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Adolescent Mother Behaviors in Malawi, A Five-Year Comparison

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Adolescent Mother Behaviors in Malawi, A Five-Year Comparison

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A thesis submitted to the Faculty of the  
Rollins School of Public Health of Emory University  
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in epidemiology  
2018

## **Abstract**

Adolescent Mother Behaviors in Malawi, A Five-Year Comparison

By Seth L. Ferrey

The transition from the Millennium Development Goals (MDGs) to the Sustainable Development Goals (SDGs) set by the United Nations has marked significant improvement in maternal and child health in developing nations. Demonstrated through Demographic Health Surveys (DHS) administered through USAID, Malawi has improved considerably in child and infant mortality in just the last five years. However, rapid population growth and high rates of adolescent pregnancy create persistent concerns. The 2015-2016 DHS survey shows adolescent birth rates in Malawi at an all-time high, while also showing disproportionate improvement in child mortality compared to other age ranges of mothers. This study seeks to understand this paradox by examining whether there have been secular trends in behavioral risk factors for infant and child mortality among adolescent mothers in Malawi between 2010 and 2015-2016. Multivariate logistic regression was used with the statistical software SAS 9.4. The behaviors considered include antenatal birth utilization, HIV status known or not, birth location, breastfeeding, and marriage status at birth. Covariates considered were location (urban or rural and region), electricity availability, water source, and education attainment. Adolescent mothers in 2015-2016 were twenty percent more likely to have adequate antenatal care (OR 1.2, 95% CI: 1.0, 1.4), four times more likely to have a facility birth compared to home birth (OR 4.03, 95% CI: 2.95, 5.49), and two times more likely to be unmarried (OR 2.03, 95% CI: 1.55, 2.67). The results varied slightly by location. Although there was an increase in adequate antenatal care, respondents from 2015-2016 were less likely to have any care (OR 0.29, 95% CI: 0.12, 0.72) when compared to 2010 respondents. Overall, however, adolescent pregnancy behaviors in the last five years have improved significantly. These changes may have influenced the decrease in overall child mortality seen in Malawi.

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## **CHAPTER I: Background/Literature Review**

Extensive research has targeted adolescent mothers from all over the world, especially in developing countries. A substantial amount of this research is provided by the World Health Organization, and largely attributable to the United Nations blueprint of improving the lives of the poorest people in the world through the Millennium Development Goals (MDGs) in 2000 and further expanded by the Sustainable Development Goals (SDGs) in 2015. The increased attention to the MDGs (especially goals four and five: to reduce child mortality and to improve maternal health, respectively) led to a global decrease in under-five mortality rate from 90 to 43 deaths per 1,000 live births between 1990 and 2015, and a growth in the cumulative knowledge of specific populations of at-risk mothers, including adolescents in African countries. The research on the topic concern two distinct yet closely related issues: maternal outcomes and child outcomes. Often the two are difficult to separate. Maternal mortality is defined as a death of a woman while pregnant or within 42 days of termination of the pregnancy. Child mortality has several classifications: neonatal mortality which represents death within the first 28 days of life, post-neonatal mortality which represents death after the first 27 days but less than one year of life, infant mortality which represents death within the first year, child mortality which represents death under the age of 14, and under-5 mortality which represents death within the first five years of life.

### **A. Maternal Outcomes**

“Sustainable Development Goals and the Ongoing Process of Reducing Maternal Mortality” by Lynn Clark Callister and Joan E. Edwards in 2017 served as a bridge between the MDGs and the SDGs with respect to maternal mortality. The article noted a 44% decline in maternal mortality globally since 1990 (Bohren et al., 2015; Chou, Daelmans, Jolivet, & Kinney, 2015; Every Woman Every Child, 2015a; Say et al., 2014). According to the WHO, more than half of worldwide maternal deaths are located in low-income and low-resource setting, due to lack of education, transportation, and resources available. Pregnancies involving young women (especially youth below the age of 15)

exacerbated these factors. The article contained several sections outlining effective programs and initiatives to decrease the global maternity mortality to less than 70 maternal deaths per 1000 live births.

The research titled “WHO Guidelines on Preventing Early Pregnancy and Poor Reproductive Outcomes Among Adolescents in Developing Countries,” by Chandra-Mouli looked at a broad overview of guidelines meant to improve adolescent mother and child outcomes, including “preventing early marriage; preventing early pregnancy through sexuality education, increasing educational opportunities and economic and social support programs; increasing the use of contraception; reducing coerced sex; preventing unsafe abortion; and increasing the use of prenatal care childbirth and postpartum care.” The qualitative results supported the guidelines that the WHO would like to further investigate.

“Adolescent Maternal Mortality in Mozambique,” in 2001 by Granja et al was a more specific investigation. Using data from a major hospital in-country (Maputo Central Hospital), a table summarized maternal deaths from 1989 to 1993. The primary causes of death were hemorrhage at 27%, malaria at 27%, and pregnancy induced hypertension-eclampsia (21%). As stated in the results “The overall maternal mortality ratio in this study was 320, among adolescents 387, and among non-adolescents 294 per 100,000 live births.”

## **B. Maternal and Child Outcomes**

Adolescent pregnancies are a worldwide concern because there can be significant variability by area. “Adolescent pregnancy: Maternal and fetal outcomes in patients with and without preeclampsia,” by Bakwa-Kanyinga et al in 2017 examined adolescent maternal complications in childbirth in the Obstetric Center of the Hospital de Clínicas de Porto Alegre (HCPA), Brazil. The adolescent mothers in the study (17.7% of births), the prevalence of preeclampsia (PE) was 5.3%. This was considerably higher than PE global prevalence documented by the WHO of 4.3%. To prevent PE, multivitamin use is common, especially among risk groups, closely related to adequate prenatal care and facility existence. Many of the adolescent mothers with PE were successful in

attaining an adequate amount of prenatal care (defined as six or more visits in Brazil). The paper concluded by acknowledging that extensive outreach and support for adolescent mothers is essential for both maternal and child health.

“Adolescence As Risk Factor for Adverse Pregnancy Outcome in Central Africa – A Cross-Sectional Study,” by Kurth et al in 2010 researched adolescent pregnancies in Gabon. This study classified adolescent mothers as 16 years old or younger, rather than 10 to 19 as defined by the WHO (Encyclopedia Britannica). Some of the most notable differences between the adolescent mothers and the adult mothers were the prevalence of low birth weight among term newborns (OR: 3.7, 95%CI: 1.4–9.6), and average antenatal care visits (3.3 average visits for adolescent compared to 4.4 for adult mothers).

“Maternal education and child mortality in Zimbabwe,” by Grépin et al in 2015 investigated maternal education and child mortality. Zimbabwe was analyzed as a unique case study to evaluate education because of the abrupt change in secondary school availability which occurred in the early 1980s. As with many other African countries, Demographic Health Surveys were utilized to assess child mortality. Ultimately, the study found a 1.7% decrease in child mortality for each one-year increase in maternal education. There was a 21% decrease in child mortality among women who benefited from the education policies, overall, when compared to child mortality among slightly older women who were less likely to have benefited from the education policies. The study was also able to control for covariates like the impact of Zimbabwe independence. The specific mechanism through which education has a positive effect on child mortality are poorly understood, however. The authors posited four specific channels for the positive impact of education on child mortality: 1) education may make people more aware of prevention; 2) education may make people more aware of different treatments; 3) increased education might lead to higher incomes, which could directly affect health by increasing the purchasing power of individuals and; 4) additional pathways (like marrying a more affluent member of society).

### **C. Antenatal Care and Area Specific Concerns**

Many studies have evaluated antenatal care as an indicator for the health of both the mother and the child. In late 2017, a systematic review by Moller et al in “Early antenatal care visit: a systematic analysis of regional and global levels and trends of coverage from 1990 to 2013,” estimated that antenatal care has increased from 40.9% to 58.6% globally. In low income settings, 24% utilized antenatal care facilities, while 81.9% utilized antenatal care in high income settings. Oceania and Sub-Saharan Africa have the lowest antenatal care utilization (18.6% and 24.9%, respectively) with adolescents utilizing the facilities less than other age groups. The same two areas also have the highest maternal mortality rates (187 and 546 per 100,000 livebirths in 2015, respectively, published in 2015 by Alkema L and Chou D, Hogan D, et al) and highest neonatal mortality rates (22 and 29 per 1000 livebirths in 2015, respectively, published in 2015 by You D, Hug L and Ejdemyr S, et al).

In “Maternal health services utilization by Kenyan adolescent mothers: Analysis of the Demographic Health Survey 2014,” Behaviors of Kenyan mothers aged 15 to 19 years of age was used as a case study to assess antenatal care (ANC), skilled birth attendance (SBA), and postnatal care (PNC). Nearly half of the study population had had their first child by the age of 16. The study found that 93% of adolescent mothers utilized ANC (at least one visit), 65% SBA, and 92% PNC. Higher education and affluence (upper quintile) were the most significant contributing factor for ANC utilization (OR = 1.36–5.99 and OR = 1.16–10.34, respectively). Similar factors contributed to SBA utilization, while the most important contributing factor for PNC was parity. Also, partner education played a significant role in ANC utilization.

Similarly, Owolabi et al evaluated the use of antenatal care facilities in “Comparing the use and content of antenatal care in first-time mothers in 13 countries of west Africa: a cross-sectional analysis of Demographic and Health Surveys,” in 2017. The survey respondents were grouped into three categories: aged 10–19 years (adolescents), 20–24 years (young adults), and 25 years or older (adults). Overall, only 47% of the population studied had at least one antenatal care visits within the first trimester. Sixty-eight percent (11,856 of 17,386) used the antenatal care services with the

recommended frequency (at least four visits) and receipt of any antenatal care ranged from about half (56%) of women in Nigeria to nearly all women (96%) in Burkina Faso. Adolescent girls were less likely to receive an adequate number of visits and also less likely to receive the four basic components of antenatal care, including blood pressure reading, urine sample taken, blood sample taken, and information on pregnancy complications than other age groups.

Malarial infection in pregnancy is a concern. A review by Desai et al in 2007 explained that because malaria infection may be asymptomatic during pregnancy, the infections tend to remain untreated and can cause maternal anemia and result in delivery of a low birthweight infant. Congenital infection is also possible. Adolescent pregnancies are especially susceptible to infection because of they are less likely to have adequate immunity which is acquired over time. The research by Orish et al in “Adolescent pregnancy and the risk of *Plasmodium falciparum* malaria and anaemia—A pilot study from Sekondi-Takoradi metropolis, Ghana,” in 2012 illuminated the importance in malaria treatment, especially for adolescent mothers. The study found that adolescent pregnant girls had 1.65 (95% CI, 1.03–2.65) times the odds of having malaria when compared to other pregnant adult women. The adolescent pregnant girls also had 1.63 times the odds of being anemic (95% CI, 1.01–2.62) compared to the adult pregnant population.

#### **D. Malawi**

According to Sedgh et al (published in 2015), Malawi had an estimated fertility rate of 154 pregnancies per 1,000 adolescent females (100,300 total pregnancies) in 2009. This rate was one of the highest not only in Sub-Saharan Africa, but also around the world. Work has been dedicated to understanding the challenges of these pregnancies, particularly given the abovementioned risks of maternal and child mortality and morbidity that are associated with teen pregnancy. The variable quality in delivery facility also confounds the problem. In 2016, a study by Leslie et al attempted to understand why neonatal mortality had decreased at a slower rate when compared to the dramatic increase in access to health facility for birth. Specifically, the study looked at the nuanced differences of neonatal mortality by facility quality. The study controlled for various covariates, including

socioeconomic status, pregnancy characteristics (e.g. whether the mother had the minimum recommended antenatal care visits of 4), and characteristics of the birth. The results suggest dramatic disparities. Among the top 25% of health care facilities, neonatal mortality was 5.2 deaths per every 1000 live births compared to 28.3 deaths per every 1000 live births at the lower 75% health care facilities (the United States neonatal mortality rate is 5.8 deaths per every 1000 live births, as of 2014, for comparison). The neonatal mortality rate in lower-quality facilities extrapolated in the Leslie et al study closely resembles the neonatal mortality of the Malawi 2015-2016 DHS (table 1). This study did not specifically investigate adolescent delivery location.

A study by Kanyuka et al (2016) investigating maternal education in Malawi had similar conclusions to Grépin et al in 2015 (investigating maternal education in Zimbabwe). In 2000, children born to mothers with no education had a nearly 70% increased risk of childhood mortality compared to mothers with secondary or higher education. In 2010, their excess risk declined to 14%. Ultimately, the changes in behaviors, access to care, and policy implementation dramatically reduced the under-5 mortality rate in Malawi from 247 per 1000 live births in 1990 to 71 in 2013. Additional research is necessary for mothers in the highest risk categories in Malawi, however, especially adolescents.

A Policy Brief on Malawi by the World Bank Group was released in 2016 expressing concern about the increasing adolescent pregnancy rate in recent years. This Policy Brief defines an “economic dividend” as

“A demographic dividend is the accelerated economic growth that may result from a rapid decline in a country’s mortality and fertility rates and the subsequent shift in the age structure of the population. As a country’s working-age population grows in relation to the number of young dependents, a small window of opportunity exists to achieve strong economic growth.”

Referencing the United Nations Department of Economic and Social Affairs in 2015, the adolescent population makes up 24% of the total population. This population is expected to double by the year

2050 to 8.8 million and is projected to continue rising without addressing the booming fertility rate.

The policy outlines four pillars to harness the economic dividend: 1) keeping girls in school; 2) equipping out-of-school girls with skills; 3) beginning a family and adopting a healthy lifestyle; and 4) addressing the early childhood development needs of children born to teenage mothers.

Previous research conclude that adolescent pregnancies are high risk for both the mother and the infant, especially in locations like Sub-Saharan Africa. Research suggests that adolescent mothers tend to have less knowledge of pregnancy related complications and less knowledge of where to find adequate care and counseling for primigravidae births. This is compounded in areas with low income and sub-optimal facilities with little transportation available. High HIV prevalence and malaria infections that can be asymptomatic can lead to congenital infection. Malawi provides an opportunity to investigate a population with a confluence of the above factors and the convenience of a recent extensive DHS survey.

**CHAPTER II: Manuscript****A. Title, Author(s), Abstract****Adolescent Mother Behaviors in Malawi, A Five-Year Comparison**

by Seth Ferrey

**ABSTRACT**

The transition from the Millennium Development Goals (MDGs) to the Sustainable Development Goals (SDGs) set by the United Nations has marked significant improvement in maternal and child health in developing nations. Demonstrated through Demographic Health Surveys (DHS) administered through USAID, Malawi has improved considerably in child and infant mortality in just the last five years. However, rapid population growth and high rates of adolescent pregnancy create persistent concerns. The 2015-2016 DHS survey shows adolescent birth rates in Malawi at an all-time high, while also showing disproportionate improvement in child mortality compared to other age ranges of mothers. This study seeks to understand this paradox by examining whether there have been secular trends in behavioral risk factors for infant and child mortality among adolescent mothers in Malawi between 2010 and 2015-2016. Multivariate logistic regression was used with the statistical software SAS 9.4. The behaviors considered include antenatal birth utilization, HIV status known or not, birth location, breastfeeding, and marriage status at birth. Covariates considered were location (urban or rural and region), electricity availability, water source, and education attainment. Adolescent mothers in 2015-2016 were twenty percent more likely to have adequate antenatal care (OR 1.2, 95% CI: 1.0, 1.4), four times more likely to have a facility birth compared to home birth (OR 4.03, 95% CI: 2.95, 5.49), and two times more likely to be unmarried (OR 2.03, 95% CI: 1.55, 2.67). The results varied slightly by location. Although there was an increase in adequate antenatal care, respondents from 2015-2016 were less likely to have any care (OR 0.29, 95% CI: 0.12, 0.72) when compared to 2010 respondents. Overall, however, adolescent pregnancy behaviors in the last five years have improved significantly. These changes may have influenced the decrease in overall child mortality seen in Malawi.

## **B. Introduction**

Adolescent pregnancy (pregnancy from 10-19 years of age) is understood to have negative consequences for the mother, the child, and economic growth[1-5]. International organizations like the World Health Organization (WHO), United Nations, and Unicef have made the topic a primary concern because pregnancies among teens are known to be at increased risk for both maternal and child outcomes. Given the high risks among teen mothers, the Millennium Development Goal 5 (MDG 5) and the Sustainable Development Goal 3 (SDG 3) specifically address adolescent pregnancy. Since the MDG implementation in 2000, maternal mortality in adolescent pregnancy has declined by 45 percent. The under-five mortality rate has declined by more than 50 percent[6-9].

Persistent problems remain, however, especially in Sub-Saharan Africa. Inadequate maternal education is associated with poor outcomes for the mother and the child [5, 10]. Preeclampsia [11], malaria infection [12, 13], and lower than optimal antenatal care utilization [14-18] are also associated with adolescent mothers. Delivery location (e.g. home compared to facility) is especially important as a factor of child mortality [21-25]. The high prevalence of HIV can lead to pregnancy complications and congenital infections [26-28].

Malawi offers its own unique case study of adolescent pregnancy. Adolescents now comprise 28 percent of the total population. Thirty percent of Malawian women give birth before the age of 20[5, 31]. Intriguingly, despite the high rate of adolescent pregnancy (154 per 1,000 females age 15-19 years old)[4], Malawi has lowered the under-five mortality from 247 deaths per every 1000 live births in 1990 to around 71 deaths in 2013[33, 34]. According to the most recent Demographic Health Survey (DHS) administered in 2015-2016 there is an increasing proportion of adolescent pregnancies compared to other age groups[31]. The paradoxical increase in adolescent pregnancies in Malawi while also decreasing rate of childhood mortality suggests an improvement in childhood mortality among children born to adolescent mothers (tables A and B in Appendix).

Behavior changes are a possible reason for improved childhood mortality. The USAID Demographic Health Surveys from 2010 and 2015-2016 provide extensive information, including

pregnancy outcome indicators of HIV status, sufficient antenatal care utilization, place of delivery, breastfeeding[29, 30] and marriage status. Adolescent mother respondents from 2010 can be compared to adolescent mother respondents from 2015-2016 to provide insight to hypothesized behavior changes. Specifically, we investigated access to care variables in addition to marriage and breastfeeding that could account for the increase in adolescent birth rates and decrease in child and maternal mortality.

### C. Methods

Demographic Health Survey (DHS) datasets for the 2010 and 2015-2016 surveys administered through USAID were used for this analysis. The survey results are designed to be generalizable of the Malawi population down to the Region subcategory. Results are provided at a country level (overall) and location level (urban and rural). The final population analyzed were primigravidae adolescent (15-19) mothers who had given birth within five years of administered survey. Multivariate logistic regression was utilized with maximum likelihood estimation (MLE) and Wald confidence intervals. Interaction was assessed at an alpha level of .05 and confounding was based on resulting gold standard model ( $\text{logit}(\text{behavior}) = \beta_0 + \beta_1(\text{DHS Year}) + \beta_2(\text{Education}) + \beta_3(\text{Water}) + \beta_4(\text{Electricity}) + \beta_5(\text{Region})$ ). Statistical Analysis System (SAS) version 9.4 (SAS Inst, Cary, NC) was used. Exposure of interest was survey year, outcomes of interest were based on access to health care previously researched that have been associated with poor maternal and child outcomes and were available in the DHS surveys. These include ever been tested for HIV (yes or no) antenatal care utilization (dichotomized at 4; 3 or less insufficient, 4 or more sufficient and ever versus never) and place of delivery (home or other home versus any facility); as well as two behavioral risk factors: breastfeeding (yes or no), marriage at birth (yes or no)

This study also included possible confounding by factors of region within country, electricity presence or absence, source of drinking water (piped into dwelling versus not piped into dwelling), education level attained, and place of residence (urban or rural). Electricity and source of drinking

water serve as proxy variables to represent affluence. Education was considered a potential confounder and not an outcome of interest based on previous research[34] suggesting improved childhood mortality regardless of mother's education in Malawi. Education was dichotomized between no education and any education.

#### **D. Results**

Age at birth ranged from 12 to 19 years old (median 18) with birth years ranging from 1987 to 1995 for the 2010 survey and 1992 to 2000 for the 2015-2016 survey. Newborn birth dates ranged from 2006 to 2010 for the 2010 survey and 2011 to 2016 for the 2015-2016 survey. Out of 23,748 women interviewed in 2010, 1,193 respondents fit the target population definition and 1,518 out of 24,562 women surveyed in 2015-2016. The total population of was 2,711 respondents Tables 1 and 2 show behavior and covariate breakdown between survey years. Table 3 shows overall adjusted odds ratios. Table 4 shows more detailed crude and adjusted odds ratios for access to care variables. Table 5 shows access to care variables stratified by location (urban and rural).

##### **Antenatal Visits**

Inadequate antenatal care was common in the two surveys analyzed. Over half of the adolescent mothers in 2010 had inadequate care (55.8%) compared to 51.5% for in 2015-2016. Adolescent mothers surveyed in 2015-2016 had a twenty percent increase in the odds of at least four visits for adequate antenatal care (OR 1.2 95%CI 1.0, 1.4) compared to adolescent mothers surveyed in 2010 (table 3). Proportionally, there was an eight percent increase in adequate care.

Although adolescent mothers delivering in 2011 to 2016 were more likely to have received at least four prenatal visits than those delivering earlier, they were also more likely to have not received any prenatal care. In the 2015-2016 survey year, adolescent mothers were more likely to have no visits when compared to the 2010 survey year (OR 3.42 95%CI 1.41, 8.38) (table 4). No care was very rare, however (only .01% of population in 2010 and 1.9% of population in 2015-2016).

### Tested for HIV

Overall, women surveyed in 2015-2016 were more likely to know their HIV status than those surveyed 5 years earlier (OR 1.21 95%CI .89, 1.65), although when stratified by region, urban respondents in 2015-2016 had .23 the odds of knowing their HIV status compared to respondents 5 years earlier (table 5). This was due to an increase in proportion of unknown HIV status from 0% in 2010 to 3.1% in 2015-2016. In the population surveyed in 2010, 7% of adolescent mothers had never been tested for HIV. In 2015-2016, 5.8% of adolescent mothers had never been tested for HIV.

### Facility Birth

Home births were much less common in 2015 than in 2010. Fourteen percent of the adolescent mothers surveyed in 2010 had a home delivery compared to only four percent in 2015-2016, corresponding to a 3.5-fold proportional increase in facility births and an OR of 4.03(95%CI 2.95, 5.49). Rural areas had almost four times the odds of facility birth compared to 2010 respondents in the same location (OR 3.96 95%CI 2.88, 5.45), and urban over five times the odds of facility birth (OR 5.68 95%CI 1.47, 22.02).

### Breastfeeding

Breastfeeding was roughly unchanged (2% in 2010 and 2% in 2015-2016; OR .87 95%CI .52, 1.46). Respondents in rural locations in 2015-2016 had 0.80 times (95%CI .46, 1.39) the odds for breastfeeding compared to respondents in rural locations in 2010, and urban 2.00 times the odds of breastfeeding (95%CI .49, 8.2)

### Marriage

Overall, respondents from the 2015-2016 DHS survey were nearly two times more likely to be unmarried when compared to DHS survey respondents in 2010 (7% in 2010 and 13% in 2015-2016; OR 2.03 95%CI 1.55, 2.67). Rural respondents in 2015-2016 had 2.09 (95%CI 1.55, 2.80) times the odds of being unmarried compared to rural respondents in 2010, and 1.74 (95%CI .84 3.57) times the odds of being unmarried in urban locations.

## **E. Discussion**

Behaviors of Malawian adolescent mothers are rapidly changing. Antenatal care and health care facility birth location were significantly more common among women surveyed in 2015-2016 than in respondents from 2010, while marriage was less common. This shift in behavior has aligned with a dramatic improvement in under-5 mortality: 247 per 1000 live births in 1990 to 71 in 2013[34].

Overall, these data suggest that there have been rapid improvements to access to health care. In 2010, 36.2% of adolescent mothers surveyed had all three access to care variables (at least four antenatal care visits, delivery at a facility and HIV status known). In 2015-2016, this proportion increased to 45.6%. Adolescent mothers surveyed in 2015-2016 are more likely to have a sufficient amount of visits compared to 2010, although adolescent mothers are also more likely to have no visits. This is an extremely small portion of the overall population, however (.01% in 2010 and only in rural locations and 1.9% in 2015-2016 primarily in rural locations). One possible reason for the partial decline in visits likely is related to the mother's distance to a local health care facility. The population with fewest visits are women in rural locations. The women in urban locations receive public health related messages easier and faster. The women in remote locations are less likely to receive these messages. The resulting concern involves the reason why less urban women are now utilizing any antenatal care. Possible reasons include transportation issues, disenfranchisement, lack of community ownership of local facilities, incorrect knowledge, and lack of empowerment.

Interestingly, adolescent women in 2015-2016 had two times the odds to be unmarried compared to the respondents in 2010. These results are probably directly related to new policies implemented by the Malawian Government in 2015 and 2017 increasing the legal age of marriage from 15 to 18[32]. The law appears to have no effect in reducing the amount of adolescent pregnancies. This analysis only involved respondents from late 2015 and early 2016, however (the law was only recently passed), and behaviors may slowly evolve over years.

Birth location comprised the most change in this analysis. Adolescent mothers in 2015-2016 were five times more likely to give birth in a facility rather than home (or someone else's home) when

compared to the 2010 respondents. Caution should be used when interpreting this difference. The crude response of “home birth” on the survey does not mean there were not adequate facilities located in the home (i.e. the home may have had running water, electricity, and a trained midwife or even nurse to help with the delivery, which would be improved from many of the health care facilities located in rural areas).

Recall and information bias are present in survey data. Mothers with recent births, for example, are more likely to remember the specific number of antenatal visits compared to mothers giving birth five years ago. Respondents reporting 3 visits when the actual number of visits was 4 would be misclassified. This is probably equally likely in both surveys. Antenatal care visits, HIV status known or not, and breastfeeding are subject to societal norms and can affect responses. These societal norms, however, have probably not changed from 2010 to 2015. This study was limited to primigravidae adolescent girls. Some at-risk pregnancies were likely excluded from this analysis and could impact the results. A miscarriage in the first trimester due to lack of antenatal care, for example, would probably not be reported on either survey resulting in under-reporting of inadequate care. This consideration would be equally important for both survey years.

Ultimately, this analysis demonstrates behaviors have changed in Malawi for first-time adolescent mothers in just the past five years. Improved behaviors of adolescent pregnancies can have significant impacts on the health of the child and mother. This analysis does not attempt to explain why behaviors have changed. The end line goal push for MDGs and resulting outreach programs from the Malawian Government and NGOs are one likely reason. Further research could find relevant programs attempt to quantify the impact of the outreach programs, for adolescent mothers especially. This knowledge could then be used to improve maternal and child outcomes for both Malawi and other developing countries with similar challenges.

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## G. Tables

**Table 1** Demographic Health Survey 2010 (n=1,193) and 2015-2016 (n=1,518) behavior frequency

	2010		2015-2016	
	Rural n(%)	Urban n(%)	Rural n(%)	Urban n(%)
<b>Antenatal care</b>				
0 Visits	6(.01)	0(0)	24(1.6)	4(.3)
1-3 Visits	605(50.9)	57(4.8)	655(43.3)	95(6.3)
≥ 4 Visits	463(38.9)	58(4.9)	610(40.3)	126(8.3)
<b>HIV Status</b>				
Not Known	84(7.8)	0(0)	81(6.3)	7(3.1)
Known	993(92.2)	116(100)	1211(93.7)	219(96.9)
<b>Delivery Location</b>				
Home <sup>a</sup>	163(15.1)	9(7.8)	56(4.3)	4(1.8)
HCF <sup>b</sup>	914(84.9)	107(92.2)	1236(95.7)	222(98.2)
<b>Marriage</b>				
Married	1005(93.3)	104(89.7)	1128(87.3)	190(84.1)
Unmarried	72(6.7)	12(10.3)	164(12.7)	36(15.9)
<b>Breastfeeding</b>				
Breastfed	1050(98.0)	112(96.6)	1259(97.5)	222(98.2)
Did Not Breastfeed	22(2.0)	4(3.4)	33(2.5)	4(1.8)

<sup>a</sup>Home includes responses: home, respondent's home, or other home

<sup>b</sup>HCF includes responses: public sector, government hospital, government health center, government health post/outreach, other public sector, private sector, private hospital/ clinic, CHAM/MISSION hospital, CHAM/MISSION health center, BLM, or other private medical sector

**Table 2** Demographic Health Survey 2010 (n=1,193) and 2015-2016 (n=1,518) covariate frequency

	<b>2010</b>	<b>2015-2016</b>
	n (%)	n (%)
<b>Region</b>		
North	254 (21.3)	282 (18.6)
Central	347 (29.1)	465 (30.6)
South	592 (49.6)	771 (50.8)
<b>Highest Education Attained</b>		
No Education	60 (5.0)	68 (4.5)
Incomplete Primary	958 (80.3)	1173 (77.3)
Complete Primary	174 (14.6)	272 (17.9)
Incomplete Secondary <sup>a</sup>	1 (.08)	5 (.3)
<b>Location</b>		
Urban	116 (9.7)	226 (14.9)
Rural	1077 (90.3)	1292 (85.1)
<b>Household Has Electricity</b>		
No	1093 (91.9)	1382 (91.0)
Yes	65 (5.5)	111 (7.3)
<b>Source of Drinking Water</b>		
Piped Water	200 (17.62)	127 (9.7)
Public Tap	0 (0)	144 (9.5)
Tube Well or Borehole	688 (57.8)	920 (60.6)
Protected Well	46 (3.9)	71 (4.7)
Unprotected River/Spring/Other	248 (20.8)	236 (15.56)

<sup>a</sup>Complete secondary and higher categories not included because of 0 values

**Table 3** Odds ratios and 95% CI comparing Demographic Health Survey responses in 2010 to 2015-2016.

	Overall	Malawi Region		
		North	Central	South
<b>Antenatal Visits</b>				
Any Visits <sup>a</sup>	.29 (.12 .72)	1.11 (.07 17.85)	.53 (.12 2.8)	.17 (.05 .58)
0 Visits (referent)	1	1	1	1
Sufficient Visits ( $\geq 4$ ) <sup>b</sup>	1.2 (1.0 1.4)	.92 (.65 1.30)	1.17 (.88 1.56)	1.37 (1.10 1.71)
<3 Visits (referent)	1	1	1	1
<b>Tested for HIV</b>				
Status Known	1.18 (.86 1.61)	1.20 (.55 2.61)	1.58 (.90 2.76)	1.00 (.65 1.54)
Status Unknown (referent)	1	1	1	1
<b>Facility Birth</b>				
HCF	4.03 (2.95 5.49)	5.96 (2.58 13.8)	2.95 (1.79 4.85)	4.77 (3.00 7.59)
Home (referent)	1	1	1	1
<b>Breastfed</b>				
Breastfed	.87 (.52 1.46)	2.24 (.73 6.89)	.75 (.33 1.72)	.59 (.24 1.46)
Not Breastfed (referent)	1	1	1	1
<b>Marriage Status</b>				
Unmarried	2.03 (1.55 2.67)	2.36 (1.07 5.22)	3.22 (1.75 5.92)	1.68 (1.20 2.36)
Married (referent)	1	1	1	1

**Table 4** Odds ratios and 95% CI comparing Malawi Demographic Health Survey responses by adolescent primigravidae mothers in 2010 to 2015-2016 with respect to access to care variables (antenatal visits, ever tested for HIV and delivery location)

	Frequency n(%)		OR	
	2010	2015-2016	Crude (95%CI)	Adjusted (95%CI) <sup>c</sup>
<b>Antenatal Visits<sup>d</sup></b>				
0 Visits	6(.01)	28(1.9)	4.12(1.70,10.00)	3.83(1.56, 9.36)
1-3 Visits (referent)	662(55.7)	750(49.6)	1	1
4+ Visits	521(43.8)	736(48.6)	1.25(1.07, 1.45)	1.24(1.06, 1.44)
<b>Tested for HIV</b>				
Known	1,109(93.0)	1,430(94.2)	1.23(.90, 1.68)	1.21(.89, 1.65)
Unknown (referent)	84(7.0)	88(5.8)	1	1
<b>Delivery Location</b>				
HCF <sup>b</sup>	1021(85.6)	1458(96.1)	4.09(3.02, 5.55)	4.12(3.02, 5.61)
Home <sup>a</sup> (referent)	172(14.4)	60(3.9)	1	1

<sup>a</sup>Home includes responses: home, respondent's home, or other home

<sup>b</sup>HCF includes responses: public sector, government hospital, government health center, government health post/outreach, other public sector, private sector, private hospital/ clinic, CHAM/MISSION hospital, CHAM/MISSION health center, BLM, or other private medical sector

<sup>c</sup>Adjusted model incorporates education level, electricity, region, and water use

<sup>d</sup>Antenatal visits referent groups were >0 for "0 Visits," 0 or ≥4 for "1-3 Visits," and 0-3 for "4+ Visits"

**Table 5** Odds ratios and 95% CI comparing Malawi Demographic Health Survey responses by adolescent primigravidae mothers in 2010 to 2015-2016 with respect to access to care variables (antenatal visits, ever tested for HIV and delivery location) and stratified by location (urban or rural)

	Urban				Rural			
	Frequency n(%)		OR		Frequency n(%)		OR	
	2010	2015-2016	Crude (95%CI)	Adjusted (95%CI) <sup>c</sup>	2010	2015-2016	Crude (95%CI)	Adjusted (95%CI) <sup>c</sup>
<b>Antenatal Visits<sup>d</sup></b>								
0 Visits	0(0)	4(1.8)	2.36(.26, 21.62)	2.74(.30, 25.30)	6(.6)	24(1.9)	3.70(1.50, 9.10)	3.34(1.34, 8.30)
1-3 Visits (referent)	57(49.6)	95(42.2)	1	1	605(56.3)	655(50.8)	1	1
4+ Visits	58(50.4)	126(56)	1.28(.81, 2.02)	1.20(.76, 1.91)	463(43.1)	610(47.3)	1.22(1.03, 1.43)	1.22(1.04, 1.44)
<b>Tested for HIV</b>								
Known	116(100)	219(96.9)	.27(.03, 2.24)*	.27(.03, 2.24)*	993(91.2)	1211(93.7)	1.27(.92, 1.74)	1.26(.92, 1.73)
Unknown (referent)	0(0)	7(3.1)	1	1	84(8.8)	81(6.3)	1	1
<b>Delivery Location</b>								
HCF <sup>b</sup>	107(92.2)	222(98.2)	4.67(1.41, 15.50)	5.68(1.47, 22.02)	914(84.9)	1236(95.7)	3.94(2.87, 5.40)	3.96(2.88, 5.45)
Home <sup>a</sup> (referent)	9(7.8)	4(1.8)	1	1	163(15.1)	56(4.3)	1	1

<sup>a</sup>Home includes responses: home, respondent's home, or other home

<sup>b</sup>HCF includes responses: public sector, government hospital, government health center, government health post/outreach, other public sector, private sector, private hospital/ clinic, CHAM/MISSION hospital, CHAM/MISSION health center, BLM, or other private medical sector

<sup>c</sup>Adjusted model incorporates education level, electricity, region, and water use

\*Cells with zero reference values had cell value of 1 for odds estimate

## H. Appendix

**Table A** Comparison of early childhood mortality rate (per 1000 live births) by Demographic Health Survey year\*

DHS Survey	Neonatal (NN)	Post-neonatal (PNN)	Infant mortality (5q0)	Child mortality (5q1)	Under-5 mortality (5q0)
2010	31	35	66	50	112
2015-2016	27	15	42	23	63

\*Rate based on 0-4 years prior to survey administration

**Table B** Early childhood mortality percent change from 10-year period before 2010 DHS to 10-year period before 2015-2016 DHS

Mother's age at birth	% change				
	Neonatal (NN)	Post-neonatal (PNN)	Infant mortality (5q0)	Child mortality (5q1)	Under-5 mortality (5q0)
<20	-12	-27	-38	-26	-59
20-29	-6	-20	-26	-29	-53
30-39	-7	-18	-37	-28	-50
40-49	1	13	14	-45	-29

### **Chapter III:** Summary, Public Health Implications, Possible Future Directions

Many Sub-Saharan countries, including Malawi, are recognizing and improving basic health concerns. The Millennium Development Goals and the Sustainable Development Goals developed by the United Nations have been driving forces to improve these concerns. One fundamental topic addressed by the goals is related to maternal and child health. Issues related to poor outcomes for maternal and child health are exponentiated in areas with rapidly expanding populations, which is a common concern in developing countries.

Malawi is a convenient case study. High fertility rates, especially among adolescent girls, have provided a rapidly growing adolescent population. Although the fertility rate continues to increase, childhood mortality rates have decreased for nearly all maternal ages. Over the same time period, behaviors of adolescent mothers seem to have changed, also. According to the latest Demographic Health Survey, adolescent mothers are more likely to have adequate antenatal care, more likely to have a delivery in a facility rather than home, and more likely to be unmarried at birth.

There are multiple public health implications for this study. First, childhood mortality can be improved in developing countries within a relatively short time (5 years in this analysis). Second, adequate antenatal care and delivery location in Malawi have been improving in recent years. This suggests the public health initiatives in Malawi over the last five years have been successful in pushing for decreased childhood mortality (MDG 4).

Initiatives in Malawi should be investigated for adaptation and implementation in similar locations struggling with low antenatal care use and high prevalence of home birth. Although birth location and antenatal care are associated with child mortality, direct association between childhood mortality and adolescent mother behavior was not investigated in this study. Future directions could investigate the direct relationship by utilizing facility records and respondent location. Also, behaviors should be analyzed for other maternal age groups. This would help provide insight as to whether initiatives are strategically targeting adolescent age groups or targeting all age groups equally.