The effect of armed conflict on maternal and child health services in Uganda, 2007-2010

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ABSTRACT

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The allocation and utilization of maternal and child health (MCH) services has been shown to be severely diminished during periods of protracted conflict. A limited body of research describes the lingering effects that civil war can have on already stressed health systems in sub-Saharan Africa. To assess the effects of conflict on maternal and child health services and outcomes, we analyzed monthly facility records for the four-year period immediately following the Lord's Resistance Army's (LRA) occupation of Northern Uganda. Facilities located in high conflict areas reported substantially fewer MCH services between 2007-2010 than those in areas not affected by the LRA conflict. Facilities located in high conflict areas also reported a greater number of maternal and infant deaths between these years and after controlling for HIV prevalence, sanitation, education, facility level, month, and year.

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Acknowledgements

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List of Acronyms

MCH – Maternal and Child Health
LRA – Lord's Resistance Army
IDP – Internally Displaced Person(s)
UPDF - Ugandan People's Defense Force
HSMF – Holy Spirit Mobile Force
CDC – Centers for Disease Control and Prevention
PEPFAR – President's Emergency Plan for AIDS Relief
HMIS – Health Management Information System
UBOS – Uganda Bureau of Statistics
ANC – antenatal care
ACCS - Advisory Consortium on Conflict Sensitivity
OPD – outpatient department
IPT – intermittent preventative treatment
SD – standard deviation
CI – confidence interval
IRR – incidence rate ratio

1. Introduction

It is important for decision makers in war-torn nations to be aware of the potential effect that civil war can have on struggling health care systems and developing economies. At the beginning of 2007 there were 15 ongoing events classified as significant armed conflicts (1000 or more reported deaths) worldwide with nearly two-dozen other areas, at that time described as hot spots, with deaths reported and potential for increased bloodshed (Sidel, 2008). African countries with recent civil conflict have a 30.5% higher under-5 mortality rate and a 26.8% higher maternal mortality rate compared to countries with no conflict. Armed conflict is also one of the most important determinants of poverty in developing countries and it is estimated that annual losses in sub-Saharan Africa due to conflict are close to $15 billion (O'Hare, 2007).

The goal of our study was to better understand how MCH services in post-conflict areas of Northern Uganda differed from those areas removed from the violence. We answer our research question using the population-adjusted annual rate of services provided at facilities located in areas experiencing different degrees of conflict. In the four years following the LRA conflict, there were fewer MCH services provided and more maternal and infant deaths reported by health facilities located in high conflict areas. These findings have led us to conclude that priority must be given to increasing the utilization of antenatal and postnatal care services in post-conflict areas. It is also recommended that more attention be given to increasing access to preventative health services, improving the quality of services provided at health facilities, and collecting representative health system data from war-torn regions of sub-Saharan Africa.

2. Background

2.1 War and Health

Africa has been experiencing the negative health consequences of foreign occupation and war for much of the past five decades. The rapid rate of decolonization in the 1960s forced many imperialist regimes to abandon their claims. One result of these revolutionary departures was the disproportionate reallocation of wealth and power throughout a continent struggling to redefine itself. The degeneration of nations into

periods of extended conflict has informed the neocolonial narrative of sub-Saharan Africa and detracted from advances made in this region since the end of formalized occupation. Violent conflict is an all too common reality in this part of the world as are the long-term negative health consequences of war and population displacement.

Protracted conflict not only subjugates victims exposed to the brutality but also undermines the long-term success of nation states. The indirect effects of collective violence can cause, “serious health consequences through impacting the physical, economic, social and biological environments in which people live” (Sidel, 2008). The high levels of morbidity and mortality associated with civil war in Africa are both directly and indirectly associated with the violence as these conflicts often have a significant affect on societal infrastructure, the delivery of health and other social services, and the disruption of transport and communication systems. This type of violent conflict has a “direct, immediate and deadly impact on human life and health” and leaves a lasting impression upon its victims, destroying families, communities, and cultures (IDMC, 2012). These effects are especially apparent for refugees and internally displaced persons (IDPs) who are forced to flee their homes to escape death, disease, and starvation (Sidel, 2008). Refugees or displaced persons are, “out-crops of the routine tactics of armed political violence and civil unrest” (Ogbonna-Nwaogu, 2008) and as recent as 2010 it was estimated that sub-Saharan Africa accounted for 40.4% of the total number of IDPs worldwide (IDMC, 2012).

Civil war is especially problematic for already impoverished nations. In Somalia, political upheaval was the norm between 1999 and 2005 and a large number of civilians were displaced during these years. A UNICEF survey estimated that during this time Somalia experienced, “a demographic mortality rate of 135 deaths per 1,000 children under the age of five years.” These rates were substantially higher than neighboring Ethiopia and Kenya (Guhu-Sapir, 2009). Deaths resulting from preventable disease and malnutrition were more problematic than those resulting from violence. The lack of a functional public health system both precipitated and exacerbated these issues, limiting the amount of vaccines that could be administered and food aid distributed to those displaced by the conflict (Guhu-Sapir, 2009). Similarly, when the nation of Liberia emerged from 14 years of civil war in 2003, it was faced with a health system

in complete disrepair (242 of 293 health facilities were considered non-functional), a total lack of usable infrastructure (roads, electricity, water, etc.), and an aggressively depleted health workforce. Following the end of the conflict, the under-five mortality rate was estimated to be 110 per 1000 live births and the maternal mortality rate was 994 deaths per 100,000 live births, a 71% increase from 2000. Child mortality, although lower than during the war, was ten times as high as some developed countries and maternal mortality was still amongst the highest in the world (Kruk, 2010).

The short, medium, and long-term ways in which conflict disproportionately undermines marginalized groups are myriad. The experience of men and women, boys and girls differs in conflict and post-conflict settings with social, cultural, and biological factors increasing the type and number of risks affecting mothers and adolescent girls. Women and children are especially vulnerable post-conflict (Ormhaug, 2009) and the, “vast majority of refugees and internally displaced persons as a result of war are women, children and elderly people, who may be highly vulnerable not only to disease and malnutrition, but also to threats of their security” (Sidel, 2008). Furthermore, the health care system in conflict-affected districts is oftentimes weaker than in other areas as there are, “fewer health facilities, little skilled manpower, and poor referral services” (Orach, 2009) to address the needs of potential patients.

2.2 Northern Uganda

On October 9, 1962, the Republic of Uganda gained independence from Great Britain and in doing so became the 33rd nation on the African subcontinent to break away from colonial oppression. This particular transition from subject to ruler was one mired with instability and violent conflict as competing figures jockeyed for control of limited resources. President Yoweri Museveni took office in 1986 following decades of turmoil and in the midst of tribal, cultural, social, and economic fragmentation. Many of the ideologies and individuals who opposed the new President were absorbed into the Ugandan People’s Defense Force (UPDF) or joined Alice Lakwena’s Holy Spirit Mobile Force (HSMF), later know as the Lord’s Resistance Army. The effects of this conflict were felt on either side of the North-South divide with the most affected population in the North being the, “Acholi people from the districts of Gulu, Amuru, Kitgum and Pader, who worked on small land-holding for subsistence and income before the conflict” (Roberts, 2009).

The LRA conflict in Uganda spanned 20-plus years, during which time dispensaries and schools were destroyed, households and granaries were burned, and both soldiers and rebels brutally abused citizens. In the late 1990s, the government began herding civilians into “protected villages” and Operation Iron Fist (following the Anti-Terrorist Act of 2002) did little more than allow the rebels to solidify their position in the North (Dolan, 2011). The LRA has not been active in Uganda since 2006 but has “continued to displace civilians in the Central African Republic, Democratic Republic of the Congo and South Sudan, despite international military efforts” (Dolan, 2011). As of 2011, the LRA had played a large role in displacing 440,000 people in these three countries (IDMC, 2012) in addition to displacing nearly 2 million people in Uganda (USDS, 2012). Nearly 1.8 million Ugandans have returned to their homes since 2006 but they still face a range of risks, “related to their displacement, including threats to their physical security and integrity, a lack of access to basic necessities such as clean water, food, shelter and health care, and to the livelihoods which would improve their standard of living” (IDMC, 2012).

2.3 Research question

We posed the following research question, using data from monthly health facility reports submitted to the Ugandan Ministry of Health between 2007-2010:

> *How did the utilization of maternal and child health services, along with certain maternal and child mortality outcomes, vary in relation to the conflict-affected location of health facilities between 2007 and 2010?*

Our specific aims were to describe trends observed in the rate of maternal and child health services in the four years immediately following the LRA conflict and to make inferences about the relationship between degree of conflict and MCH outcomes.

3. Methods

3.1 Background

The current investigation was conducted secondary to a retrospective study involving colleagues at the University of Washington and in partnership with Makerere University in Kampala, Uganda, in a cooperative agreement with the Centers for Disease Control and Prevention (CDC). The overarching project researched the effects that the President's Emergency Plan for AIDS Relief (PEPFAR) had on non-HIV service utilization between mid-2005 and mid-2011. The author of this thesis (JEB) worked as a part-time Research Assistant on the PEPFAR project in 2011 and 2012, while a graduate student at the University of Washington.

The PEPFAR research was organized through a Cooperative Agreement from the CDC and the University of Washington, using a PEPFAR Public Health Evaluation award in late 2010. Makerere University was sub-contracted by the University of Washington to provide leadership, management, and scientific guidance. The Ministry of Health's Resource Center and the Uganda office of the CDC were also designated as partners on this project. The purpose of this research was to, identify spillover effects on the health system, if any, of PEPFAR investments intended to stem the HIV epidemic over a 6-year period. The idea was to assess what health system expansions, as observed by increases in the number of non-HIV services utilized, could be linked to PEPFAR investments at the district level (Luboga, 2015).

A number of institutional review boards, including the University of Washington, Makerere University, the Ugandan National Council of Science and Technology, and the CDC, approved the original PEPFAR study and the Ugandan Ministry of Health provided access to Health Management Information System (HMIS) data and a letter of introduction to facilitate the data collection process at district health offices and health facilities.

3.2 Study setting

The setting for this study was the country of Uganda, a largely Christian and English speaking nation with dozens of ethnic groups, colonized by Britain during the period 1894-1962. The total population in 2014

was 35 million people, 57% under the age of 18 (UBOS, 2014). Uganda has among the fastest growth rates in the world (World Bank, 2015), and almost two thirds of the population survives on less than $2 per day (Index Mundi, 2012). Total fertility rate is 6.7 births per woman, with uneducated women having on average three times more children than women with some secondary education (UBOS, 2007). Forty percent of births occur in a health facility and only one quarter of women receive postnatal care of some kind in the five years following their live birth. Only 46% of children between the ages of 12 and 23 have been fully vaccinated and, four in ten Ugandan children under five years of age (38 percent) are stunted (short for their age), 6 percent are wasted (thin for their height), and 16 percent are underweight. One in every 13 children dies before the age of one (UBOS, 2007).

3.3 Selection of study facilities

We restricted our analysis to the period 2007-2010 for several reasons. The LRA has not been active in Uganda since 2006, when President Yoweri Museveni attended the Juba Peace Talks in Sudan. Also around this time, the Ugandan government and the LRA signed the Cessation of Hostilities Agreement resulting in improvements in security and a large number of IDPs returning to their villages (Roberts, 2009). Furthermore, our research question is interested in MCH services post-conflict. The conflict was still considered ongoing in 2005 and 2006, so we dropped those years from our analysis. We excluded 2011 data because these services were too far removed from the war to be included in a post-conflict analysis. All facilities with data available for these years from the original PEPFAR study were included in our analysis.

Sampling method

The 308 health facilities included in our analysis were identified through a process of stratified random sampling within districts. We excluded health centers with less operational capacity (HCI and HCII), but included larger facilities (HCIII, HCIV, and Hospitals) whose stated scope was such that antenatal or postnatal care would be provided to patients. It was also felt that the smaller facilities would be difficult to track over time, as they were more likely to close or change name. The 2010 Uganda Bureau of Statistics (UBOS) Statistical Abstract describes HCIVs as, “mini hospitals with the kind of services found at Health

Centre IIIs" and states that these types of facilities, "serve a county or a parliamentary constituency." Health Center IIIs include an operating room and a clinical officer who oversees a section devoted to minor surgeries (UBOS, 2010). These facilities are "intended to serve 20,000 people at the sub-county level" and Health Center IVs are often able to provide patients with overnight care (Luboga, 2015).

3.4 Sources of data

HMIS paper-based records were available from mid-2005 onwards. Data collection was conducted in 2011 and 2012 with support from the Ugandan Ministry of Health and Makerere University. Project teams collected HMIS data from 112 District Health offices, as well as 315 health care facilities. Only health care facility level data was used in this study.

The data used for the current investigation were from the HMIS 105: Health Unit Monthly Report. These records included information about wellness visits, outpatient attendance, laboratory tests, maternal and infant deaths, vaccinations, and family planning activities. Forms were scanned by data collectors at the health facility as a means to reduce time spent in the field and to provide quick access to forms for the centralized data entry team in Kampala.

3.5 Data Analysis

STATA (version 12.1) was used for both our descriptive and inferential analysis with Microsoft Excel used for basic calculations and to construct tables and graphs. Our unit of analysis was facility-month and the main measure of central tendency was the mean number of services provided each month by year and degree of conflict. Population-adjusted annual rates were used for our descriptive analysis, with output provided in Appendix 7.4 and 7.5.

Hypothesis

We were interested in determining whether, for geographically dissimilar areas in Uganda, degree of conflict was associated with the number of MCH services and deaths reported by individual health facilities in the four years following the end of the LRA conflict in Northern Uganda (2007-2010). The lead author, who had spent a considerable amount of time in Acholiland after the Juba Peace Talks, believed

the number of services delivered in areas more affected by the LRA conflict would be fewer and the number of maternal and infant deaths in these areas would be higher, compared to areas with less or no contact with the LRA conflict (1986-2006).

Predictor variable

Our variable of interest was the degree of conflict as defined by sub-regions described in a 2013 publication written by the Advisory Consortium on Conflict (ACCS), a partnership between three organizations: International Alert, Refugee Law Project and Saferworld. This study was funded by the UK Department for International Development and was a follow-up to Uganda's Peace, Recovery and Development Plan for Northern Uganda published in 2007. The objectives of this plan were specific to war-torn sub-regions of Northern Uganda. The authors recommended that the government consolidate state authority, rebuild and empower local communities, revitalize the economy in the North, and work to build peace while encouraging reconciliation (Republic of Uganda, 2007). Data collection for the ACCS report occurred between 2010 and 2012 and covered all Ugandan regions and sub-regions. The key finding of this report described both latent and perpetual issues linked to conflict in many of the sub-regions located in Northern Uganda.

We used this report's geographic classifications to determine the degree of conflict experienced by individual health facilities (Appendix 7.1). We validated these classifications via two key informants who founded, alongside the lead author and others, the Northern Uganda Health Initiative. The initiative is a community-based organization operating in the city of Pader, located in north-central Uganda. These informants grew up in Acholiland and provided us with feedback that was instrumental in grouping facilities by degree of conflict.

Image 1 in Appendix 7.3 provides a summary of the areas defined as the epicenter of the LRA conflict in Northern Uganda. The districts described (Kitgum, Gulu, Pader, Apac, Lira, Soroti, Katakwi, and Kumi) have since the production of this map been separated into smaller districts as part of Uganda's decentralization process. To the North of Kitgum is South Sudan where many people identify as part of the Acholi ethnic group. The largest cities in these areas are Gulu, Kitgum, and Lira.

Those areas not affected by the LRA conflict were numerous and concentrated entirely in the southern parts of Uganda. Image 2 and 3 in Appendix 7.3 provide a better understanding of where individual districts are located throughout the country. Image 2 describes the districts as classified before district splitting occurred and shows a total of 56 districts. Image 3 describes the districts as classified after district splitting occurred and shows a total of 112 districts.

The conflict scale is defined as described below:

Table 1: Conflict scale with descriptions for each used in our analysis	
Classifications	Definition
HIGH	Epicenter of the LRA conflict and with high levels of violence
MEDIUM	Affected in a significant yet indirect way by the conflict
LOW	Not directly affected by the conflict but received IDPs
NONE	Only affected on the periphery; Southern Uganda

Facilities not defined as in or experiencing the effects of the LRA conflict were not included in the ACCS report. The most notable limitation to this method was that the ACCS report included only information about the sub-regions of Northern Uganda. Facilities located in these districts were assigned values of HIGH, MEDIUM, and LOW, as all of these areas were in some way affected by the war. Facilities located in regions not described in the ACCS report were all located in Southern Uganda. Appendix 7.1 includes two tables (Tables 6 & 7) that highlight the final assignment of regions, sub-regions, and districts to HIGH, MEDIUM, and NONE/LOW. Tables 4 & 5 describe our classifications before conferring with our key informants.

Outcome variables

We analyzed ten maternal and child health specific variables. The average completeness for each of these variables across all years was above 89% (Appendix 7.2) and the data were believed to be both valid and reliable. Our service provision variables included ANC (antenatal care) 4th re-attendance visits, postnatal visits, deliveries, OPD (outpatient department) visits (0-4 years), second dose intermittent preventative treatment (IPT), DPT-HepB+Hib3 doses (under 1 year), and new family planning injectable

users (see Tables 10-13). OPD visits were recorded as the number of OPD visit between 0 and 4 years old and compared to the total number of OPD visits by degree of conflict and year. We also looked at the number of pregnant women who received their second dose of IPT for malaria and the number of children under the age of one who were vaccinated for diphtheria, tetanus, pertussis, and influenza type B. Maternal and infant death variables stillbirths, asphyxia, and maternal deaths (see Tables 14-17).

Statistical methods

We reported descriptive statistics to identify how maternal child health outcome variables behaved independently over time without regard to our predictor variable of interest (conflict). We also portrayed these outcome variables for facilities in relation to each of our geographic conflict categories. Finally, we reported incidence rate ratios (IRR), a relative difference measure used to compare the incidence rates of events in relation to conflict after introducing control variables for confounders. We used negative binomial regressions to generate the incidence rate ratios. These methods allowed us to compare population-adjusted service counts across areas and defined by degree of conflict and year.

The conditional expectation of the outcome given the covariates and the overdispersion is:

$$\exp\{x_{ij}\beta + \ln\delta_j + P_{ij}\}$$

Where $x_{ij}\,\beta$ is the linear combination of all covariates. $\ln\delta_j$ is the overdispersion term and is equal to the facility intercept. P_{ij} is the exposure term and is the facility catchment area population. All covariates are included as factor variables with a separate term for each level (other than the reference level) included in the model.

The STATA command used for our primary analysis is a random-effects negative binomial regression, xtnbreg. A separate model was run for each outcome.

$$E(\gamma_{ij}|x_{ij},\delta_j) = \beta_0 + \beta_1 C_{2_{ij}} + \beta_2 C_{3_{ij}} + \beta_3 Y_{2008_{ij}} + \beta_4 Y_{2009_{ij}} + \beta_5 Y_{2010_{ij}} + \beta_6 M_{2_{ij}} + \ldots \beta_{16} M_{12_{ij}} +$$

$$\beta_{17} S_{2_{ij}} + \beta_{18} S_{3_{ij}} + \beta_{19} E_{2_{ij}} + \beta_{20} E_{3_{ij}} + \beta_{21} H_{2_{ij}} + \beta_{22} H_{3_{ij}} + \beta_{23} F_{2_{ij}} + \beta_{24} F_{3_{ij}} + \ln\delta_j + P_{ij}$$

Month within facility – *i*

Facility – *j*

Where C is degree of conflict, Y is year, M is month, S is sanitation, E is education, H is HIV prevalence, F is facility level, and subscripts indicate the factor levels included in the model. $\ln\delta_j$ is the overdispersion term and is equal to the facility intercept. P_{ij} is the exposure term and is the facility catchment area population. The exposure term for models with stillbirths, asphyxia, and maternal deaths as the outcome replaces facility catchment area population with the number of deliveries in health facilities.

Descriptive analysis

Our descriptive analysis allowed us to quantify and chart trends in the number of services and deaths over time. Frequency tables were used to show dispersion by year and degree of conflict. The facility catchment area population varied significantly depending on the level of the facility and geographic location. We used population-adjusted annual rates as a means to compare facilities directly and it was essential to do so, as we included HCIII, HCIV, and Hospitals in our analysis. Each of these facility types was equipped to address the needs of a certain number of patients with a certain range of morbidities. By adjusting for population, we controlled for variability in service counts directly attributed to the size of the facility catchment area population.

Inferential analysis

Using repeated measurements each month for the outcome variables in the facilities between 2007 and 2010, we were able to conduct a retrospective longitudinal study. While we collected the data retrospectively, they were recorded at the facility level each month over the period we were interested in. Longitudinal studies, with measures over time, can also include covariates collected at the time to account for confounders (Diggle, 2002).

We chose to use a mixed effects negative binomial regression model, because this type of model is most appropriate for count data, adjusts for random effects at the facility level, and accounts for overdispersion. We controlled for HIV prevalence, sanitation, education, facility level, month, and year. Facility level was stratified by HCIII, HCIV, and Hospital and our month variable was used to control for seasonality. Sanitation (the proportion of population covered by pit latrines) and education (the proportion of children of elementary age enrolled in school) were used as proxy measures for poverty and infrastructure. HIV prevalence, sanitation, and education were used in tertiles, that is, they were divided into three evenly distributed groups of observed counts.

We ran separate models for each outcome variable. Facility catchment area population was used as an exposure term for ANC 4th visits, postnatal visits, deliveries, OPD visits (0-4 years), second dose IPT, DPT-HepB+Hib 3 (under 1 year), and new family planning injectable users. Number of deliveries per facility-month was used as an exposure term for stillbirths, asphyxia, and maternal deaths. We used random effects at the facility level to allow for facilities to have unique intercepts.

4. Results

4.1 Characteristics of the study sample

Each of our outcome variables contained relatively complete data across all years. Individual variables were reported, on average, 96% of the time (Table 8 & 9). The number of missing data points decreased over time with an average of 5.7% of values missing in 2007 and only 3% missing in 2010 (Tables 8 & 9). Reports with missing data were included in our analysis. Table 2 describes the response rate by year and degree of conflict.

4.2 Tables and figures

Classification of facilities

Our sample included 50 facilities located in high conflict areas, 52 facilities located in areas of medium conflict, and 32 facilities located in areas of low conflict. Facilities located in areas with no conflict numbered 174. Appendix 7.1 includes a list of all regions, sub-regions, and districts included in this analysis and stratified by degree of conflict.

The following table describes the number of HMIS reports received from facilities located in each of the four degrees of conflict. We had significantly more records for facilities unaffected by the conflict, but all facilities recorded increases in the number of monthly forms submitted between 2007 and 2010.

Table 2: Total number of monthly reports by degree of conflict and year

Degree of conflict	Facility-months (% of total)	2007 (response rate)	2008 (response rate)	2009 (response rate)	2010 (response rate)
HIGH	2180 (16.6%)	534 (89.0%)	555 (84.5%)	548 (91.3%)	543 (90.5%)
MEDIUM	2160 (16.5%)	507 (81.3%)	529 (84.8%)	551 (88.3%)	573 (91.8%)
LOW	1295 (9.9%)	309 (80.5%)	322 (83.9%)	336 (87.5%)	328 (85.4%)
NONE	7474 (57.0%)	1826 (87.5%)	1891 (90.6%)	1851 (88.6%)	1906 (91.3%)
TOTAL	13109	3176	3297	3286	3350

The classifications of conflict described in Tables 4 & 5 were informed solely by the ACCS report and were revised after consulting with two key informants. Tables 6 & 7 in Appendix 7.1 reflect an updated version of these classifications.

Descriptive analysis

Appendix 7.4 includes four tables that portray the trends (raw counts and population-adjusted rates) for MCH service variables and describes the annual change rate by conflict level and year. Appendix 7.5 includes four similar tables that describe annual trends for our death variables (stillbirths, asphyxia, and maternal deaths). Tables 10 & 14 describe secular count data and population-adjusted annual rates for each of our outcome variables when excluding our predictor variable. The total number of services and

deaths by degree of conflict and year are included in Tables 11-13 and Tables 15-17. The population-adjusted annual rate is the number of services or deaths divided by the facility catchment area population multiplied by 1000, and then multiplied again by 12 (number of months in a year). Graphs depicting the population-adjusted annual rate of each outcome by degree of conflict can be found in Appendix 7.7.

Service counts

ANC 4th visits

There was an overall negative trend in the rate of ANC 4th visits throughout Uganda during the study period (a decline of 3.19 visits per 1000 population between 2007 and 2010) but, as shown in Table 13, this decrease was especially evident in high conflict areas, with half as many population-adjusted visits reported in 2010 than in 2007 (9.3 visits per 1000 population in 2007 compared to 3.9 visits in 2010). Facilities in high conflict areas reported the lowest population-adjusted rate of ANC 4th visits in 2009 and 2010. All other conflict areas experienced an annual change rate greater than -1.0, but the annual change rate for high conflict areas was -1.90 (see Tables 11-13). In 2007, the rate of ANC 4th visits in high conflict areas was lower than in areas with no or low levels of conflict (9.3 versus 10.4 visits per 1000 population respectively). This difference increased by 2010 (3.9 visits in high conflict areas compared to 7.6 visits per 1000 population, see Figure 1).

Postnatal visits

Postnatal visit rates across Uganda improved slightly during the period 2007 to 2010, with an annual rate of change of positive 0.79 visits per 1000 population (Table 10). In 2007, the rate of postnatal visits in high conflict areas was almost twice as high as areas of medium, low, and no conflict (see Tables 11-13). However, facilities in high conflict areas experienced a decrease in the rate of postnatal visits in each year of our study (annual change rate of -1.11) while facilities in areas with medium, low, or no conflict experienced a steady increase between 2007 and 2010 (see Figure 2). The population-adjusted rate of postnatal visits in no and low conflict areas increased from 3.31 in 2007 to 8.00 in 2010 (see Table 11) while the rate in high conflict areas decreased from 6.76 in 2007 to 3.52 in 2010 (see Table 13).

These findings are perplexing as we expected women living in high conflict areas to have better access to postnatal services 3-4 years after the end of the insurgency than in the year immediately following it.

Deliveries in health facilities

In 2007, the population-adjusted rate of in-facility deliveries in Uganda had improved slightly, from 7.9/1000 to 9.1, a rate of 0.36. Facilities in high conflict areas reported similar rates in 2007 (7.4/1000) as the nation, but its rate didn't improve as much by 2010 (a rate of increase of only 0.11, for 7.85 in-facility births per 1000). The rate for facilities located in high conflict areas was lower than any other level in 2007 and 2010, but in 2008 and 2009, the rate of deliveries in high conflict areas was slightly higher than that observed in medium conflict areas (see Tables 13 & 12). By contrast to high conflict areas, facilities in no or low conflict areas reported a steady increase between 2007-2010 (see Figure 3).

It appears that mothers in high and medium conflict areas were either less able or less willing to travel to a health facility to give birth than women located in areas with no or low conflict. It is also possible that cultural practices in the North may have influenced the likelihood that pregnant women chose to give birth at a health facility.

OPD visits (0-4 years)

Overall, Uganda observed a decrease in the rate of OPD visits for children aged 0-4 between 2007 and 2010 (see Table 10). In 2007, the population-adjusted rate of OPD visits for children aged 4 and younger in areas with high conflict was higher than in other conflict category areas, but those rates did not persist (see Tables 11-13). The annual change rate was negative (-5.05 visits per 1000) for high conflict areas. A similar trend was observed for no or low conflict areas (-1.41) but the annual change rate in medium conflict areas was positive (1.67).

A higher percentage of OPD visits in high conflict areas were for children under the age of five than were reported by all other degrees of conflict. For example, in 2007, children under the age of five accounted for 38% of all OPD visits in high conflict areas compared to 28% of the OPD visits in no conflict areas (see Table 3). This could be indicative of higher rates of diseases of poverty in high conflict areas or

increased care seeking behavior of parents for young children with opportunistic infections. The output described in this table is not adjusted for population.

Table 3: Percentage of OPD visits administered to patients under the age of five				
Degree of conflict	2007 (total number of OPD visits)	2008 (total number of OPD visits)	2009 (total number of OPD visits)	2010 (total number of OPD visits)
HIGH	37.8% (1,110,637)	36.2% (1,184,315)	36.2% (1,109,644)	34.9% (1,162,213)
MEDIUM	35.5% (843,000)	35.7% (859,448)	34.8% (898,437)	33.8% (1,022,706)
LOW	35.8% (634,826)	33.4% (605,294)	33.6% (653,663)	30.6% (612,598)
NONE	27.6% (2,829,022)	26.5% (2,854,485)	26.7% (2,951,691)	26.5% (3,168,592)
TOTAL	5,417,485	5,503,542	5,613,435	5,966,109

Second dose IPT

The World Health Organization recommends three or more doses of "intermittent preventive treatment" (IPT) with sulfadoxine-pyrimethamine for pregnant women in malaria endemic areas (WHO, 2015). Measures of second dose IPT administered in Uganda fell from 8.65 per 1000 population to 7.9 between 2007 and 2010. High conflict areas experienced the largest negative annual change rate (.60 decline per 1000), and low conflict areas experienced the least decline (.14 per 1000), see Tables 11-13. In 2007, the rate of second dose IPT in high conflict areas (9.32 doses per 1000 population) was higher than facilities located in no or low conflict areas (8.03 doses per 1000 population). Interestingly, the rate of second dose IPT in medium conflict areas was higher than all other areas across all years (Figure 5).

The trend described parallels ANC 4th visits as we observed notable decreases for both of these variables during the study period. This is surprising, as we would expect access to these services to improve over time. It is possible that doses of IPT were more readily available in medium and high conflict areas in 2007 than in 2010 because aid organizations were less active over time. We also do not know if the Ugandan Ministry of Health was supporting targeted immunization campaigns in medium conflict areas during these years but our rates indicate that this might be the case.

DPT-HepB+Hib 3 (under one year)

There was very little change across Uganda overall with regard to rates of immunization for DPT-HepB+Hib 3 for children younger than age one between 2007 and 2010. In 2007, the population-adjusted rate of vaccines administered in high conflict areas (11.75 doses per 1000 population) was higher than the rate reported by facilities located in areas with no or low conflict (10.54 doses per 1000 population). However, in 2008 and 2009, the rate of DPT-HepB+Hib 3 vaccines administered in high conflict areas was lower than that observed in no conflict areas (see Table 13 & 11). By 2010, the rate of DPT-HepB+Hib 3 vaccines administered in high conflict areas was again lower than that observed in medium, low, or no conflict areas (see Figure 6). We observed a steady decrease in the rate of DPT-HepB+Hib 3 vaccines administered in high conflict areas (annual change rate of -0.77) while rates for each of the other classification increased over time. This is surprising as the percentage of OPD visits accounted for by children under the age of five was highest in high conflict areas (see Table 3).

We would assume that these children would also have access to vaccinations during these visits but that does not appear to the case. Our assumption is that stockouts were more common in high conflict areas or that fewer vaccines were allocated to these areas over time. It does not appear that this potential supply chain issue affected areas of medium, low, or no conflict as vaccination rates in those areas increased between 2007 and 2010.

New family planning injectable users

Uganda enjoyed a very modest increase in family planning injectable use across the period 2007 to 2010, rising from 2.18 per 1000 to 2.40 users per 1000. In high conflict areas, the population-adjusted rate of new family planning users was consistently lower, but increased in 2008 and 2009 before decreasing again in 2010 (see Figure 7). The annual change rate for high conflict areas was 0.001 per 1000, indicating flat utilization. An opposite trend was observed for no or low conflict areas as the rate decreased between 2007 and 2008 and then increased between 2009 and 2010 (see Figure 7), although overall the change rate was only 0.03. The rate of new family planning injectable users in medium conflict areas increased considerably during the study period with an annual change rate of 0.39.

There is unfortunately no readily identifiable pattern that allows us to ascertain why the rate of new family planning injectable users would be higher or lower in one area compared to another (see Figure 7). It is however notable that there were fewer new family planning injectable users in high conflict areas in both 2007 and 2010 than in all other conflict areas. The demand for this form of contraceptive in Uganda is believed to be quite high but intrauterine devises and hormonal implants are also common. It is possible that lack of access to and stockouts at facilities could be influencing the availability of injectable contraceptives in high conflict areas.

Death variables

Stillbirths

Stillbirths in Uganda numbered close to 5000 babies each year between 2007 and 2010, with a very small rate of increase (0.004), see Table 14. Surprisingly, the rates of stillbirth reported in high conflict areas were lower than the rates in no conflict areas across the period (see Figure 8). We would expect the opposite to be true given that the rate of service delivery was lower in high conflict areas (see Tables 11-13). In high conflict areas, the population-adjusted rate in 2007 and 2010 was 0.18 stillbirths per 100,000 population with some small fluctuations in 2008 and 2009 (see Table 17), compared to about 0.28 in Uganda overall those years.

We believe women in high conflict areas and with limited access to care would be less likely to visit a health facility for complications during pregnancy or following the abortion of a fetus. It is entirely possible that, for this reason, the number of stillbirths in high conflict areas was not fully captured by health facilities. We do not have evidence to support this claim but believe it to be a rational justification for lower rates of stillbirths in high conflict areas.

Birth asphyxia

The rate of birth asphyxia increased throughout Uganda during the study period with an annual change rate of 0.04 across all 308 facilities included in our sample. In 2007, 2008, and 2009, the population-adjusted rate of birth asphyxia in areas of high conflict was lower than in areas with no, low, or medium conflict (see Tables 15-17). Surprisingly, in 2010, the population-adjusted rate for medium conflict areas

(0.16 cases per 100,000 population) was less than the rate for high conflict areas (0.18 cases per 100,000 population). Unlike all other classifications, medium conflict areas observed a decrease in the rate of birth asphyxia with an annual change rate of -0.002 (see Table 16). In 2009, there were almost four times more cases of birth asphyxia reported by facilities in no or low conflict areas than in high conflict areas (see Figure 9).

It is likely that cases of birth asphyxia were not fully captured in health facilities located in high conflict areas because the rate of deliveries was less in these areas. We also believe that women with complicated pregnancies and living in high conflict areas would be less able to access care due to the cost of services and greater distance to the nearest health facility.

Maternal deaths

Uganda enjoyed a small decline in maternal deaths over the period in question (.002 fewer deaths per 100,000 population), falling from .032 deaths to .026. As was also the case for stillbirths and birth asphyxia, the population-adjusted annual rate of maternal deaths was lowest for high conflict areas (Tables 15-17). In 2007, there were fewer maternal deaths in high conflict areas compared to areas with no, low, or medium conflict (Figure 10). By 2010, this difference had become even more evident as the population-adjusted rate of maternal deaths in high conflict areas decreased from 0.024 to 0.014, an annual change rate of -0.004. The annual change rate was also negative for no or low and medium conflict areas, but to a lesser degree (see Tables 15 & 16). Surprisingly, in 2007 and 2010, the rate of maternal deaths was highest in medium conflict areas but, in 2008 and 2009, the maternal death rate was highest in no or low conflict areas (see Figure 10).

We believe lower rates of maternal death in high conflict areas may have been attributable to under-reporting or that women in these areas were less likely to become pregnant than in other areas of the country.

Inferential analysis

We ran separate regression models for each of our outcome variables, controlling for HIV prevalence, sanitation, education, facility level, month, and year. Appendix 7.6 includes two tables that highlight the IRRs for all MCH services and death variables. These ratios provided us with the relative rate of the outcome measure among high and medium conflict areas in relation to no or low conflict areas while holding constant a select number of confounders. In other words, we estimated the number of times more or less likely the outcome was to occur for high and medium conflict areas in each facility-month, compared to no or low conflict areas, when all other variables were held constant. We present the IRR for MCH services in Table 18 and death variables in Table 19. The 95% CI and p-value for each degree of conflict is reported for each outcome variable.

Our model suggests health facilities in high conflict areas had 43% fewer ANC 4th visits when compared to facilities located in no or low conflict areas [IRR = 0.57, 95% CI (0.53-062)], after adjusting for HIV prevalence, sanitation, education, facility level, month, and year. The number of postnatal visits was 52% lower in high conflict areas compared to no or low conflict areas [IRR = 0.48, 95% CI (0.44-0.52)], in similarly configured models. We estimated that health facilities in high conflict areas had 44% fewer deliveries when compared to facilities located in no or low conflict areas [IRR = 0.56, 95% CI (0.51-0.62)].

For outpatient visits delivered to children aged four and younger, our adjusted regression showed 44% fewer visits in high conflict areas when compared to no or low conflict areas [IRR = 0.56, 95% CI (0.52-0.60)]. The number of second doses of IPT was estimated to be 46% lower in high conflict areas compared to no or low conflict areas [IRR = 0.54, 95% CI (0.50-0.59)], after controlling for the confounders specified above. We estimated that health facilities in high conflict areas had 46% fewer DPT-HepB+Hib 3 vaccinations administered to children under the age of one compared to no or low conflict areas [IRR = 0.54, 95% CI (0.50-0.59), after adjusting for the same confounders reported above (see Table 18). The number of new family planning injectable users was estimated to be 56% lower in high conflict areas compared to no or low conflict areas [IRR = 0.44, 95% CI (0.40-0.49)].

We estimated that health facilities in high conflict areas had 12% more stillbirths when compared to facilities located in no or low conflict areas [IRR = 1.12, 95% CI (0.91-1.38)], after adjusting for HIV prevalence, sanitation, education, facility level, month, and year. These findings were not statistically significant, however (see Table 19). The number of cases of birth asphyxia was 28% higher in high conflict areas compared to no or low conflict areas [IRR = 1.28, 95% CI (1.01-1.63)], in similarly configured models. Our model showed 3% more maternal deaths in high conflict areas [IRR = 0.56, 95% CI (0.52-0.60)], compared to no or low conflict areas, but results were not statistically significant (see Table 19).

Our model also suggested that health facilities located in medium conflict areas had 19% more ANC 4th visits when compared to facilities located in no or low conflict areas [IRR = 1.19, 95% CI (1.10-1.30)], after adjusting for HIV prevalence, sanitation, education, facility level, month, and year. The number of postnatal visits was 19% higher in medium conflict areas compared to no or low conflict areas [IRR = 1.19, 95% CI (1.08-1.31)], in similarly configured models. We estimated that health facilities in medium conflict areas had 28% more deliveries when compared to facilities located in no or low conflict areas [IRR = 1.28, 95% CI (1.14-1.46)].

For outpatient visits delivered to children aged four and younger, our adjusted regression showed 29% more visits in medium conflict areas when compared to no or low conflict areas [IRR = 1.29, 95% CI (1.20-1.39)]. The number of second doses of IPT was estimated to be 89% higher in medium conflict areas compared to no or low conflict areas [IRR = 1.89, 95% CI (1.73-2.05)], after controlling for the confounders specified above. We estimated that health facilities in medium conflict areas had 2% fewer DPT-HepB+Hib 3 vaccinations administered to children under the age of one compared to no or low conflict areas [IRR = 0.98, 95% CI (0.91-1.08), after adjusting for the same confounders reported above (see Table 18). The number of new family planning injectable users was estimated to be 40% higher in medium conflict areas compared to no or low conflict areas [IRR = 1.40, 95% CI (1.25-1.56)].

We estimated that health facilities in medium conflict areas had 20% more stillbirths when compared to facilities located in no or low conflict areas [IRR = 1.20, 95% CI (0.97-1.50)], after adjusting for HIV prevalence, sanitation, education, facility level, month, and year. These findings were statistically significant (see Table 19). The number of cases of birth asphyxia was 196% higher in medium conflict areas compared to no or low conflict areas [IRR = 2.96, 95% CI (2.23-3.91)], in similarly configured models. Our model showed 30% more maternal deaths in medium conflict areas [IRR = 1.30, 95% CI (0.83-2.03)], compared to no or low conflict areas, but results were not statistically significant (see Table 19).

The directionality of these findings appeared to be similar to those uncovered in our descriptive analysis. However, the inclusion of HIV prevalence, sanitation, education, facility level, month, and year revealed great disparities in the provision of MCH services in high conflict areas compared to no or low conflict areas. Facilities located in high conflict areas reported significantly lower rates of maternal and child health services in the four years following the end of the LRA conflict, when controlling for these covariates (see Table 18). These results are concerning as women and children in high conflict areas are a particularly vulnerable population. We believe that these findings are precipitated by a number of factors including long distances to health facilities, lack of financial autonomy, stockouts of vaccines and malaria prophylaxis, variations in care seeking behavior, degree of exposure to opportunistic infections, and supply chain issues.

5. Discussion

Our results highlighted sizable differences between the rate of MCH service utilization in high conflict areas and no and low conflict areas. We hypothesized that fewer MCH services would be reported in high conflict areas and discovered that the differences were quite large, when controlling for a select number of variables. A comprehensive review of death variables led us to believe that better data collection is needed in post-conflict areas. It is crucial that national surveillance systems account for access to care issues and take the steps necessary to quantify maternal and infant deaths not occurring at health facilities.

5.1 Strengths and limitations

The strengths of this study lie in its methodology (population-adjusted rates, negative binomial regressions, etc.), the categorization of facilities by conflict using recent development reports, the completeness of the HMIS 105 data collected in country in 2011 and 2012, and the rigor by which we ran our analysis and used findings to further inform next steps. The process of defining facilities based on sub-region allowed us to develop a more comprehensive understanding of the breath of the LRA conflict in Northern Uganda and adjusting for population allowed us to discuss output regardless of the size or scope of health facilities.

This study also had numerous limitations. The ACCS report used to define conflict did not describe sub-regions in Southern Uganda and it was often difficult to determine if a facility should be classified as in an area of low or medium conflict. Therefore, there may be miscategorization. The violence occurring during the LRA conflict was also highly variable and we were unable to determine when and how individual facilities in high conflict areas were affected by the war. The nature of the conflict was an unavoidable limitation as violence was sporadic and often followed by periods of relative peace (USDS, 2012).

Furthermore, some would argue that though the LRA has not been active in Uganda since 2006, Northern Uganda is still in a "latent state of conflict" with individual districts and sub-regions experiencing varying degrees of nodding disease, land disputes, tensions over the promise of oil, and inadequate transitional justice (Llamazares, 2013). The conflict also attracted a proliferation of non-governmental relief organizations and their staff, thus altering everything from cultural patterns to commodity pricing. One can also make a case that Northern Uganda is central to a number of long-standing and ongoing tribal conflicts both pre-dating and resulting from the LRA conflict. We do not believe that the magnitude of these issues is enough to compromise the integrity of our study or the validity of our findings.

Population denominators used to calculate rates might also be incorrect. The total number of women living in and around conflict-affected areas between 2007 and 2010 may have been less than in areas removed from the violence. The LRA conflict displaced nearly two million people and many Acholi women

relocated to avoid abduction, abuse, or death. Unfortunately, we were unable to determine how many women from high conflict areas migrated and resettled away from the war. Furthermore, women living in rural poverty and with enough means are more likely to travel to urban centers with well-established health facilities during pregnancy or to give birth to their children. This concern is of central importance when considering the rate of MCH services delivered in high conflict areas. The exposure variable we used for these outcomes was facility catchment area population, not disaggregated by gender or age. However, the exposure variable for reported stillbirths, asphyxia, and maternal deaths was the number of deliveries in health facilities, so this is less of a concern for these variables.

5.2 Key findings

The results of this study provided some clarity about health service provision following large-scale conflict and displacement, but also raised a number of new questions. Even without conflict, service volume rates in Uganda improved only slightly and in some cases declined for our variables of interest, in no small way likely complicated by rapid population growth. When comparing rates of service delivery in high conflict areas, after controlling for confounders, we consistently found about half the rate of services for ANC 4th visits, postnatal visits, deliveries in health facilities, outpatient visits for children younger than age five, second dose IPT, DPT immunizations and new family planning injectable users in high conflict areas compared to no and low conflict. By comparison, and somewhat puzzlingly, utilization of these services was consistently higher in medium conflict areas compared no or low conflict areas, with the exception of DPT immunizations. Death rates in high and medium conflict areas were also consistently higher than in no or low conflict areas, after controlling for confounders.

Our findings were reached after controlling for facility catchment area population and confounders and indicate a disparity between areas with no or low conflict and areas with high conflict. In the four years following the end of the LRA conflict, the rate of postnatal visits, DPT-HepB+Hib 3 vaccinations, and new family planning injectable users increased throughout Uganda. However, steady decreases were observed in high conflict areas during this same period of time. The population-adjusted rate of ANC 4th visits in 2009 and 2010 was also lowest for high conflict areas as was the rate of deliveries in 2007 and 2010. It is possible that there are lingering issues of trust within the Acholi sub-population and that these

communities are less likely to rely upon the current healthcare system for these essential services. We must also acknowledge the influx of international aid organizations in Acholiland both during and immediately following the war. It is possible that women in high conflict areas chose to secure medical care from these and other community-based organizations between 2007 and 2010. This could present a potential explanation for why the population-adjusted annual rate of MCH services was higher in no or low and medium conflict areas.

We also observed fluctuations in rates of death after controlling for population and confounders. Our belief is that this is either a case of misreporting or that facilities in the North are worse equipped to address complicated pregnancies and deliveries. It is also possible that women in high conflict areas are more likely to have bacterial infections, preeclampsia, or be subjected to physical trauma during their pregnancies (Accorsi, 2005). This would increase the risk of stillbirth among this sub-population. Furthermore, it is possible that women in these areas are more likely to seek the support of tradition healers or skilled birth attendants in these situations (Ediau, 2013). However this is less likely, as our denominator for stillbirths, asphyxia, and maternal deaths was the number of deliveries, not the facility catchment area population.

We did not expect high conflict areas to differ so much from no and low conflict areas. As described, when controlling for HIV prevalence, sanitation, education, facility level, month, and year, we observed that high conflict areas reported 43-56% fewer MCH services compared to areas of no or low conflict. These findings identify a huge service delivery gap and one that is not reflected in academic journals or reports published by the Ugandan Bureau of Statistics. We also found that, when controlling for the aforementioned confounders, facilities in high conflict areas reported 12% more stillbirths, 28% more cases of birth asphyxia, and 3% more maternal deaths. Our study has served to uncover a phenomenon not otherwise described in the literature.

5.3 Implications

This study provides a better understanding of population-adjusted service counts and deaths in the four years immediately following a long-term and violent conflict. We conclude that the number of maternal and child health services provided in facilities located in high conflict areas were significantly less than those areas with less conflict. Results in medium conflict areas, however, were mixed and sometimes unexpected, suggesting more investigation is needed to explain these findings. Population-adjusted annual rates provided us with a valuable way to compare facilities independent of their size and scope. The vast amount of readily available and relatively complete confounder data allowed us to control for covariates that might have otherwise biased our results.

The findings discussed can inform policy makers, academic researchers, and public health practitioners interested in post-conflict studies and health service utilization in war-torn African nations. The current project has raised a number of new questions about resource allocation, lack of infrastructure, health seeking behaviors of women in post-conflict areas, the role of international aid organizations, the use of traditional healers and skilled birth attendants, data quality issues post-conflict, and the prospect of misreporting facility level service counts in under-resourced areas of the developing world. We recommend increased resource allocation to the investigation of these topics and similar subject matter, as the implications are quite extensive.

Our study has also been a testament to the use and effective application of health system data to quantify the reach of a struggling health system. This analysis has made evident the fact that about half as many MCH services were provided to post-conflict areas in Uganda than were reported in areas removed from the conflict. We believe a commitment to collecting valid and reliable health systems level data is necessary to identify and address the allocation of services in post-conflict areas. We also hope that this study, and others like it, will help to emphasize the negative effects of war on vulnerable populations and facilitate dialogue and diplomacy amongst leaders with military means and competing political agendas.

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7. Appendices

7.1 Defining conflict by region, sub-region, and district

Table 4: ACCS informed classifications of conflict in areas affected by the LRA conflict		
Degree of conflict	Sub-region	Name of district
HIGH	Acholi	Gulu, Amuru, Nwoya, Kitgum, Pader, Lamwo, Agago
	Lango	Alebtong, Amolatar, Apac, Dokolo, Kole, Lira, Oyam, Otuke
MEDIUM	West Nile	Arua, Adjumani, Koboko, Maracha, Terego, Nebbi, Moyo, Yumbe, Zombo
	Karamoja	Moroto, Kotido, Kaabong, Nakapiripirit, Amudat, Abim, Napak
LOW	Bunyoro	Buliisa, Hoima, Kibaale, Kiryandongo, Masindi
	Teso	Amuria, Bukedea, Kumi, Kabermaido, Katakwi, Ngora, Soroti, Serere
	Elgon	Mbale, Manafa, Bududa, Sironko, Bulambuli, Bukwe
	Bukedi	Busia, Tororo, Palisa, Buteleja, Budaka

Table 5: ACCS informed classifications of no conflict areas located in Southern Uganda		
Degree of conflict	Region	Name of district
NONE	Central	Iganga, Kalangala, Kayunga, Bukomero, Kiboga, Mayuge, Nakaseke, Nakasongola, Wakiso, Bugiri, Kaliro, Kamuli, Namutumba, Mityana, Mpigi
	Southwest	Bushenyi, Ibanda, Isingiro, Kanungu, Kasese, Kiruhura, Kisoro, Ntungamo, Rukungiri, Bundibugyo, Kabarol
	West	Kabale, Kyenjonjo, Kamwenge, Mubende, Ssembabule

Table 6: Key informant classifications of conflict in areas affected by the LRA conflict		
Degree of conflict	Sub-region	Name of district
HIGH	Acholi	Gulu, Amuru, Nwoya, Kitgum, Pader, Lamwo, Agago
	Lango	Alebtong, Amolatar, Apac, Dokolo, Kole, Lira, Oyam, Otuke
	Teso	Amuria, Bukedea, Kumi, Kabermaido, Katakwi, Ngora, Soroti, Serere
MEDIUM	West Nile	Arua, Adjumani, Koboko, Maracha, Terego, Nebbi, Moyo, Yumbe, Zombo
	Karamoja	Moroto, Kotido, Kaabong, Nakapiripirit, Amudat, Abim, Napak
	Bunyoro	Buliisa, Hoima, Kibaale, Kiryandongo, Masindi
LOW	Elgon	Mbale, Manafa, Bududa, Sironko, Bulambuli, Bukwe
	Bukedi	Busia, Tororo, Palisa, Buteleja, Budaka

Table 7: Key informant classifications of no conflict areas located in Southern Uganda		
Degree of conflict	Region	Name of district
NONE	Central	Iganga, Kalangala, Kayunga, Bukomero, Kiboga, Mayuge, Nakaseke, Nakasongola, Wakiso, Bugiri, Kaliro, Kamuli, Namutumba, Mityana, Mpigi
	Southwest	Bushenyi, Ibanda, Isingiro, Kanungu, Kasese, Kiruhura, Kisoro, Ntungamo, Rukungiri, Bundibugyo, Kabarol
	West	Kabale, Kyenjonjo, Kamwenge, Mubende, Ssembabule

7.2 Percentage of missing records for all outcome variables

Table 8: Percentage of missing records for MCH service variables by year					
Outcome variable	% missing records (2007)	% missing records (2008)	% missing records (2009)	% missing records (2010)	Average % missing
ANC 4th visits	2.65%	1.61%	1.35%	1.03%	1.66%
Postnatal visits	8.99%	7.81%	7.65%	7.45%	7.97%
Deliveries	3.10%	1.95%	1.31%	1.23%	1.89%
OPD visits (0-4 years)	1.28%	1.33%	0.88%	0.45%	0.99%
Second dose IPT	3.69%	3.47%	2.74%	2.18%	3.03%
DPT-HepB+Hib3 (Under 1 year)	4.94%	6.27%	5.25%	4.41%	5.22%
New family planning injectable users	10.13%	10.37%	9.46%	8.79%	9.69%

Table 9: Percentage of missing records for death variables by year					
Outcome variable	% missing records (2007)	% missing records (2008)	% missing records (2009)	% missing records (2010)	Average % missing
Stillbirths	5.16%	3.44%	2.56%	2.50%	3.41%
Birth asphyxia	6.42%	4.51%	2.80%	2.91%	4.16%
Maternal deaths	7.66%	5.83%	3.11%	2.91%	4.88%

7.3 District and conflict zone specific maps of Uganda

Image 1: Conflict-affected sub-regions and districts

Image 2: Map of Uganda before district splitting

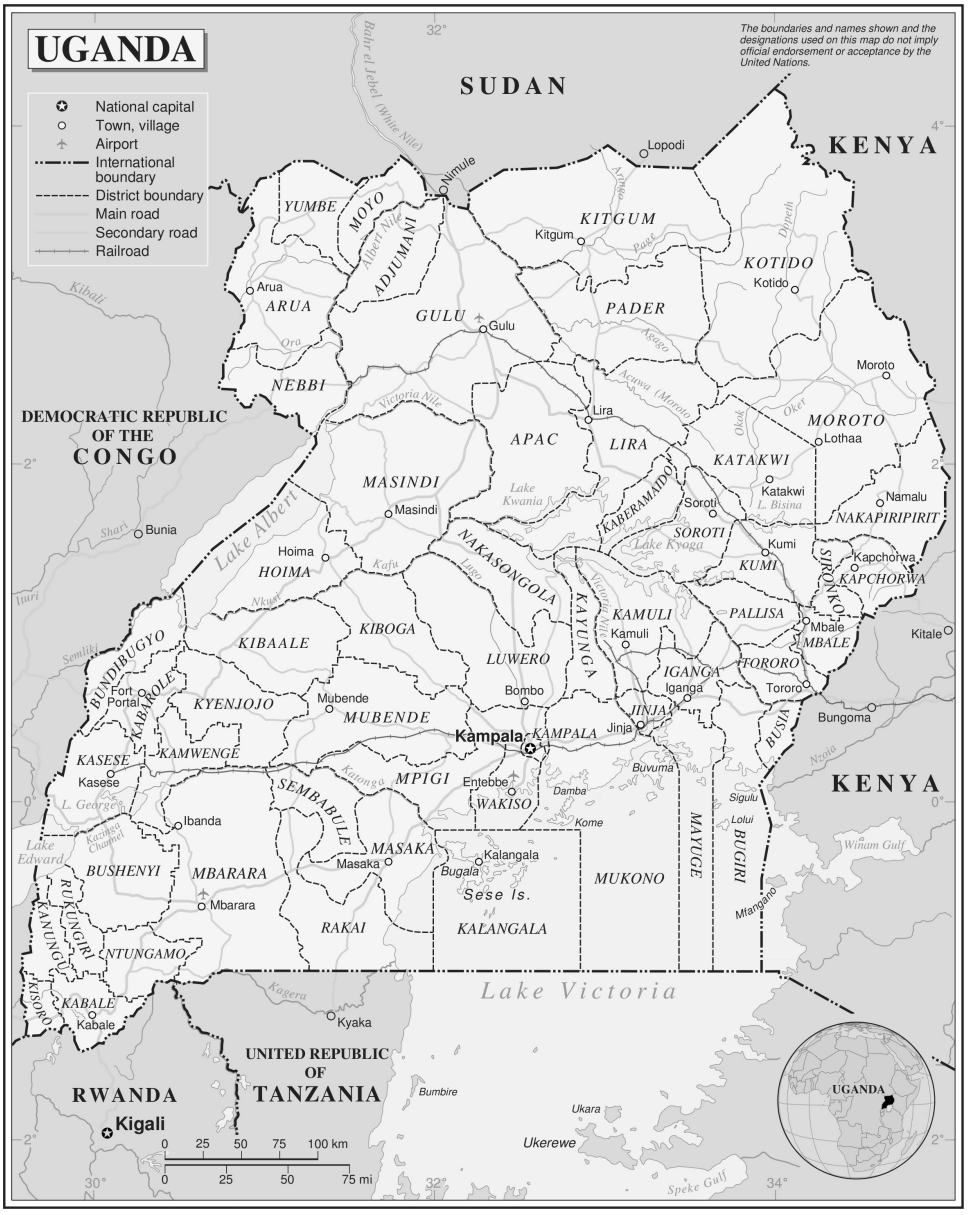

Image 3: Map of Uganda after district splitting

7.4 MCH service counts and population-adjusted annual rates of services

Table 10: Counts and population-adjusted rates of MCH services in Uganda, 2007-2010					
Outcome variable with population-adjusted rate	2007	2008	2009	2010	Annual Change Rate **
ANC 4th visits	161025	144664	116808	115813	
ANC 4th visits (per 1000 population)	9.80	8.61	6.89	6.61	-1.13
Postnatal visits	59282	70345	79723	109833	
Postnatal visits (per 1000 population)	4.05	4.48	4.89	6.55	0.79
Deliveries	131983	149503	148595	159642	
Deliveries (per 1000 population)	7.88	8.91	8.78	9.12	0.36
OPD visits, 0-4 years	1698433	1611962	1613319	1648588	
OPD visits, 0-4 years (per 1000 population)	97.71	93.95	93.31	92.38	-1.66
Second dose IPT	143753	147897	133067	137569	
Second dose IPT (per 1000 population)	8.65	8.86	7.92	7.94	-0.31
DPT-HepB+Hib 3 under 1 year	183774	183554	181892	194990	
DPT-HepB+Hib 3 under 1 year (per 1000 population)	10.85	10.99	10.70	11.23	0.09
New family planning injectable users	34992	32596	34905	39222	
New family planning injectable users (per 1000 population)	2.18	2.02	2.14	2.40	0.08

** linear regression slope of change in outcome rate per year

Table 11: Count and population-adjusted rates for MCH services in areas defined as NONE/LOW					
Outcome variable with population-adjusted rate	2007	2008	2009	2010	Annual Change Rate **
ANC 4th visits	105746	96950	82965	82364	
ANC 4th visits (per 1000 population)	10.36	9.19	7.84	7.56	-0.98

Postnatal visits	30109	39186	53652	83525	
Postnatal visits (per 1000 population)	3.31	4.07	5.26	8.00	1.53
Deliveries	84116	98231	97369	106972	
Deliveries (per 1000 population)	8.04	9.32	9.22	9.84	0.53
OPD visits, 0-4 years	1002259	908473	932777	957599	
OPD visits, 0-4 years (per 1000 population)	90.68	83.35	85.41	85.28	-1.41
Second dose IPT	83596	88484	82629	83102	
Second dose IPT (per 1000 population)	8.03	8.41	7.84	7.76	-0.14
DPT-HepB+Hib 3 under 1 year	114312	118297	119371	126099	
DPT-HepB+Hib 3 under 1 year (per 1000 population)	10.54	11.17	11.12	11.46	0.27
New family planning injectable users	27202	22810	22774	28367	
New family planning injectable users (per 1000 population)	2.77	2.27	2.27	2.87	0.03

** linear regression slope of change in outcome rate per year

Table 12: Count and population-adjusted rates for MCH services in areas defined as MEDIUM					
Outcome variable with population-adjusted rate	2007	2008	2009	2010	Annual Change Rate **
ANC 4th visits	22058	20386	16985	18336	
ANC 4th visits (per 1000 population)	8.37	7.61	6.16	6.58	-0.68
Postnatal visits	9041	11257	11415	13702	
Postnatal visits (per 1000 population)	3.51	4.35	4.23	4.98	0.43
Deliveries	20734	21211	21643	22468	
Deliveries (per 1000 population)	7.89	7.94	7.85	8.06	0.04
OPD visits, 0-4 years	277779	287923	295974	308437	
OPD visits, 0-4 years (per 1000 population)	104.97	106.98	107.17	110.48	1.67

Second dose IPT	26808	26746	23126	24209	
Second dose IPT (per 1000 population)	10.17	10.08	8.53	8.71	-0.59
DPT-HepB+Hib 3 under 1 year	28634	27469	29023	34260	
DPT-HepB+Hib 3 under 1 year (per 1000 population)	10.94	10.52	10.69	12.34	0.44
New family planning injectable users	3326	3660	6149	6109	
New family planning injectable users (per 1000 population)	1.28	1.41	2.28	2.30	0.39

** linear regression slope of change in outcome rate per year

Table 13: Count and population-adjusted rates for MCH services in areas defined as HIGH

Outcome variable with population-adjusted rate	2007	2008	2009	2010	Annual Change Rate **
ANC 4th visits	33221	27328	16858	15113	
ANC 4th visits (per 1000 population)	9.28	7.66	4.68	3.93	-1.90
Postnatal visits	20132	19902	14656	12606	
Postnatal visits (per 1000 population)	6.76	5.71	4.31	3.52	-1.11
Deliveries	27133	30061	29583	30202	
Deliveries (per 1000 population)	7.40	8.43	8.19	7.85	0.11
OPD visits, 0-4 years	418395	415566	384568	382552	
OPD visits, 0-4 years (per 1000 population)	113.56	116.49	106.61	100.01	-5.05
Second dose IPT	33349	32667	27312	30258	
Second dose IPT (per 1000 population)	9.32	9.28	7.67	7.85	-0.60
DPT-HepB+Hib 3 under 1 year	40828	37788	33498	34631	
DPT-HepB+Hib 3 under 1 year (per 1000 population)	11.75	10.77	9.45	9.64	-0.77

New family planning injectable users	4464	6126	5982	4746	
New family planning injectable users (per 1000 population)	1.24	1.74	1.69	1.26	0.001

** linear regression slope of change in outcome rate per year

7.5 MCH deaths and population-adjusted annual rates by conflict area

Table 14: Counts and population-adjusted rates of MCH deaths in Uganda, 2007-2010					
Outcome variable with population-adjusted rate	2007	2008	2009	2010	Annual Change Rate **
Stillbirths	4459	5130	4804	5033	
Stillbirths (per 100000 population)	0.27	0.31	0.29	0.29	0.004
Birth asphyxia	2740	3373	5243	4922	
Birth asphyxia (per 100000 population)	0.18	0.22	0.32	0.29	0.04
Maternal deaths	523	568	511	451	
Maternal deaths (per 100000 population)	0.032	0.035	0.031	0.026	-0.002

** linear regression slope of change in outcome rate per year

Table 15: Count and population-adjusted rates for death variables in areas defined as NONE/LOW					
Outcome variable with population-adjusted rate	2007	2008	2009	2010	Annual Change Rate **
Stillbirths	3140	3592	3342	3595	
Stillbirths (per 100000 population)	0.31	0.35	0.32	0.33	0.003
Birth asphyxia	1896	2415	4221	3809	
Birth asphyxia (per 100000 population)	0.21	0.26	0.41	0.37	0.063
Maternal deaths	337	394	375	301	
Maternal deaths (per 100000 population)	0.033	0.038	0.036	0.028	-0.002

** linear regression slope of change in outcome rate per year

Table 16: Count and population-adjusted rates for death variables in areas defined as MEDIUM					
Outcome variable with population-adjusted rate	2007	2008	2009	2010	Annual Change Rate **
Stillbirths	693	821	764	737	
Stillbirths (per 100000 population)	0.26	0.31	0.28	0.27	0.00
Birth asphyxia	445	506	607	430	
Birth asphyxia (per 100000 population)	0.17	0.21	0.22	0.16	-0.002
Maternal deaths	99	80	74	97	
Maternal deaths (per 100000 population)	0.039	0.031	0.027	0.035	-0.002

** linear regression slope of change in outcome rate per year

Table 17: Count and population-adjusted rates for death variables in areas defined as HIGH					
Outcome variable with population-adjusted rate	2007	2008	2009	2010	Annual Change Rate **
Stillbirths	626	717	698	701	
Stillbirths (per 100000 population)	0.18	0.20	0.19	0.18	-0.001
Birth asphyxia	399	452	415	683	
Birth asphyxia (per 100000 population)	0.11	0.13	0.12	0.18	0.02
Maternal deaths	87	94	62	53	
Maternal deaths (per 100000 population)	0.024	0.027	0.018	0.014	-0.004

** linear regression slope of change in outcome rate per year

7.6 IRR tables for all outcome variables by degree of conflict

Table 18: Incidence rate ratios for MCH services with NONE/LOW as the comparison group				
Outcome variable of interest	Medium level of conflict, IRR (95% CI, P-value)	High level of conflict, IRR (95% CI, P-value)	Number of Monthly reports with data	Denominator variable for rates (model offset)
ANC 4th visits	1.19 (1.10 – 1.30, <0.001)	0.57 (0.53 – 0.62, <0.001)	12861	Facility catchment area population
Postnatal visits	1.19 (1.08 – 1.31, <0.001)	0.48 (0.44 – 0.52, <0.001)	12054	Facility catchment area population
Deliveries in health facilities	1.28 (1.14 – 1.46, <0.001)	0.56 (0.51 – 0.62, <0.001)	12812	Facility catchment area population
OPD visits (0-4 years)	1.29 (1.20 – 1.39, <0.001)	0.56 (0.52 – 0.60, <0.001)	13040	Facility catchment area population
Second dose IPT	1.89 (1.73 – 2.05, <0.001)	0.54 (0.50 – 0.59, <0.001)	12773	Facility catchment area population
DPT-HepB+Hib 3 (Under 1 year)	0.98 (0.91 – 1.08, 0.789)	0.54 (0.50 – 0.59, <0.001)	12483	Facility catchment area population
New family planning injectable users	1.40 (1.25 – 1.56, <0.001)	0.44 (0.40 – 0.49, <0.001)	11895	Facility catchment area population

Table 19: Incidence rate ratios for death variables with NONE/LOW as the comparison group				
Outcome variable of interest	Medium level of conflict, IRR (95% CI, P-value)	High level of conflict, IRR (95% CI, P-value)	Number of Monthly reports with data	Denominator variable for rates (model offset)
Stillbirths	1.20 (0.97 – 1.50, 0.010)	1.12 (0.91 – 1.38, 0.266)	12522	Deliveries in health facilities
Birth asphyxia	2.96 (2.23 – 3.91, <0.001)	1.28 (1.01 – 1.63, 0.041)	12406	Deliveries in health facilities
Maternal deaths	1.30 (0.83 – 2.03, 0.245)	1.03 (0.70 – 1.52, 0.877)	12369	Deliveries in health facilities

7.7 Graphs of population-adjusted annual rate for each outcome variable

Figure 1: Population-adjusted rate of ANC 4th visits by facility-month, 2007-2010

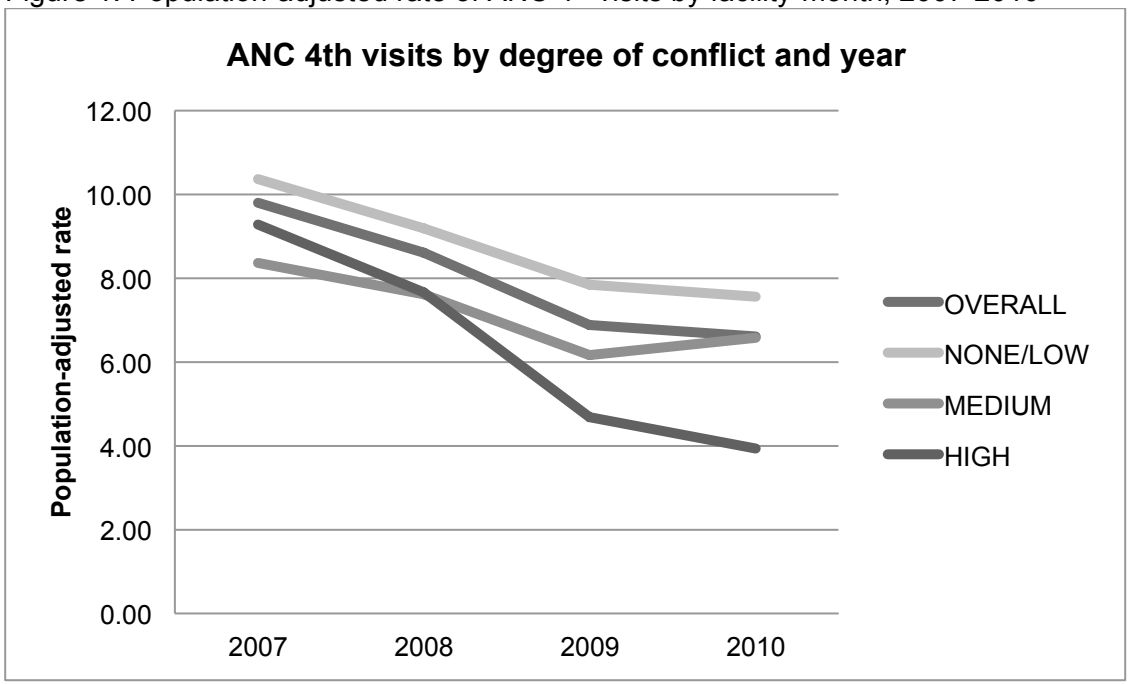

Figure 2: Population-adjusted rate of postnatal visits by facility-month, 2007-2010

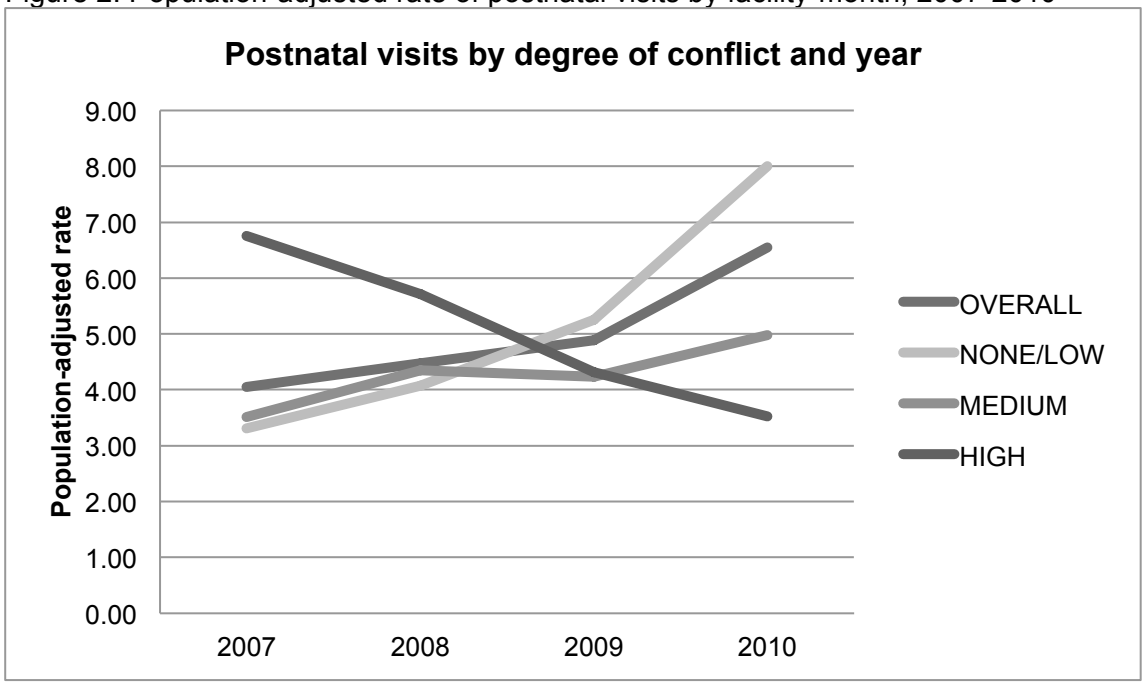

Figure 3: Population-adjusted rate of deliveries by facility-month, 2007-2010

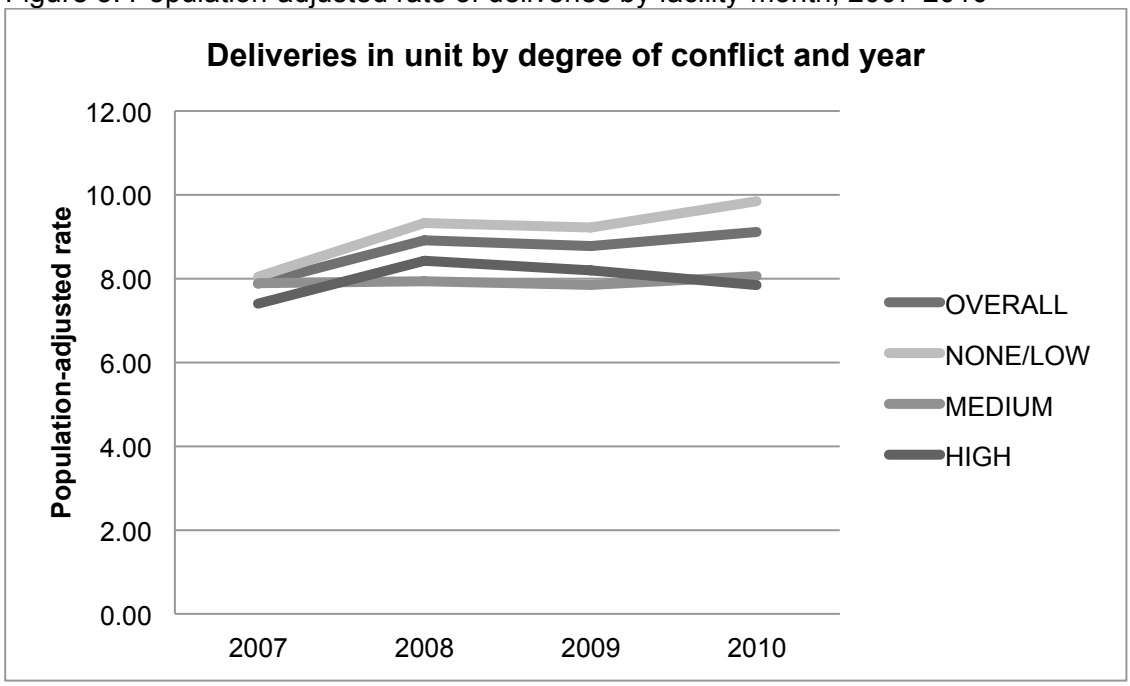

Figure 4: Population-adjusted rate of OPD visits by facility-month, 2007-2010

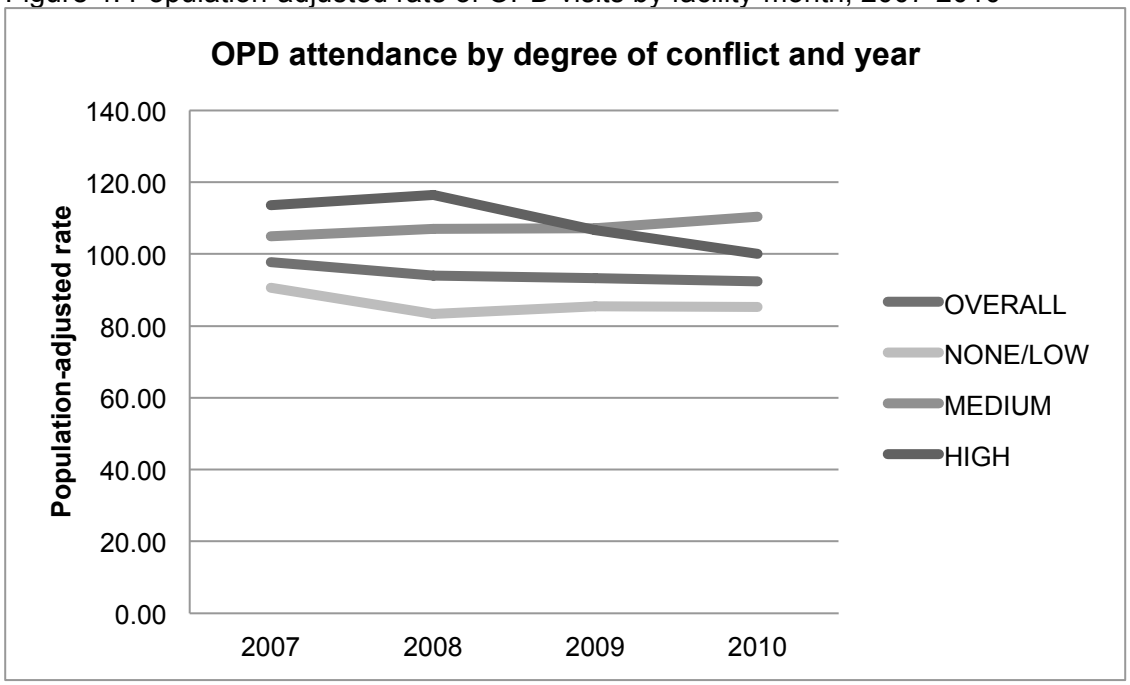

Figure 5: Population-adjusted rate of second dose IPT by facility-month, 2007-2010

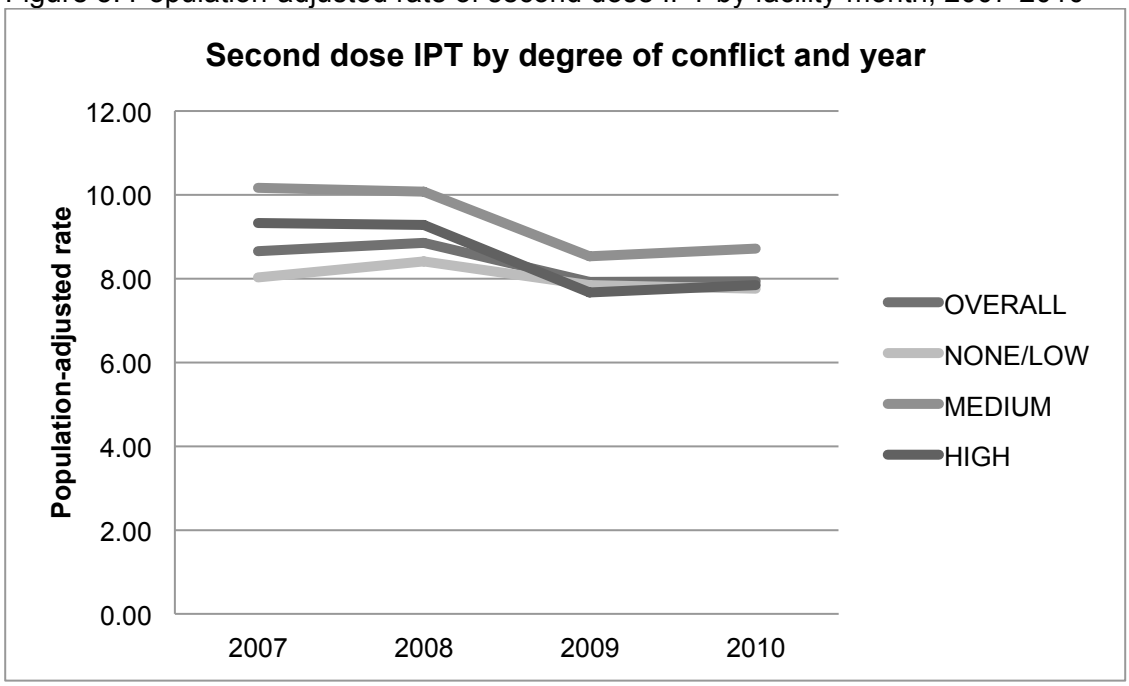

Figure 6: Population-adjusted rate of DPT-HepB+Hib 3 by facility-month, 2007-2010

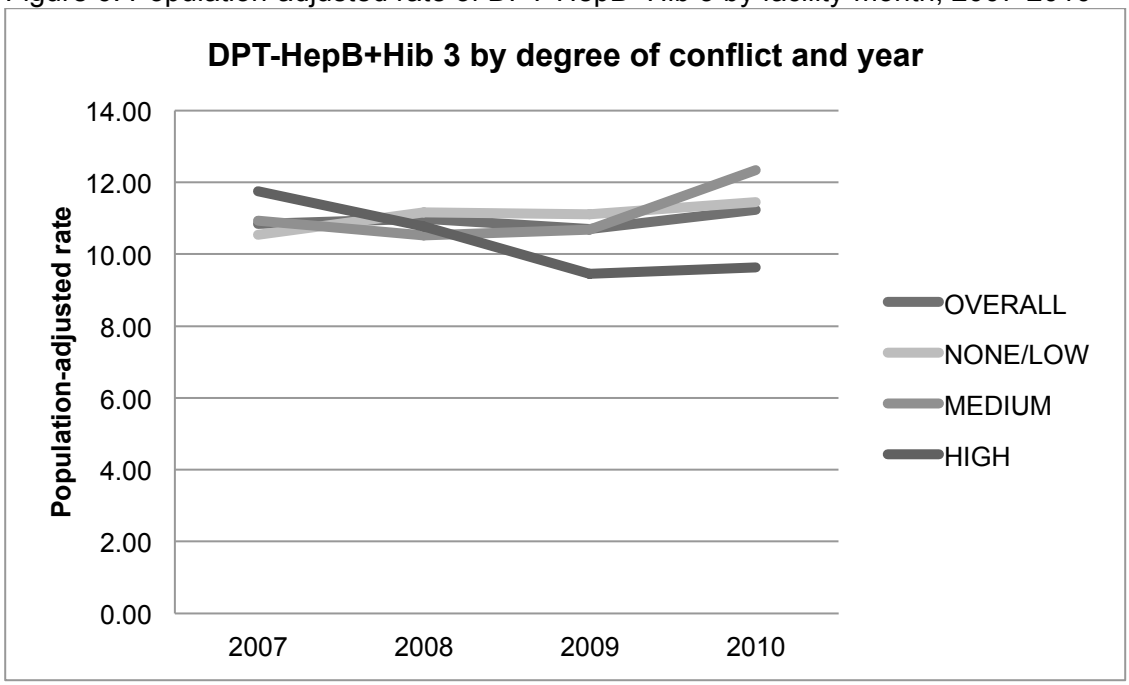

Figure 7: Population-adjusted rate of new family planning injectable users by facility-month, 2007-2010

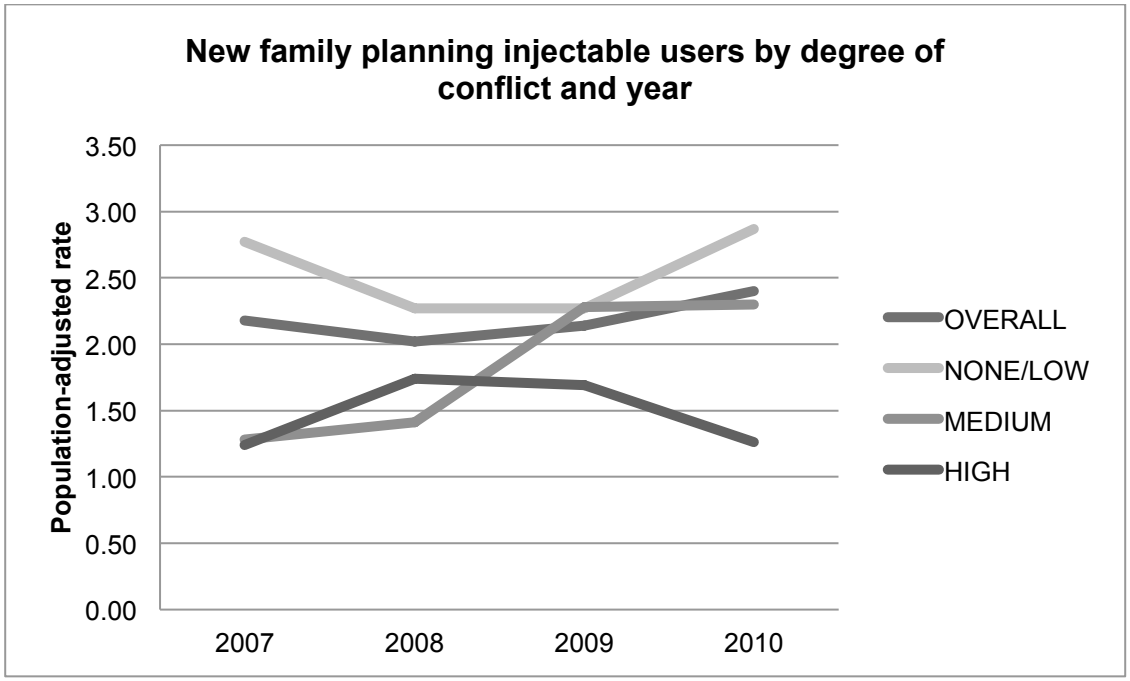

Figure 8: Population-adjusted rate of stillbirths by facility-month, 2007-2010

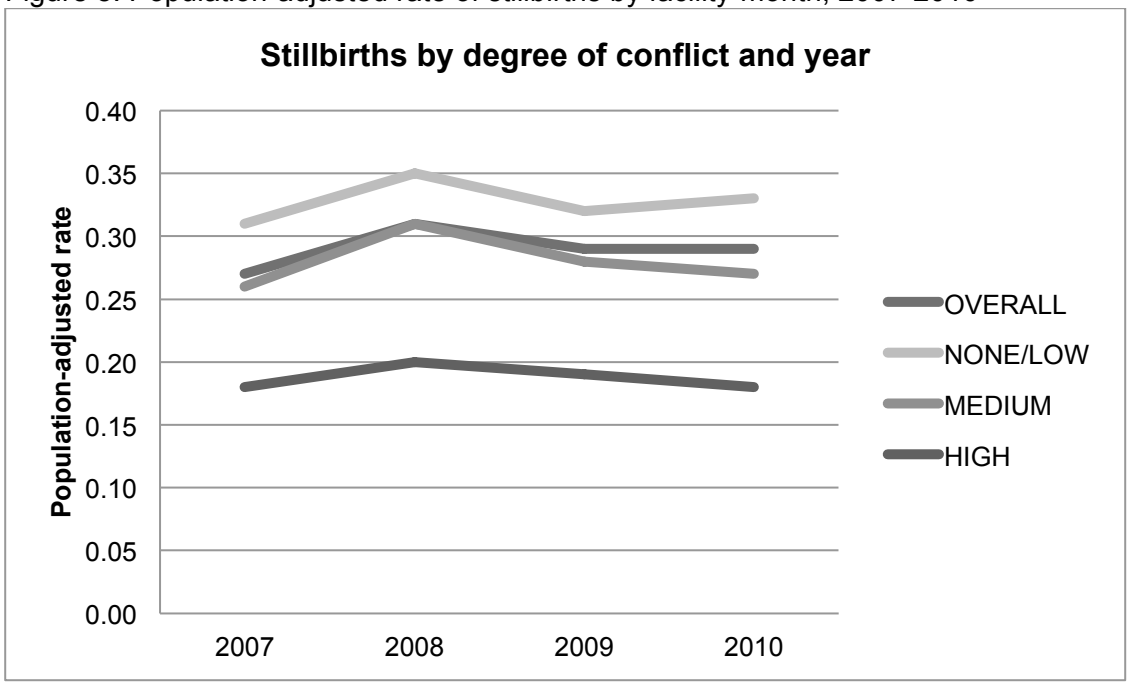

Figure 9: Population-adjusted rate of birth asphyxia by facility-month, 2007-2010

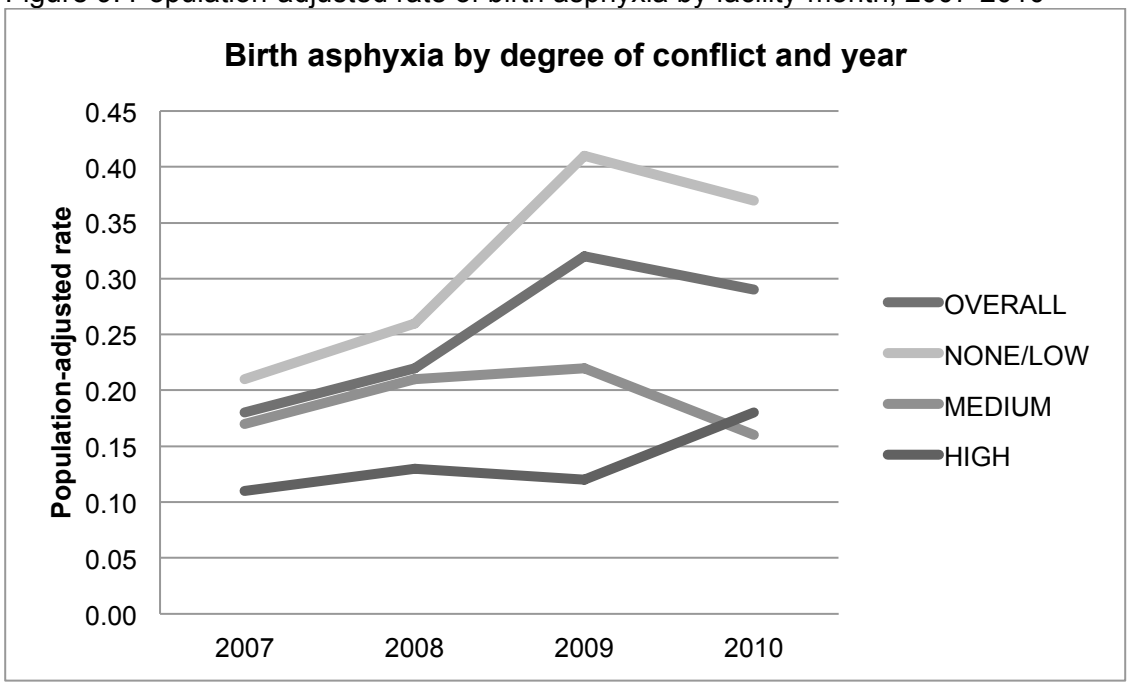

Figure 10: Population-adjusted rate of maternal death by facility-month, 2007-2010