, during the five months and one day in which data was collected from 2012, 79 women delivered. Variation existed in the number of women who came to the health center per month as seen in *Table 1*. This table shows the monthly averages of women coming to deliver, excluding June 2012 due to the data collection being incomplete for that month. Overall the mean and standard deviation of the number of women per month was 12.7±5.2. The median number of women per month was 12 and the range was from 1 to 29. The range for the monthly averages was from 19.8 for March to 7.7 in October. *Figure 2* shows the number of mothers delivering at the health center over time from January 2009

through May 2012. This figure shows that the monthly variations in the number of deliveries at the health center generally follow a yearly pattern. For example, peaks generally occur in March, June, and September, while troughs occur in February, May, July, and October. The average number of mothers delivering in March is almost three times the average number of mothers delivering in October. The last three months of the year average 8.9 mothers while the first three months of the year average 14.3 mothers.

Table 1: Monthly Averages

Month	Women
January	12.75
February	10.50
March	19.75
April	14.50
May	10.75
June	15.33
July	9.00
August	14.00
September	17.67
October	7.67
November	9.67
December	9.33

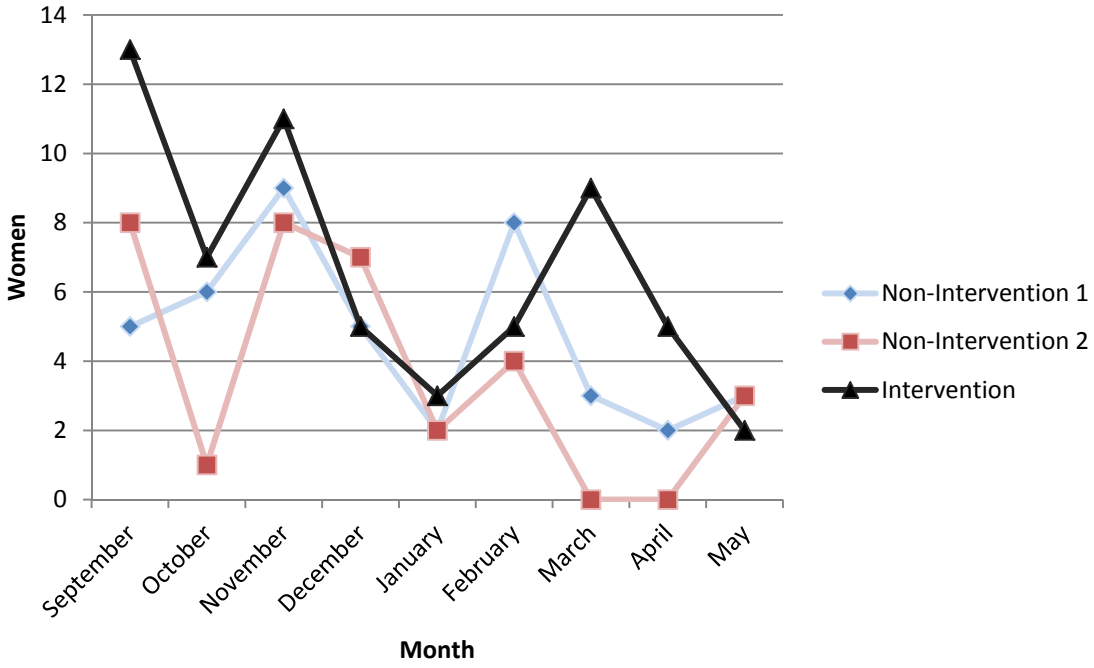


East Koguta. From the first non-intervention group there were 43 women, the second non-intervention group had 33 women, and the intervention group contained 60 women. Therefore, more women came to deliver during the intervention time period than both of the non-intervention time periods. Monthly variation also existed in the number of women from East Koguta who came to deliver, as shown in *Figure 3*. Peaks generally occurred for each non-intervention and intervention group in the months September, November, and March. On the other hand, troughs occurred in the months October, January, and May. These peaks and troughs differ slightly from what is seen in *Figure 2*.

The mean and standard deviation of the number of women delivering at the Sigoti Health Center in the first non-intervention group was 4.8±2.5 women. The

median for this group was 5 women and the range was from 9 women in November to 2 women in both January and April. For the second non-intervention group, the mean and standard deviation was 3.7±3.3 women. The median for this group was 5 women and the range was from 8 women in September and November to no women in March and April. The intervention group had a mean and standard deviation of 6.7±3.7 women. The median for the intervention was 5 and the range was from 13 women in September to 2 women in May.

Figure 3: East Kaguta Women Delivering at Sigoti Health Center



Age

All Sub-Locations. There were recorded ages for 517 of the 522 mothers (99.0%). The ages of the women covered a large span, but most women coming to the health center tended to be in their teens or early 20's. The mean and standard deviation of age among all the women was 22.9±5.7 years. The oldest mother was 42 years while the youngest was 13 years. The median age was 22 years, revealing a slight positive skew in age. The middle 50% of women were between the ages of 19 and 27 years.

East Koguta. In the first non-intervention group, ages were recorded for all 43 women. The mean and standard deviation of age in this group was 21.9±4.6 years. The median age was 22 and ages ranged from 14-32 years. The middle 50% of the women were between the ages of 18 and 26 years. In the second non-intervention group, ages were recorded for all 33 women. The mean and standard deviation of age in this group was 23.6±5.6 years. The median age was 22 and ages ranged from 16-37 years. The middle 50% of the women were between the ages of 20-27 years. Lastly, in the intervention group, ages were recorded for all 60 women. The mean and standard deviation of age in this group was 22.8±5.8 years. The median age was 21 and ages ranged from 14-42 years. The middle 50% of the women were between the ages of 19 and 26 years. The ages of women in the intervention group were not statistically different from the ages of women in the non-intervention groups (T=0.26, p=0.798).

Marital Status

All Sub-Locations. Marital status was recorded for 518 of the 522 women (99.2%). Most women were married, though a considerable number did not have a spouse at the time of the delivery. Of those who reported marital status, 77.1% reported to be married at the time of delivery, 19.7% were single and had never married, 2.1% were widowed, and 1.2% were divorced.

East Koguta. Marital status was recorded for all 43 women in the first non-intervention group. In this group, 79.1% were married, 2.3% were widowed, none were divorced, and 18.6% were single. For the second non-intervention group, marital status was recorded for all 33 women. In this group, 72.7% were married, 6.1 % were widowed, none were divorced, and 21.2% were single. In the intervention group, marital status was recorded for all 60 women. In this group, 73.3% were married, 1.7% were widowed, 3.3% were divorced, and 21.7% were single.

Parity

All Sub-Locations. Parity was recorded for 507 of the 523 women (97.1%). For the majority of the women coming to the health center to deliver, parity tended to be quite low. The range of parity was from 0 to 8 with a median of 1. Of those who reported parity, the most common parity was 0 (140 women or 27.6%). Close to this percentage was the number of women with a parity of 1 (131 women or

25.8%). Therefore, women with a parity of 0 or a parity of 1 composed over half the women attending the Sigoti Health Clinic for delivery services. With each increase in parity, the percentage of women decreased.

East Koguta. Parity was recorded for all 43 women in the first non-intervention group. In this group, 74.4% had a parity of 0, 1, or 2. For 27.9% of the women, this was their first delivery. The mean and standard deviation of parity was 1.7±1.6. In the second non-intervention group, parity was recorded for all 33 women. Seventy six percent of the women had a parity of 0, 1, or 2. For 30.3% of the women, this was their first delivery. The mean and standard deviation of parity was 1.7±1.9. For the intervention group, parity was recorded for 57 of the 60 women (95.0%). In this group, 64.9% of the women had a parity of 0, 1, or 2. For 24.6% of the women, this was their first delivery. The mean and standard deviation of parity was 2.0±1.7. The parities of women in the intervention group were not statistically different from the parities of women in the non-intervention groups (T=1.05, p=0.294).

Prenatal Care

All Sub-Locations. The number of prenatal care visits was recorded for 483 of the 522 women (92.5%). The range in prenatal care visits was from 0 to 6 with a median of 3. Only two of the women were reported to have never attended a prenatal care visit. Most of the women attended between 1 and 4 prenatal care visits (94.5%). There were 90 women who attended one session (18.6%), 135

women who attended two sessions (27.9%), and 128 women who attended three sessions (26.5%). One hundred and twenty nine women attended four or more sessions as recommended by the WHO (26.7%) (Medhanyie et al.). The mean and standard deviation of the number of prenatal care visits was 2.7±1.2 visits

East Koguta. For each non-intervention group and the intervention group, there were no recorded women who did not come to at least one prenatal care visit. The number of prenatal care visits was recorded for 36 of the 43 women in the first non-intervention group (83.7%). Nineteen percent of the women attended the recommended four or more prenatal care visits. The mean and standard deviation of the number of prenatal care visits was 2.6±1.0 visits. In the second non-intervention group, the number of prenatal care visits was recorded for 31 of the 33 women (93.9%). Thirty nine percent of this group attended the recommended four or more prenatal care visits. The mean and standard deviation of the number of prenatal care visits was 2.8±1.3 visits. In the intervention group, the number of prenatal care visits was recorded for all 60 women. Thirty percent of the intervention group attended the recommended four or more prenatal care sessions. The mean and standard deviation of the number of prenatal care visits was 2.8±1.1 visits.

HIV

All Sub-Locations. Among women from all sub-locations, HIV status was recorded for 487 of the 522 women (93.3%). Of the 487 women with recorded HIV

statuses, 92 were found to be HIV-positive (18.9%) and 390 were found to be negative (80.1%). Six women were labeled as having "uncertain" HIV statuses (1.2%). See *Figure 4.*

East Koguta. HIV status was recorded for 42 of the 43 women in the first non-intervention group (97.7%). Of the 42 women with recorded HIV statuses, 5 women were positive (11.9%) and 37 were negative (88.1%). Thirty of the 33 women in the second non-intervention group had their HIV status recorded (90.9%). Of these 30 women, 8 were positive (26.7%) and 22 were negative (73.3%). When examining all women from both non-intervention groups, HIV status was recorded for 72 of the 76 women (94.7%). Of the 72 women with recorded HIV statuses, 13 were found to be HIV-positive (18.1%) and 59 were found to be negative (81.9%). No women were labeled as having "uncertain" HIV statuses. See *Figure 5.*

When examining women from the intervention group, HIV status was recorded for 57 of the 60 women (95.0%). Of the 57 women with recorded HIV statuses, 14 were found to be HIV-positive (24.6%) and 41 were found to be negative (71.9%). Two women were labeled as having "uncertain" HIV statuses (3.5%). See *Figure 6.*

Figure: 4 **HIV Prevalence of all Sub-Locations**

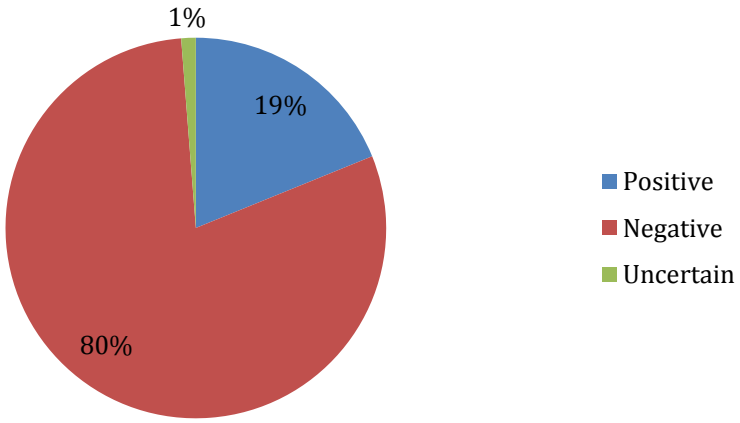


Figure: 5 **East Kaguta HIV Prevalence at Health Centre Before CHWs**

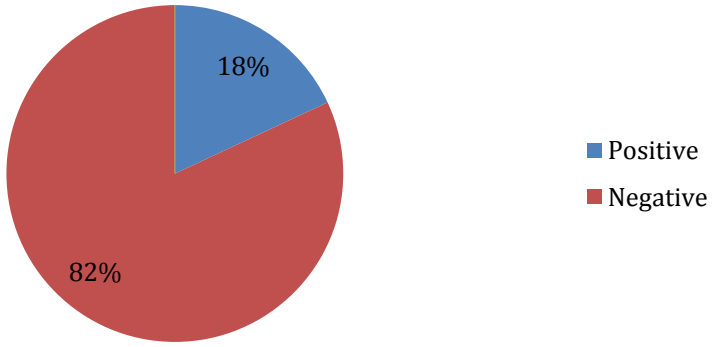
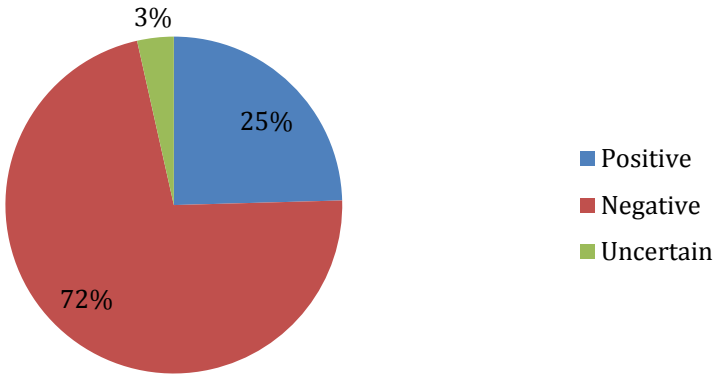


Figure: 6 **East Kaguta HIV Prevalence at Health Centre After CHWs**



Maternal Death and Referrals

All Sub-Locations. One maternal death was recorded among all women who delivered at the health center from 2009-2012. The woman who died was 14 years old. She had attended two prenatal care visits, had never been in labor before, was HIV negative, and from an unknown sub-location. She delivered a 2500 gram baby who also died before leaving the clinic. She delivered and died in March 2012 after being in labor for 24 hours.

Fifteen mothers were referred from the Sigoti Health Center to another health institution (2.9%). There were 7 different recorded reasons for referral. These include: ruptured membrane, obstructed labor, no fetal heart, anemia/breech presentation, false labor, and need of preterm incubator. Of the fifteen mothers referred, there were four mothers whose reason for referral was not specified. There were four mothers referred due to obstructed labor and three mothers

referred due to false labor. For each of the other causes, one woman was referred. See *Table 2*.

Table 2: Referrals from Sigoti Health Center

Cause for Referral	Referrals
Ruptured membrane	1
Obstructed labor	4
No fetal heart	1
Anemia and breech presentation	1
False labor	3
Need of preterm incubator	1
Unknown	4

East Koguta. Neither the first nor second non-intervention group contained any women who were referred during labor. From the intervention group, two women were referred. One woman was referred due to a ruptured membrane and the other was referred because of anemia and breech presentation.

Risk Score

All Sub-Locations. Among women from all sub-locations, risk scores ranged from 0-9 and contained a median risk score of 1. The mean and standard deviation of risk score was 1.8±1.9. Eleven percent contained a risk score of greater than or equal to 5. See *Table 3* for risk score frequencies and percentages.

Table 3: Risk Scores for All-Sub-Locations

Risk Score	Frequency	Percent
0	209	40.1
1	91	17.5
2	24	4.6
3	86	16.5
4	55	10.6
5	35	6.7
6	12	2.3
7	8	1.5
9	1	0.2
	Mean=1.8±1.9	

East Koguta. In the first non-intervention group, risk scores ranged from 0 to 6 and contained a median risk score of 1. Most women in this comparison group, as well as each of the other comparison groups, had a risk score of zero. The mean and standard deviation of risk score in the first non-intervention group was 1.4±1.8. Nine percent of women had a high risk score of greater than or equal to 5. See *Table 4*.

In the second non-intervention group, risk scores ranged from 0 to 7 and contained a median risk score of 1. The mean and standard deviation of risk score in the first non-intervention group was 2.2±2.2. Fifteen percent of women had a high risk score of greater than or equal to 5.

The intervention group closely mirrored the second non-intervention group. In the intervention group, risk scores ranged from 0 to 7 and contained a median risk score of 1. The mean and standard deviation of risk score in the first non-

intervention group was 2.2±2.2. Fifteen percent of women had a high risk score of greater than or equal to 5.

Table 3: Risk Scores

	First Non-Intervention		Second Non-Intervention		Intervention	
Risk Score	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
0	20	46.5	10	30.3	20	33.3
1	10	23.3	8	24.2	11	18.3
2	1	2.3	0	0	0	0
3	4	9.3	7	21.2	10	16.7
4	4	9.3	3	9.1	10	16.7
5	3	7	1	3	5	8.3
6	1	2.3	3	9.1	1	1.7
7	0	0	1	3	3	5
	Mean=1.4±1.8		**Mean=2.15±2.2**		**Mean=2.22±2.2**	

On average, the first non-intervention group contained women of lower risk, while women in the second non-intervention group and the intervention group contained women of approximately equal higher risk. In addition, both the second non-intervention and the intervention groups have approximately equal percentages of high-risk women who have a risk score of greater than or equal to 5. The percentage of high-risk women in both of these groups is higher than the percentage of high-risk women in the first non-intervention group. The dominating factor in the higher risk scores of the second non-intervention group and the intervention group was the relatively high HIV prevalence. Due to heavily weighting

the HIV status on overall risk score, the prevalence of this risk factor greatly influenced each mean risk score. All risk factors and their prevalence in each comparison group are shown in *Table 5*. Differences in HIV prevalence between *Table 5* and *Figures 5 and 6* are present. This is because HIV prevalence in *Figures 5 and 6* were calculated by only including women with known HIV statuses. On the other hand, the risk score calculations counted women with unknown HIV statuses as HIV-negative in order to create a conservative estimate of risk.

Table 5: Percentage of Women with Risk Factor

Comparison Group	Parity	Age	Marital Status	HIV
Non Intervention 1	39.5	7.0	20.9	11.6
Non Intervention 2	51.5	6.1	27.3	24.2
Intervention	48.3	13.3	26.7	23.3

Infant Statistics

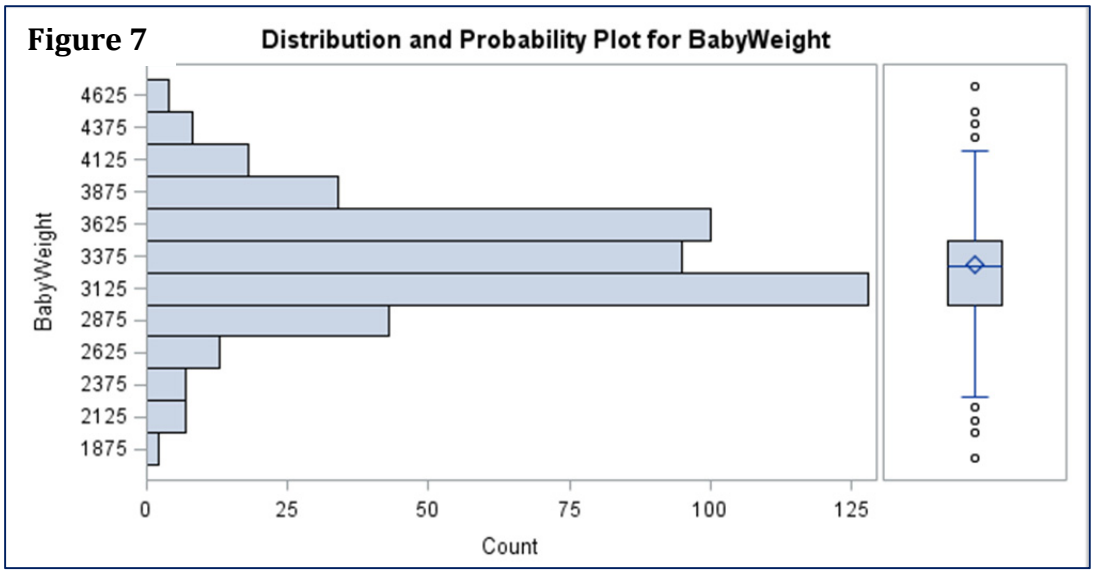
Sex, Stillbirths and Infant Mortality, Weight

All Sub-Locations. Of the 506 infants delivered at the health center, sex was recorded for 456 of them (90.1%). Two hundred and sixteen were male (47.4%) and 240 were female (52.6%). Upon delivery, 4 infants were considered fresh stillbirths and 1 was considered a macerated stillbirth. Two other infants died before leaving the Sigoti Health Center.

There were 459 infants with recorded weights (90.7%). The mean and standard deviation of the weights was 3306 ± 441 grams. The weights ranged from 1800 grams to 4700 grams and had a median of 3300 grams. The mean and median

comparison and the shape of the respective histogram reveal that the data follows a normal distribution (See *Figure 7*). Sixteen infants born weighed less than 2500 grams and are considered low birth weight infants (3.5%).

Figure 7



East Koguta. In the first non-intervention group, the sex was recorded for 29 of the 33 infants born (87.9%). In this group, 17 were male (58.6%) and 12 were female (41.4%). In the second non-intervention group, sex was recorded for 42 of the 43 infants born (97.7%). In this group, 19 were male (45.2%) and 23 were female (54.8%). Therefore, between the two non-intervention groups, there were 36 males (50.7%) and 35 females (49.3%) before the CHW program. One woman from the first non-intervention group had a stillbirth. No other infants died during or soon after the delivery process.

After the start of the CHW program, there were 59 infants born from mothers living in East Koguta. Of these 59 infants, there were 51 with recorded sex (86.4%).

There were 22 males (43.1%) and 29 females (56.9%). There were neither stillbirths nor any deaths during or soon after the delivery process.

In the first non-intervention group, weights were recorded for all 43 infants born. The mean and standard deviation of the weights were 3266 ± 466 grams. The median was 3300 grams and the weights ranged from 1800 to 4200 grams. The middle 50% of infant weights fell between 3000 and 3550 grams. In the second non-intervention group, weights were recorded for 29 of the 33 infants born (87.9%). The mean and standard deviation of the weights were 3317 ± 349 grams. The median was 3300 grams and the weights ranged from 2800-4200. The middle 50% of infant weights fell between 3000 and 3500 grams. For the intervention group, weights were recorded for 52 of the 59 infants born (88.1%). The mean and standard deviation of the weights were 3363 ± 491 grams. The median was 3400 grams and the weights ranged from 2000-4400 grams. The middle 50% of infant weights fell between 3100 and 3700 grams.

Overall, there were 7 low birth weight infants in the non-intervention and intervention groups (<2500 grams). Three of the low birth weight babies were in the non-intervention groups and 4 were in the intervention group. In addition, infant weight was regressed on maternal risk score in order to determine the impact of maternal risk on infant birth weight. Both non-intervention groups and the intervention group were included in the analysis. Only 2.8% of the variance in infant birth weight could be predicted by risk score (R^2=0.028). For every one point increase in risk score, infant weight decreased on average 36.0 grams, but the results were not significant (p=0.064).

Primary Hypothesis

The primary hypothesis of this study was that the CHW program would increase the number of women delivering at the Sigoti Health Center after adjusting for monthly fluctuation. The data analysis showed that the null hypothesis can be rejected.

Both non-intervention groups contained fewer women than the intervention group. In the first non-intervention time frame, there were 43 women who delivered, and in the second non-intervention time frame, there were 33 women who delivered. On the other hand, 60 women delivered while the CHWs were active. Using the test for equality of proportions to compare the average number of women in the two non-intervention groups (38 women) with the number of women in the intervention group, there was a statistically significant difference (X^2=9.55, p=0.014). This same method was also used to determine if there was a statistically significant difference when comparing each individual non-intervention group with the intervention group. When comparing the number of women in the first non-intervention group with the number of women in the intervention group, using the test for equality of proportions, the difference came close but did not reach statistical significance (X^2=3.38, p=0.066). When comparing the number of women in the second non-intervention group with the number of women in the intervention group, using the test for equality of proportions, there was a statistically significant difference (X^2=9.55, p=0.002).

Hypothesis 2

The second hypothesis of this study was that the women delivering at the health center after the institution of the CHW program would have higher risk than women delivering at the health center before the CHW program after adjusting for monthly fluctuation. The data analysis showed that the null hypothesis failed to be rejected.

The mean risk score for the intervention group was 2.2167 while the mean risk score of the all women in both non-intervention groups was 1.7368. In addition, the mean risk score of the intervention group was greater than each individual non-intervention group mean risk score (1.4186 for the first non-intervention group and 2.1515 for the second non-intervention group). When using a one-way analysis of variance to determine if there was a statistically significant difference in the risk scores of women in both non-intervention groups and the intervention group, the differences were determined not to be statistically significant ($F=2.16$, $p=0.119$). Therefore, the null hypothesis cannot be rejected, though the results are in the predicted direction.

Hypothesis 3

The third hypothesis of this study was that the CHW program would increase the number of HIV-positive women who delivered at the clinic after adjusting for monthly fluctuation. The data analysis showed that the null hypothesis failed to be rejected.

There were 5 HIV-positive women who delivered in the first non-intervention group, 8 HIV-positive women in the second non-intervention group, and 14 HIV-positive women in the intervention group. Therefore, there was an increase in the number of HIV-positive women after the institution of the intervention. In order to see if the increase was statistically significant, the hypothesis test for equality of proportions was used. When comparing the average number of HIV-positive women between the non-intervention groups (6.5) with the number of HIV-positive women in the intervention, the increase is not statistically significant (X^2=2.68, p=0.102). In addition, the individual non-intervention groups were each compared to the intervention group. When comparing the number of HIV-positive women in the first non-intervention group with the intervention group, the increase is statistically significant (X^2=4.28, p=0.038). When comparing the number of HIV-positive women in the second non-intervention group with the intervention group, the increase is not statistically significant (X^2=1.51, p=0.219). These results partially support the study hypothesis and suggest that, if the sample were larger, all of these tests could have been significant.

Hypothesis 4

The fourth hypothesis of this study was that the CHW program increased infant birth weight after adjusting for monthly variation and the mother's risk profile. The data analysis showed that the null hypothesis failed to be rejected.

This hypothesis was tested using a two-way analysis of variance and compared the infants born in the two non-intervention groups with the infants born in the intervention group. The intervention group contained a higher mean birth

weight (3362.5 grams) than either of the non-intervention groups (3266.3 for the first non-intervention group and 3317.2 for the second non-intervention group). Despite the increase in mean birth weight, after adjusting for maternal risk profile, the increase was not statistically significant (R^2=0.0373, F=2.35, p=0.100).

CHAPTER SIX

Discussion

Hypothesis 1: The community health worker program would increase the number of women delivering at the Sigoti Health Center.

For the first hypothesis, the null hypothesis was rejected, providing support to the idea that that the CHW program is an effective means for increasing the number of facility-based deliveries at the Sigoti Health Center. This is important due to the high prevalence of HIV among rural Luo women and the ability of the Sigoti Health Center to treat HIV-positive women before delivery. According to the 2008-2009 Kenyan Demographic and Health Survey, Luo women by far had the highest HIV prevalence (22.8%) of any ethnic and gender category. The second highest HIV prevalence of any ethnic and gender category was among Luhya women (12.0%). However, the HIV prevalence among the Luo women of rural East Koguta is potentially greater than the listed 22.8% because of two reasons: the rural HIV prevalence of Kenya is higher than the urban HIV prevalence and the 22.8% prevalence of HIV among Luo women combines both urban and rural Luo women.

To help alleviate the burden caused by a high HIV prevalence, the Sigoti Health Center provides HIV testing and antiretroviral treatment (ARV) free of charge. This is important for the mother's health during pregnancy and delivery. It is also important because ARVs reduce the probability of HIV transmission from mother to child during pregnancy and delivery. Without the use of ARVs during pregnancy, the WHO estimates the rate of mother to child transmission of HIV to be

between 15-45%; another study estimates the rate to be about 25% (Connor 1994) while yet another states it to be at 20% (Cooper 2002). However, with the use of ARVs, the rate of transmission can be reduced to 0.8% (Townsend 2008).

One goal of the health center and the CHW program is that 30% of all deliveries occurring in the health center's catchment area would happen in the health center's delivery ward. Most women living on the Upper Nyakach Division who choose not to deliver in the health center deliver at home or with the aid of a traditional birth attendant (TBA) (Damoiseaux 2013). These women do not have access through TBAs to the free ARVs that can be given throughout the pregnancy and during the delivery process. Adding to the problem is that TBAs are in competition with the health center for their services, making it unlikely for them to refer patients. Therefore, these women are most likely never tested to discover their HIV status nor administered treatments to prohibit transmission if they are HIV-positive. Consequently, these women have a greatly increased probability of passing on HIV to their infant. As can be seen, the Sigoti Health Center plays a central role in reducing the HIV prevalence rate in the Upper Nyakach Division over time.

In addition, by increasing the proportion of women who deliver at the Sigoti Health Center instead of at home or with a TBA, more maternal and infant deaths will be averted. Several studies reveal that deliveries occurring with the aid of health professionals reduce mortality rates, even if the delivery occurs at home (Mengesha 2013; Koblinksy 1999; De Brouwere 1998). These mortality rates are

further reduced when the delivery occurs with health professionals and within a health facility (Koblinksy 1999).

Hypothesis 2: The community health workers would bring higher risk women to the Sigoti Health Center in order to deliver.

Women in the non-intervention groups on average had lower risk scores than women in the intervention group. Part of the analysis was statistically significant, and the rest was in the predicted direction. However, the average increase was not statistically significant. This finding shows that the CHWs did not definitively refer higher risk pregnant women to the health center.

One of the objectives of a CHW is to bring the most severe and high-risk cases to the health center. This is important because CHWs can act as gatekeepers by encouraging the most severely ill patients in the community to see medical care first. In addition, CHWs can dissuade those who do not truly need the services of a medical professional from seeking care and congesting patient flow.

One important statistic dealing with the risk profile is the percentage of women with risk scores greater than 4. This represents women who have truly high risk. A woman with a risk factor of 5 either is HIV-positive and is in the parity risk category, or falls into each of the age, marital status, and parity risk categories. A woman with a risk score higher than 5 must have HIV in combination with another risk factor. The percentage of high-risk women who came to the health center during the first non-intervention time frame (9.3%) was lower than the percentage of high-risk women who came to the clinic during the intervention time frame

(15.0%). However, during the second non-intervention time frame, the percentage of high-risk women was slightly above the intervention time frame (15.1%).

When examining the percentages of women with each of the risk factors, it is interesting to note that the second non-intervention group is very similar to the intervention group in every statistic. One statistic that does vary greatly is age. Whereas 6.1% of the women in the second non-intervention group fall into the age risk category, more than twice as many (13.3%) in the intervention group fall into the age risk category. The first non-intervention group is well below both the second non-intervention and the intervention group in the percentage of women in each of the risk categories. The only exception is that the first non-intervention group has a slightly higher percentage of women in the age risk category. It is possible that the CHWs were trained to refer women with certain risk factors, such as age, while not highly considering other risk factors in the referral process, such as parity.

Hypothesis 3: The community health worker program would bring more HIV-positive women to the Sigoti Health Center in order to deliver.

The number of HIV-positive women who delivered at the health center increased after the beginning of the CHW program. However, this increase failed to be statistically significant. This shows that the CHWs appear to be producing the desired results, but the number of patients in this study is relatively small and may be responsible for the lack of statistical power to show a significant difference if one exists.

The importance of CHWs bringing in more HIV-positive women lies with their role in reducing mother to child transmission. The cycle of this virus being continually passed from one generation to the next is a key factor that has kept rates of HIV infection at a high level. Many developing nations plagued with high HIV prevalence rates also have high fertility rates, creating an even greater likelihood of this virus being passed on to the next generation. Community health workers, as mentioned above, play an important role in bringing pregnant women to local health institutions where they can be treated with ARVs before and after delivery.

Hypothesis 4: The community health worker program would increase infant birth weight when adjusting for the mother's risk profile

The mean infant birth weight increased after the introduction of the CHW program. However, this increase was not statistically significant, and therefore, it is not conclusive whether the CHWs played a role in increasing infant birth weight.

Many of the responsibilities of CHWs could help create better health outcomes, such as infant birth weight. Community health workers are responsible for bringing women to the health center for prenatal care and for educating pregnant women about what to do and not do during pregnancy in order to deliver a healthy infant. They also visit community members regularly in order to inquire of their health and see if the attention of a medical professional is necessary. These CHW responsibilities have the potential for increasing the average infant birth weight and decreasing the number of low birth weight infants. The data reveals that the CHWs appear to be producing the desired results, though the increase in infant birth weight was not statistically significant.

Comparable Studies

In Satti's study, the increase of facility-based deliveries through the use of CHWs was much larger than the increase seen in this study: 33 deliveries in the second non-intervention group to 60 deliveries in the intervention group (Satti, 2012). However, the yield of referred patients per CHW is 1.3 compared to the Sigoti Health Center ratio of 1:1. This difference is quite small considering that the CHWs in the Bobete study were paid, and the Sigoti CHWs were not paid. In addition, the Bobete Health Center had the "lying-in" center where women near their expected due date could stay. This center may be the most important factor in countering the negative impact of distance and transportation difficulties that women in remote rural areas face in trying to deliver at a health center.

Medhanyie's study in Ethiopia differed from the present study in that the ratio of CHWs to population was much lower in the Ethiopian study, but their CHWs were paid instead of only being offered incentives as they were in Sigoti (Medhanyie 2012). Unlike the results of the present study of the Sigoti Health Center, the results of Medhanyie reveal that, whereas the usage of antenatal care and family planning increased, the proportion of women delivering at a health facility did not change after the institution of the health extension workers. Reasons mentioned by Medhanyie for this stagnation include the low number of health extension workers per population, the distance of health facilities from households, and the population's lack of trust in health extension workers.

The combined findings of these studies with the Sigoti study show that there must be a critical mass of health workers to make a difference, even if a small number of workers are receiving pay. In addition, the resources to set up a facility near the health center where women can stay may be equally as important as the addition of CHWs.

Future Studies

Future studies could focus on other impacts the CHWs create concerning the overall health of the Sigoti Health Center's catchment area. Community health workers are responsible not only for bringing mothers into the health center for prenatal care visits and deliveries, but they are also responsible for referring sick patients for medical treatment and dispersing public health information through education. Some CHWs are trained to treat simple injuries and illnesses and to deliver pain medication. Because of the variety of focuses CHWs often have, to gain a better understanding of their impact it would be necessary to study these other factors as well. In addition, due to the variety of CHW programs, interviews could be conducted with various CHWs in the Nyanza Province to compare the utilization, focus, and effectiveness of different programs. These interviews could also aid in determining what factors contribute to CHW programs achieving their health outcome goals.

Due to the high prevalence of both HIV and malaria, a more comprehensive study could be done to compare the health outcomes from both of these diseases during the non-intervention time frames and the intervention time frame. The Sigoti Health Center keeps a record of patients treated for malaria and HIV, which

would provide data for further analysis. An extension of the present study comparing the effect of CHWs on utilization of maternal health services would be beneficial. Because data have continued to accumulate since the current analysis, future studies would have the advantage of having an increased sample size because of the longer intervention time frame.

Limitations

This study contains four possible threats to sound inference: systematic error, random error, construct validity, and generalization to other persons, settings, and times.

Systematic Error

For the first hypothesis, lurking variables potentially could have affected the results. One possible lurking variable is the effect of other CHW programs on the results. Another CHW program was established in the Upper Nyakach Division in May 2011 by a regional health expert in conjunction with another Baylor student. Discussions were held with the regional health expert and 12 of the 15 CHWs in this program in order to determine both the extent of their work and the likelihood that the program would systematically change the results of this study. It is unlikely that the program had any substantial effect on the results of this study for two reasons. The first reason is that the program instituted in May 2011 maintained a focus on health education instead of referral. On the other hand, the Koguta East CHW Program was established with the main purpose of seeking out community members in need of medical services and personally bringing them only to the Sigoti

Health Center. The second reason is that the program was not specifically attached to the Sigoti Health Center and would therefore not be incentivized to refer patients to this health facility alone. The 12 CHWs mentioned that they generally referred patients to one of three health facilities: the Nyabondo Mission Hospital, Pap Onditi Health Center, or the Sigoti Health Center. However, the CHWs stated that the health institution they most often referred patients to was the Sigoti Health Center. This program, in addition to any other unknown program that began around September 2011, potentially could have systematically altered the results of this study. If an unknown program did alter the results, then the effect most likely would have been a more profound increase in the number of women delivering at the Sigoti Health Center. Therefore, this would have caused an overestimation of the effect of the Koguta East CHW Program.

Biological fluctuations, such as variations in the number of conceptions, and outside phenomena, such as variations in weather, are true possibilities that could confound results. The presence of these possible determinants are also difficult to measure, and perhaps even more difficult to measure are their effects on the number of women coming to the Sigoti Health Center to deliver. With the scope of this study, it was not feasible to adjust for every potential confounder. However, one certain confounder that we did adjust for was monthly variation. While adjusting for monthly variation, other potential confounders are also partially adjusted, such as weather. There are two rainy seasons annually in Kenya. One starts at the end of March and goes through May, and another occurs throughout November and into early December. By creating comparable time frames

containing the same months, we were able to adjust for the rainy seasons and other confounders that occur in monthly cycles.

Random Error

Variation seen in the number of women and the risk profile of women delivering at the health center could potentially be the result of random error. The results of this study allows for the possibility that hypotheses 2-4 could be true even though the changes from the non-intervention time frames to the intervention time frame were not statistically significant. Because of the small sample size it is difficult for statistical significance to be reached and for this study to diminish the possibility of random error. In addition, this study was explicit about the potential for random error offsetting the results by including p-values for each hypothesis test.

Construct Validity

This study seeks to determine the effectiveness of CHWs by examining changes in the use of maternal health services. Community health workers in general have several purposes. The primary purpose is to refer community members in need of medical services to local health facilities. Common secondary purposes include health education, assisting health professionals in mass vaccinations or other large short-term health events, relaying information to health professionals about disease outbreaks, and the treatment of minor illnesses. This study attempts to generalize from maternal data the effectiveness of CHWs. A better measurement of overall effectiveness would also include results on changes in the

overall number of patients and the severity of illness for each of these patients. The most common and threatening diseases in the Upper Nyakach Division and tropical, rural Africa are malaria and HIV. The overall effectiveness of CHWs depends greatly on their ability to manage these two illnesses. Therefore, two other good measurements of a CHW program's effectiveness would be the number and severity of malaria cases referred and the number of previously untreated HIV-positive cases referred. Other measurements of effectiveness include decreases in the prevalence of hygiene related or highly preventable diseases, the number of vaccinated community members, and the number of minor illnesses treated. All of these measurements describe a component of the overall effectiveness of CHWs.

Due to the limited scope of this study and the limited availability of data, this study focuses on one component and then attempts to generalize the overall effectiveness of CHWs. Increasing the utilization of maternal health services was one of the primary goals of the East Koguta CHW program, and therefore, the measure used in this study is an important indicator of the effectiveness of the respective program. One of the primary goals of the Sigoti Health Center is that 30% of all deliveries occurring in the catchment area happen within the walls of their facility. One of the major contributing factors to the formation of the CHW program was an attempt to reach this goal.

Generalizations to Other Persons, Settings, and Times

The Koguta East CHWs were all Luo women except for one Luo man. Most CHW programs are composed predominately of females due to the fact that most men in rural areas spend much of their time working in agriculture. By definition,

CHWs live in and are respected members of the community where they work. It is safe to generalize that the makeup of the program analyzed is comparable to the vast majority of CHW programs. In addition, most CHW programs are instituted in predominately rural communities, such as East Koguta. It is safe to generalize that the results from this study could be replicated in other rural African communities that contain similar CHW program structures. The program began in September 2011 and data collection ended at the end of May 2012. It can be safe to assume that results from this study can be generalized to other time frames.

CHAPTER SEVEN

Conclusion

This study provides information regarding the effectiveness of CHWs. More specifically, this study highlights the impact of a CHW program on increasing the utilization of maternal health services, especially in increasing the number of facility-based deliveries. The goal of this study was to determine the effects of the recently instituted Koguta East CHW Program by examining the Sigoti Health Center's maternal registry. The primary assumption, that the number of facility-based deliveries would increase, was supported by the data. The other assumptions also proved to be in the right direction, though the differences seen between the non-intervention groups and the intervention group were not statistically significant. Due to the small sample size in this study, more recent studies with larger sample sizes are necessary in order to determine if the other hypotheses are supported.

The importance of facility-based delivery in regions with a high HIV prevalence is also emphasized in this study. Without the distribution of HIV treatment during and after pregnancy, the vicious cycle of mother to child transmission will not improve, and thus, high levels of HIV will continue to plague many regions. With proper training, incentives, and numbers of CHWs, it has been shown in this study as well as in several other studies that CHWs can play an integral part in increasing the use of maternal health services and thereby help alleviate the burden of HIV.

In addition, the presence of skilled personnel during the delivery process is important in reducing maternal and infant mortality rates, as several studies have previously shown. The Nyanza Province has the highest maternal and infant mortality rates of any province in Kenya. By encouraging more pregnant women to deliver at the health facility, CHWs are helping to decrease these mortality rates.

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