Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

[Samantha Julius] Date

Patterns in the Effect of Iron Supplementation, Deworming Medication, and Antimalarial Drug Intake on Anemia in Women of Reproductive Age in Sub-Saharan Africa: Review of Demographic and Health Survey Data

By

Samantha D. Julius
MPH

Hubert Department of Global Health

_____

Parminder Suchdev, MD, MPH, FAAP
Committee Chair

_____

Anne Williams, PhD, MPH
Committee Member

Patterns in the Effect of Iron Supplementation, Deworming Medication, and Antimalarial Drug Intake on Anemia in Women of Reproductive Age in Sub-Saharan Africa: Review of Demographic and Health Survey Data

By

Samantha D. Julius

Bachelor of Business Administration, BBA
University of Miami
2016

Thesis Committee Chairs:
Parminder Suchdev, MD, MPH, FAAP
Anne Williams, PhD, MPH

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master Public Health
in the Hubert Department of Global Health 2018

Abstract

Patterns in the Effect of Iron Supplementation, Deworming Medication, and Antimalarial Drug Intake on Anemia in Women of Reproductive Age in Sub-Saharan Africa: Review of Demographic and Health Survey Data

Objective: Approximately 528.7 million women of reproductive age (WRA) are considered to be anemic globally; 38% of pregnant women are anemic, and 29% of WRA are anemic (1). There are a variety of factors attributed to causing anemia such as iron deficiency, helminths, vitamin B12 deficiency, malaria, vitamin a. The purpose of this paper was to examine patterns in anemia and iron tablet/syrup supplementation, deworming medication, and antimalarial drug intake over time in (WRA) in Sub-Saharan Africa. This report examined existing nutrition policies in Sub-Saharan Africa and how Demographic and Health Surveys (DHS) could enhance the data it already provides in order to inform programs on how to enhance/implement nutrition protocol in terms of iron supplementation, deworming medication, and antimalarial drugs availability to WRA.

Methods: We considered all 48 Sub-Saharan African Countries for this analysis. The inclusion criteria to be included in this report were: 1) report must be for a country located within Sub-Saharan Africa, 2) DHS report must be available in English, 3) DHS report must have been published no earlier than 2003, 4) anemia prevalence in WRA must be present in at least two reports for each country in order to analyze trends, and 5) percentage of women who reported they consumed iron tablets/syrup during their last pregnancy must have been available in all chosen DHS reports. The DHS indicates that WRA are between the ages of 15-49. The countries included were: Rwanda, Ethiopia, Lesotho, Ghana, Malawi, Sierra Leone, Tanzania, and Zimbabwe. Trends were assessed over time by looking at absolute percent differences, but a statistical analysis was not conducted. These patterns were analyzed based on DHS data that had been published as early as 2003.

Results: There were 21 total surveys examined in this report. Overall, 6 of the 8 countries indicated an overall decrease in anemia prevalence from the first report to the last report of 1.72 percentage points. However, iron tablet/syrup intake among pregnant WRA increased in all eight countries of 10.03 percentage points. Only three of the 8 countries indicated patterns suggestive of decrease in anemia in WRA and both deworming medication and antimalarial drugs over time. Additionally, 2 of the 8 countries indicated patterns suggestive of decrease in anemia in WRA and deworming medication.

Conclusion: The decrease in anemia prevalence among WRA is not fully explained by the data that the DHS provides on iron supplementation, deworming medication, and antimalarial drugs. The DHS needs to improve the data that is provided to make more accurate associations on factors attributed to anemia. This would allow for stronger data provided to countries that could aid in enhancing their nutrition policies.

Patterns in the Effect of Iron Supplementation, Deworming Medication, and Antimalarial Drug Intake on Anemia in Women of Reproductive Age in Sub-Saharan Africa: Review of Demographic and Health Survey Data

By

Samantha D. Julius

Bachelor of Business Administration, BBA
University of Miami
2016

Thesis Committee Chairs:
Parminder Suchdev, MD, MPH, FAAP
Anne Williams, PhD, MPH

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master Public Health
in the Hubert Department of Global Health
2018

Acknowledgements

Parminder Suchdev, Emory University

Anne Williams, Emory University

Abbreviations

Demographic and Health Surveys (DHS)
Women of Reproductive Age (WRA)
World Health Organization (WHO)

Table of Contents

Chapter 1: Introduction

1.1-Global Burden of Anemia and Current Targets

Anemia is a major public health issue that affects people all over the world. The World Health Organization (WHO) defines anemia as "a condition in which the number of red blood cells or their oxygen-carrying capacity is insufficient to meet physiologic needs, which vary by age, sex, altitude, smoking, and pregnancy status" (1). Anemia affects pregnant women and non-pregnant women differently in terms of severity. Anemia contributes to poor health among both pregnant and non-pregnant women of reproductive age (3). The effect that anemia has on a mother during pregnancy affects both the mother and the neonate, ranging from varying degrees of morbidity to mortality. Severe anemia during pregnancy has been associated with major maternal and fetal complications, including increased risk of preterm delivery, low birth weight, intrauterine fetal death, neonatal death, maternal mortality, and infant mortality (4). In a 2015 study conducted by the WHO, approximately 528.7 million women of reproductive age (WRA) were considered to be anemic globally. The study further broke this statistic down into 32.4 million pregnant women who were considered anemic and 496.3 million non-pregnant WRA who were considered anemic (1). Furthermore, 38% of pregnant women globally are considered to be anemic and 29% of WRA globally are considered to be anemic (1). The WHO states that the World Health Assembly's target of a 50% reduction of anemia in WRA is to be reached by 2025 (37). The World Health Organization explains that it is imperative that countries review national policies, infrastructure and resources in order to act to implement strategies for the prevention and control of anemia (37). The public health strategies to prevent and control anemia in order to reach this target goal include: improvements in dietary diversity, food fortification with iron and folic acid, distribution of iron-containing supplements and the control of infections

such as malaria (37). There are a variety of both nutritional and non-nutritional causes attributed to anemia.

1.2-Nutritional and Non-Nutritional Causes of Anemia

Anemia is associated with several risk factors that can be isolated; however, they often coexist. Iron deficiency is associated with anemia around the world (2). Iron deficiency anemia (IDA) and anemia are often used interchangeably, and "the prevalence of anemia has often been used as a proxy for Iron Deficiency Anemia (IDA)" (1). Generally, it is assumed that 50% of anemia cases are associated with iron deficiency, but this proportion varies depending on the geographic region and existing health infrastructure (1). The Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) Project suggests that the underlying burden of infections may be driving the proportion of anemia due to iron deficiency (2). The BRINDA project analyzed nationally representative data from 10 surveys (n=27,018) in order to determine associations between anemia and proximal risk factors (vitamin A and iron deficiencies, inflammation, malaria, etc.), as well as distal risk factors such as education status and household sanitation (2). The article goes on to explain that the rationale for this approach was that "the causes of anemia will vary depending on environmental and socioeconomic characteristics and the intensity of exposure to infections and to inflammation-inducing conditions" (2). Blood hemoglobin concentration is often thought of as a reliable indicator of anemia when looking at the population level, but measurements of this biomarker alone do not determine the origin of anemia.

The World Health Organization explains that approximately 50% of anemia cases are attributed to iron deficiency; however, "the proportion probably varies among population groups and in different areas, according to local conditions" (1). The World Health Organization goes

onto explain the various other risk factors associated with anemia. Other causes of anemia include various micronutrient deficiencies such as: folate, riboflavin, vitamins A and B_{12} (1). Various acute and chronic conditions are associated with anemia such as malaria, cancer, tuberculosis and HIV. The BRINDA Project also discusses various "distal" risk factors such as education status, household sanitation and hygiene and urban or rural residence as being associated with anemia (2).

Another risk factor associated with anemia during pregnancy is malaria. Malaria is one of the primary risk factors of anemia during pregnancy and antimalarial drugs that women take during pregnancy can aid in the reduction of the disease. Pregnant women are fairly susceptible to acquiring malaria (5). The global malaria burden has declined over the years, but over 40% of the world's population still remains at risk (5). One article reviewed the evidence on the risks of malaria and anemia in Sub-Saharan Africa and the burden of malaria-related anemia among pregnant women (6). The study suggested that approximately 400,000 pregnant women developed anemia as a result of the malaria infection (6). The study also found that areas with lower malaria prevalence had higher hemoglobin levels in comparison with areas that had stable malaria transmission (6). When anti-malarial drugs are taken consistently, the risk of infection is reduced and as a result the likelihood of acquiring anemia is reduced (5).

Helminths are another risk associated with anemia. Blackwell explains that helminths are parasitic nematodes and trematodes that are grouped together due to morphological similarities and commonalities in the effects, such as an anemia, they have on the host (7). Helminths (worms) are another contributing factor to anemia (7). There is a loss of blood in the intestines/urinary tract when an individual contracts an infection due to geohelminths or schistosomes. As a result, anemia is now one of the most common side effects associated with

geohelminths and schistosomes (7). Hookworm is associated with reductions in hemoglobin levels during a woman's pregnancy, which in turn increases the chance of acquiring anemia. Helminth infections are often found in the presence of other infections such as malaria and other nutritional deficiencies (7). Deworming medication is effective in reducing the helminth prevalence in women, therefore, reducing one of the potential risk factors of anemia among women of reproductive age. Regardless of cause, anemia is classified using consistent cut-offs.

1.3-Anemia Determination

The World Health Organization states that "anemia is a condition in which the number and size of red blood cells, or the hemoglobin concentration, falls below an established cut-off value (37). The World Health Organization defined anemia as having a blood hemoglobin concentration as <110 g/L for pregnant women and <120 g/L for non-pregnant women of reproductive age (1). These cut-offs are established because as hemoglobin declines, the capacity of the blood to transport oxygen around the body is consequently impaired (37).

1.4-National Nutrition Policies

The World Health Organization explains that the given importance of anemia pathology globally forces countries all over the world to implement interventions aimed at reducing anemia. Often times, interventions target the groups that are most susceptible to the negative effects, which are pregnant women and young children (1). Another factor that is discussed in this report is what information national nutrition policies contain regarding nutrition recommendations to reduce anemia prevalence in WRA and how they can be improved, as well as be more accurately reflected in the DHS. Gaps in nutrition policies need to be addressed if the compliance of specific drugs and medications are to be successfully improved.

1.5-Objective

This paper will describe patterns in Sub-Saharan Africa based on DHS data between anemia prevalence in WRA (ages 15-49) and three risk factors that are thought to be associated with anemia. The risk factors for anemia examined in this paper are: iron tablet/syrup among WRA during their last pregnancy, antimalarial drug intake among WRA during their last pregnancy, and deworming medication among WRA during their last pregnancy. If WRA in Sub-Saharan Africa consistently take iron supplements, anti-malarial drugs, and deworming medication, we hypothesized that there would be an observed decreased trend in anemia prevalence among women of reproductive age.

Chapter 2: Methods

2.1-Inclusion Criteria

We considered all 48 Sub-Saharan African Countries for this analysis. The inclusion criteria to be included in this report were: 1) report must be for a country located within Sub-Saharan Africa, 2) DHS report must be available in English, 3) DHS report must have been published no earlier than 2003, 4) anemia prevalence in women of reproductive age (WRA) must be present in at least two reports for each country in order to analyze trends, and 5) percentage of women who reported they consumed iron tablets/syrup during their last pregnancy must have been available in all chosen demographic and health survey (DHS) reports. There were not any countries that were excluded because the data on iron tablet/syrup intake was not available. The countries that had reports consisting of data after 2003 on anemia prevalence in WRA all contained data on the percentage of women who reported they consumed iron tablets/syrup. Nigeria, Kenya, and Zambia were excluded from the report because the DHS reports did not contain data on anemia prevalence in WRA, but all three reports did contain data on iron tablet/syrup intake. Antimalarial drug medication intake and deworming medication intake during last pregnancy were not part of the inclusion criterion, but when available, that data was extracted to aid in the analysis. Eight countries were analyzed: Rwanda, Ethiopia, Lesotho, Zimbabwe, Malawi, Tanzania, Ghana, Sierra Leone (Figure 1). There were only four countries that had the ability to look at patterns between anemia and iron intake, deworming medication, and antimalarial drugs over time (Figure 1). These four countries were: Zimbabwe, Malawi, Ghana and Sierra Leone. Refer to Figure 2 to view the location of the countries examined.
Refer to Figure 2 to view the location of the countries examined.

2.2-Data Extraction

The data for this report were extracted from publicly available Demographic and Health Surveys (DHS). Anemia data among all WRA were extracted from the DHS reports in Sub-Saharan African Countries, as well as iron tablet/syrup intake, deworming medication and antimalarial drug intake among pregnant women. Sub-Saharan was chosen to be examined in this paper as anemia is a common issue among WRA that contributes to health problems. The purpose for these risk factors being analyzed in association with anemia is due to research suggesting an association between the factors above and anemia and these are indicators that the DHS reports on among WRA. There are other risk factors for anemia that the DHS reports on such as HIV. The DHS data available for these countries does not provide data on HIV for WRA, which is why HIV was excluded as a risk factor for anemia in the analysis of this report

Overall, mild (Hemoglobin (Hb) 10.0-10.9 g/dl: pregnant women, Hb 10.0-11.9 g/dl: non-pregnant women), moderate (Hb 7.0-9.9 g/dl), and severe anemia (Hb < 7.0 g/dl) prevalence estimates for WRA were extracted from DHS reports. All estimates were rounded to one decimal place. The number of DHS reports varied by country (Table 1).

The sample size of non-pregnant WRA and the sample size of pregnant women was recorded. The ages of the women sampled were 15-49, based on DHS definitions for WRA. Hemoglobin was the biomarker used to assess anemia among WRA. The blood was taken from a finger prick and collected in a microcuvette. The raw measured values of hemoglobin were obtained using the battery operated portable HemoCue instrument. For iron tablet/syrup intake, antimalarial drug intake, and deworming medication intake, the percentage of women who took them was extracted from the DHS reports. The DHS reports rounded the numbers to one decimal place.

Iron tablet/syrup intake during pregnancy among women with a child born in the past 5 years was available in all the reports that contained anemia prevalence data. The DHS provided data on iron tablet/syrup intake only for women who have had a child in the last five years, not all WRA. The DHS divided iron tablet/syrup intake among mothers who have had a child in the past 5 years into three categories: women who took tablets for less than 60 days during their last pregnancy, between 60 and 89 days during pregnancy, and greater than 90 days during pregnancy.

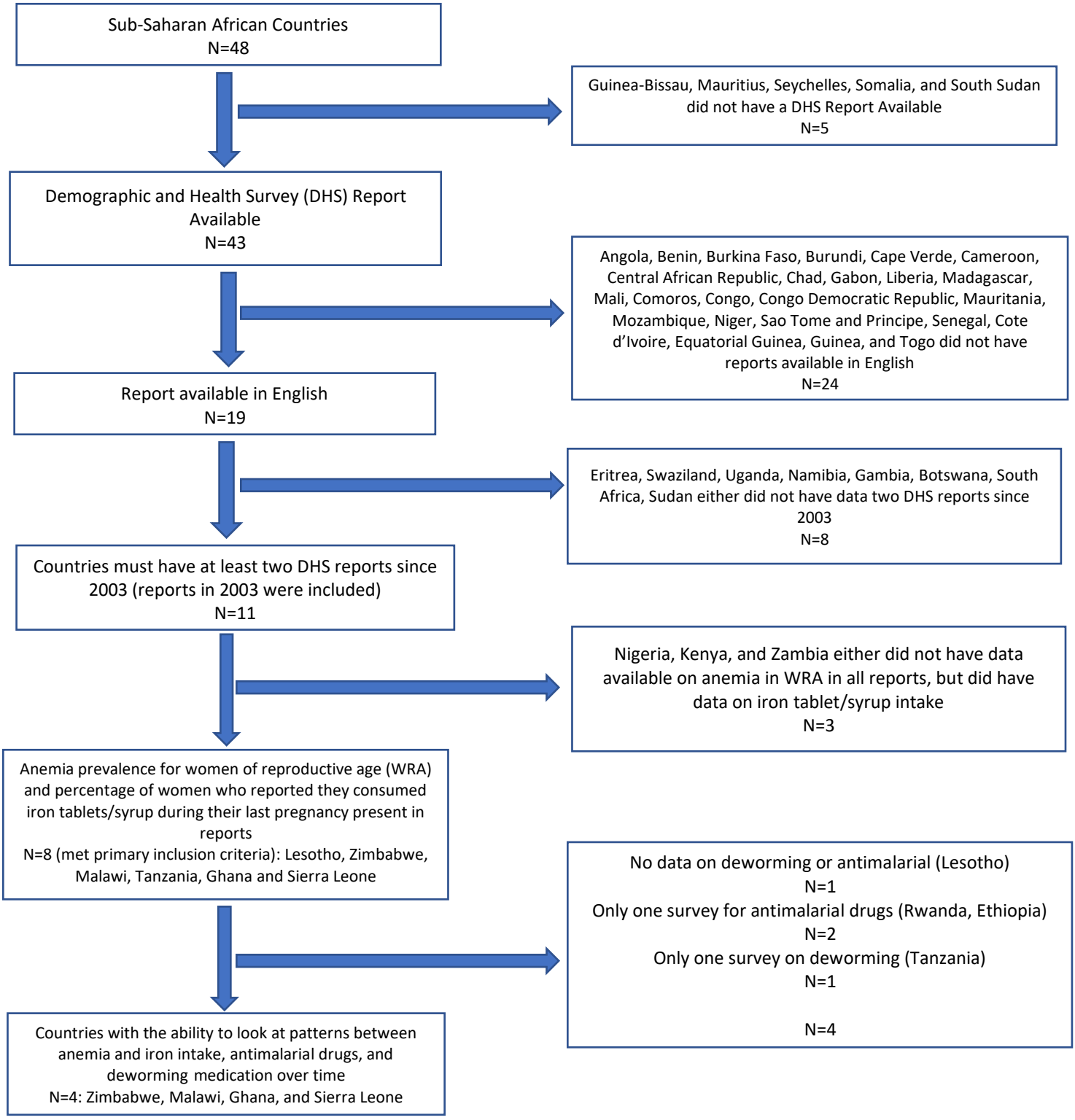
Not every country that had data on anemia prevalence also had data on antimalarial drugs use during last pregnancy. The percentage of women who took antimalarial drugs during their last pregnancy among women with a child born in the past two years was gathered by the DHS. Five country reports had data available on women who took antimalarial drugs during their last pregnancy. Ghana, Malawi, Tanzania, Zimbabwe, and Sierra Leone had DHS data available to analyze trends in antimalarial drug use (Figure 2). The DHS sampled women for antimalarial drugs if they had a child in the last two years.

Not every country that had data on anemia prevalence had data on women who took deworming medication. The percentage of women who took deworming medication during their last pregnancy among women with a child born in the past five years was gathered by the DHS. Five country reports had data available on women who took deworming medication during their last pregnancy. Ghana, Rwanda, Malawi, Zimbabwe, and Sierra Leone had DHS data available to analyze trends in deworming medication use (Figure 2). Similar to iron tablet/syrup intake and antimalarial drug intake, the DHS only surveyed women on the intake of deworming medication if they previously had a child in the last five years

2.3-Analysis

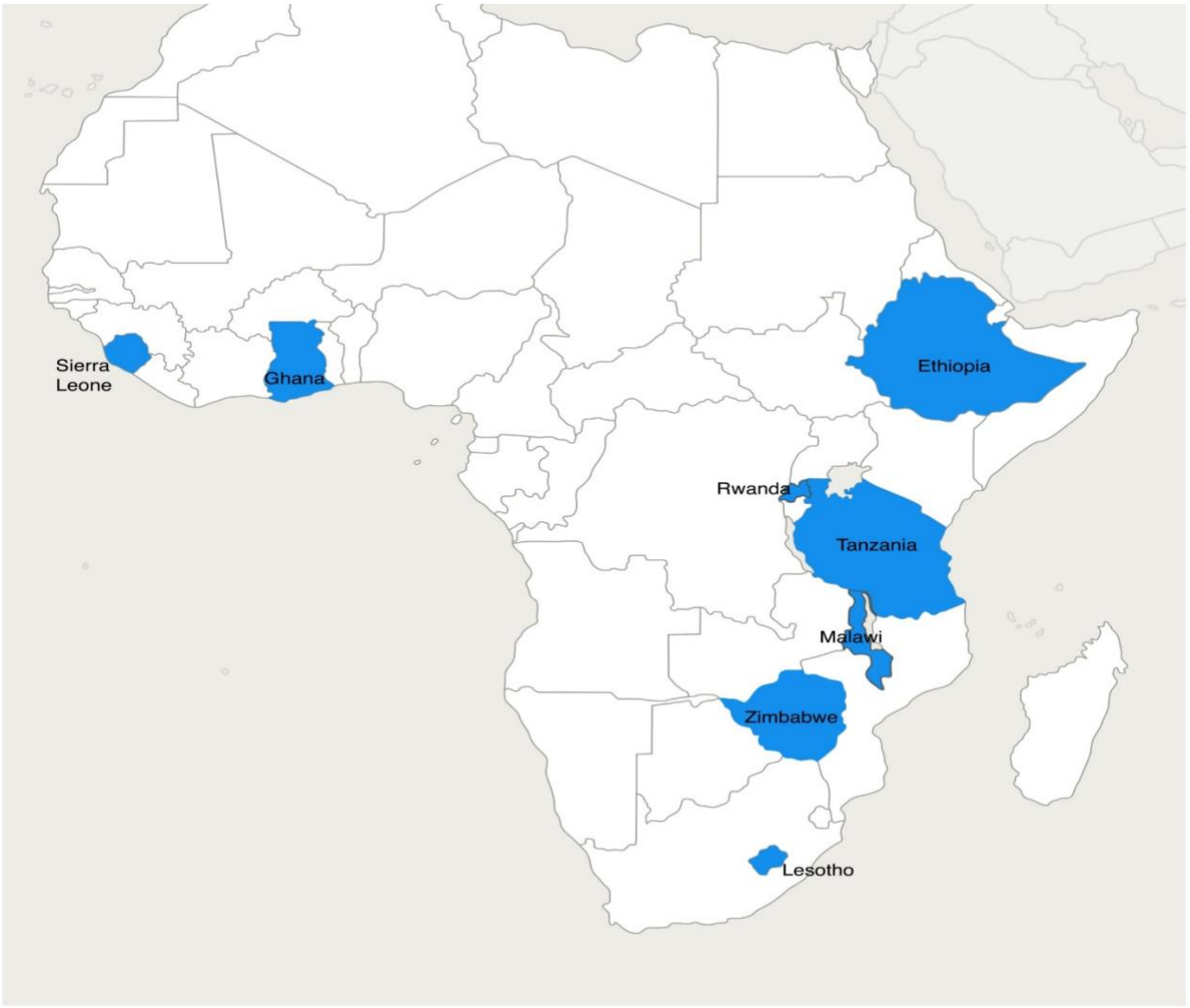
Trends among the countries will be assessed by comparing anemia prevalence over time. Five of the countries will have trends analyzed between three reports, and three of the countries will have trends analyzed between two reports. The prevalence of anemia will be examined among WRA for all countries. The prevalence of women who took iron tablets/syrup during their last pregnancy (among women who have had a child in the last five years), the prevalence of women who took antimalarial drugs during their last pregnancy (among women who have had a child in the last two years), and the prevalence of women who took deworming medication during their last pregnancy (among women who have had a child in the last five years) will all be examined and compared to anemia prevalence in order to figure out if these are factors associated with anemia.

Figure 1: Inclusion Criteria for Country Determination



This figure depicts the methods that were used to determine which Sub-Saharan African Countries were analyzed in this report.

Figure 2: Sub-Saharan African Countries Included in the Analysis



This figure shows the location of the Sub-Saharan African Countries that were analyzed for the association between anemia in WRA and iron tablet/syrup intake during pregnancy, antimalarial drug intake during pregnancy, and de-worming medication intake during pregnancy

Table 1: Number of Reports that Contained Anemia Data for Each Sub-Saharan Country Analyzed within the Past 15 Years

Country	Number of Reports Examined	Year 1	Year 2	Year 3
Rwanda	3	2007-2008	2010	2014-2015
Ethiopia	3	2005	2011	2016
Lesotho	2	2009	2014	N/A
Zimbabwe	3	2005-2006	2010-2011	2015
Malawi	3	2004	2010	2015-2016
Tanzania	2	2010	2015-2016	N/A
Ghana	3	2003	2008	2014
Sierra Leone	2	2008	2013	N/A

This table displays each country that was examined in this paper, as well as how many reports were examined for anemia in WRA for each country. Lesotho, Tanzania, and Sierra Leone only contained two DHS reports in the past 15 years where prevalence of anemia in WRA was reported on, while Rwanda, Ethiopia, Zimbabwe, Malawi, and Ghana contained three DHS reports in the past 15 years where prevalence of anemia in WRA was reported on.

Chapter 3-Results

3.1-Anemia prevalence

Overall, 6 of the 8 countries showed overall decreasing anemia prevalence from the first report to the last report (Figure 3). There were 21 total surveys examined in this report. Overall, 6 of the 8 countries indicated an overall decrease in anemia prevalence from the first report to the last report of 1.72 average percentage points. Iron tablet/syrup intake among pregnant WRA increased in all eight countries from the first report to the last report of 10.03 average percentage points. Antimalarial drug intake among pregnant WRA increased from the first report to the last report an average of 4.31 average percentage points. Deworming medication intake among pregnant WRA increased from the first report to the last report an average of 4.7 average percentage points. Mild, moderate, and severe anemia often differed within each country in terms of magnitude of increase/decrease in comparison to overall anemia (Figure 3). The magnitude of the percent point difference did not vary, and some countries showed an increase from the 2nd to the 3rd report even if there was an overall decrease from the first report to the last report (Figure 3). Rwanda indicated a 7.9 decreased percentage point difference from the first report to the final report. Zimbabwe indicated only a 1.4 decrease percentage point difference from the first report to the final report. Ethiopia indicated only a 3 decreased percentage point difference from the first report to the final report. Malawi's overall anemia prevalence decreased percent point difference in WRA from the first report to the last report was very small at .1%. Ghana indicated only a 2.3 decrease percentage point difference from the first report to the final report. Lesotho and Tanzania both indicated an increase in overall anemia prevalence among WRA. Sierra Leone indicated a decreased percent point difference in overall anemia prevalence; however, the decrease was almost non-existent at only .4%. Anemia prevalence trends from year to year

among WRA varied between each country (Figure 3). Iron tablet/syrup intake was one of the factors said to affect the anemia trends.

3.2-Iron supplementation coverage

Figure 4 illustrates the changes in iron tablet/syrup intake among women who have had a child in the past five years for each country. All countries indicated an increase in iron tablet/syrup consumption during pregnancy among women who have had a child in the past 5 years from the first report to the last report (Figure 4). Overall, women reported that they took iron supplements for less than 60 days during their pregnancy the most frequently. Malawi, Ghana, and Sierra Leone had a higher prevalence of women taking iron supplements for greater than 90 days. Antimalarial drugs were another factor that was looked at when assessing factors contributing to anemia in these eight countries.

3.3-Antimalarial Drug coverage

Figure 5 displays the percent increase/decrease in antimalarial drugs among women during their last pregnancy. The number of DHS reports that contained data on women who took antimalarial drugs was relatively inconsistent in comparison with reports that contained iron tablet/syrup consumption. Among the 21 total DHS reports that were examined, 14 consisted of available data on women who took antimalarial drugs during their last pregnancy. Malawi, Tanzania, Ghana, and Sierra Leone displayed data on women who took antimalarial drugs during their last pregnancy in all of the reports that were examined. Rwanda displayed data on women who took antimalarial drugs during their last pregnancy in one of the three reports that were examined, Ethiopia displayed data on women who took antimalarial drugs during their last pregnancy in one of the three reports that were examined, and Zimbabwe displayed data on women who took antimalarial drugs during their last pregnancy in two of the three reports that

were examined. Lesotho did not have any reports (among the ones that were analyzed) containing data on women who took antimalarial drugs during their pregnancy.

3.4-Deworming Medication coverage

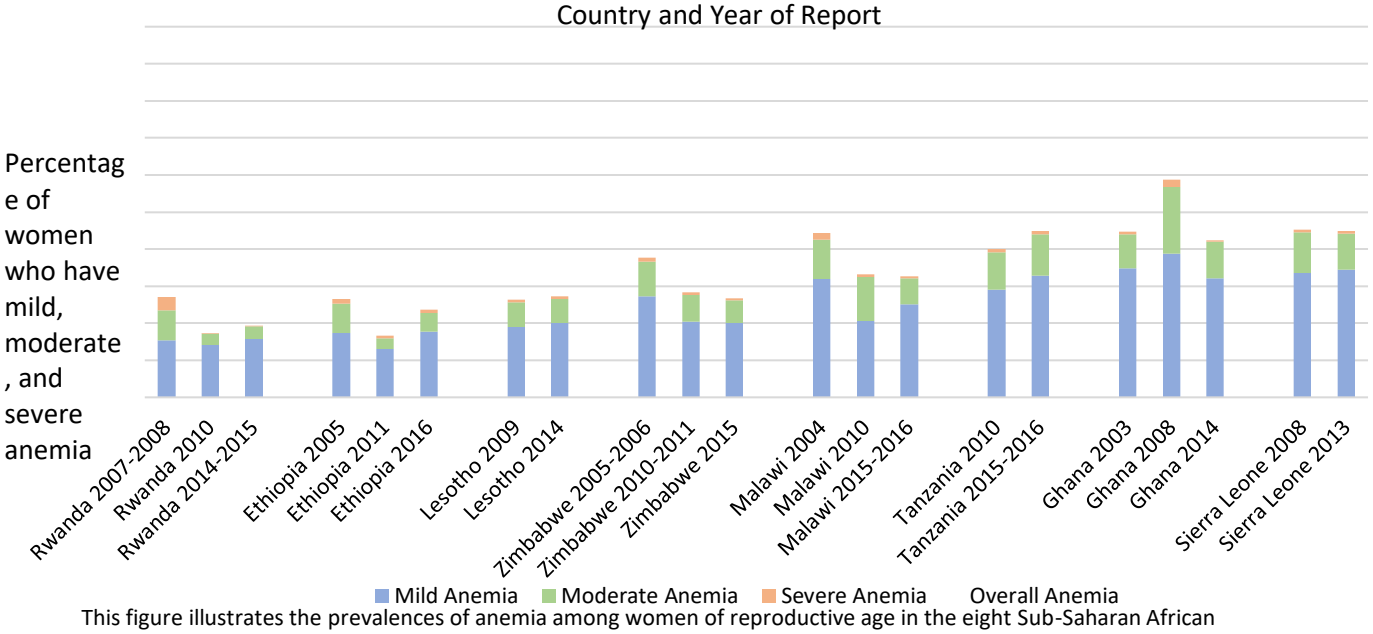
Figure 6 displays the percent increase/decrease in deworming medication among women during their last pregnancy. The number of DHS reports that contained data on women who took deworming medication was also relatively inconsistent in comparison with reports that contained iron tablet/syrup consumption. Among the 21 total DHS reports that were examined, 14 consisted of available data on women who took deworming drugs during their last pregnancy. This was the same number of reports that contained data in the DHS reports on women who took anti-malarial drugs during their last pregnancy. Rwanda and Sierra Leone displayed data on women who took deworming drugs during their last pregnancy in all of the reports that were examined. Ethiopia displayed data on women who took deworming medication during their last pregnancy in two of the three reports that were examined, Zimbabwe displayed data on women who took deworming medication during their last pregnancy in two of the three reports that were examined, Malawi displayed data on women who took deworming medication during their last pregnancy in two of the three reports that were examined, Tanzania displayed data on women who took deworming medication during their last pregnancy in one of the two reports that were examined, and Ghana displayed data on women who took deworming medication during their last pregnancy in one of the two reports that were examined. Lesotho did not contain any data on women who took deworming medication in either of their reports.

3.5-Overall Patterns Observed

Overall, the results were not completely aligned with the hypothesis that there would be an association between anemia in WRA and women who took iron tablets/syrup during their last

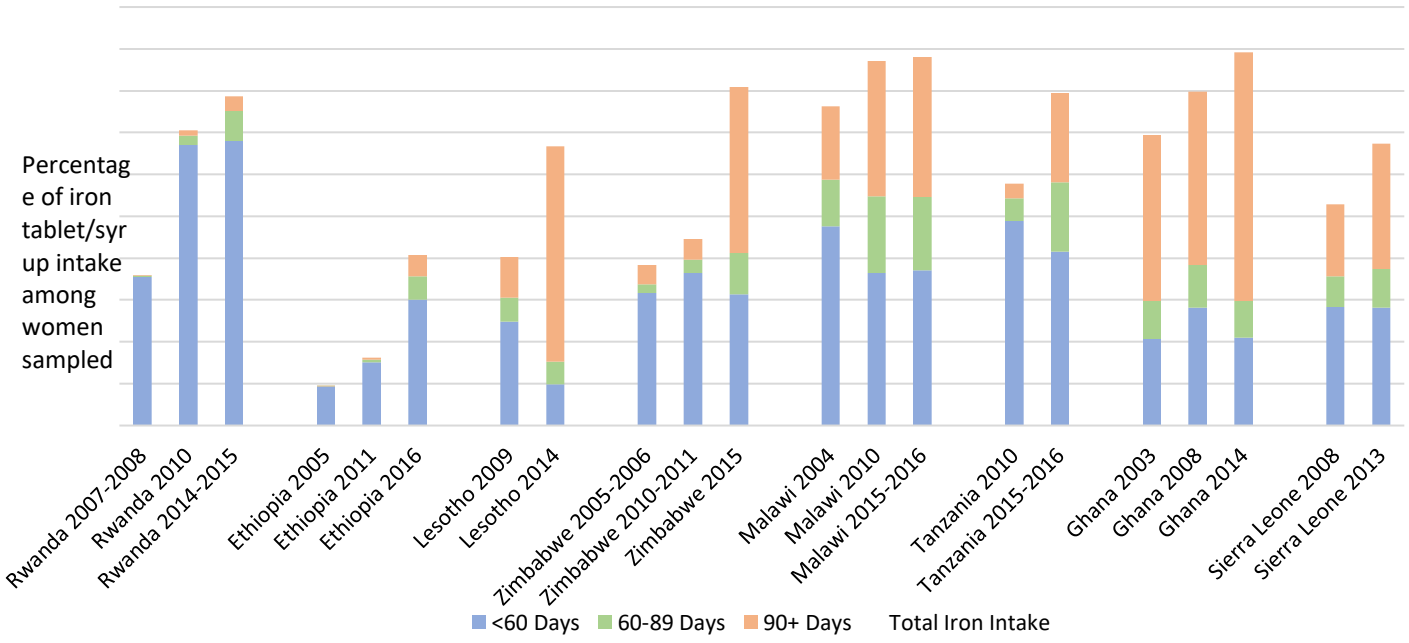
pregnancy, women who took deworming medication during their last pregnancy, and women who took antimalarial drugs during their last pregnancy. While anemia appears to be decreasing overall in the countries examined and the intake of iron supplementation, antimalarial drugs, and deworming medication is increasing, there was not a strong pattern observed between interventions and anemia prevalence by country. Six of the eight countries that were analyzed showed a decline in anemia in at least one report. Every country that was analyzed for anemia prevalence among WRA also had DHS data available on women who took iron tablets/syrup during their last pregnancy. Figure 7 examines which countries showed an association between anemia prevalence among WRA and the intake of iron tablets/syrup among women during their last pregnancy. Figure 8 examines which countries showed an association between anemia prevalence among WRA and the intake of antimalarial drugs/deworming medication among women during their last pregnancy.

Figure 3: Anemia Prevalence in Pregnant and Non-Pregnant Women of Reproductive Age by Country and Year of Report



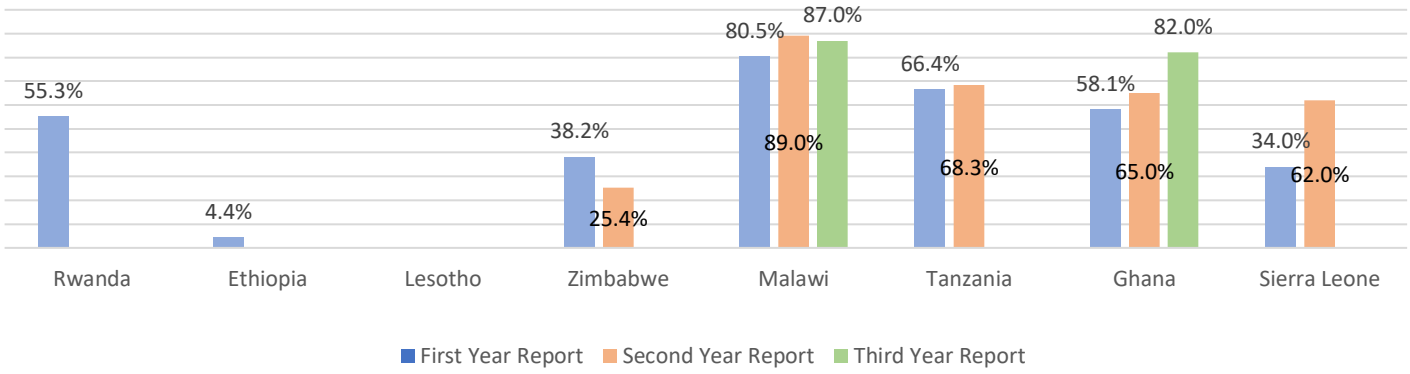
This figure illustrates the prevalences of anemia among women of reproductive age in the eight Sub-Saharan African Countries that were analyzed. These percentages account for both pregnant and non-pregnant WRA. Mild anemia was determined using hemoglobin levels and the cutoffs that the DHS used were: 10-11.9 g/dL. Moderate anemia was determined using hemoglobin levels and the cutoffs that the DHS used were: 7-9.9 g/dL. Severe anemia was determined using hemoglobin levels and the cutoffs that the DHS used were: less than 7 g/dL. The overall anemia percentages for each country and year of report are displayed above the columns in the light blue boxes. These numbers were obtained by summing mild, moderate, and severe anemia.

Figure 4: Prevalence of Iron Tablet/Syrup Intake



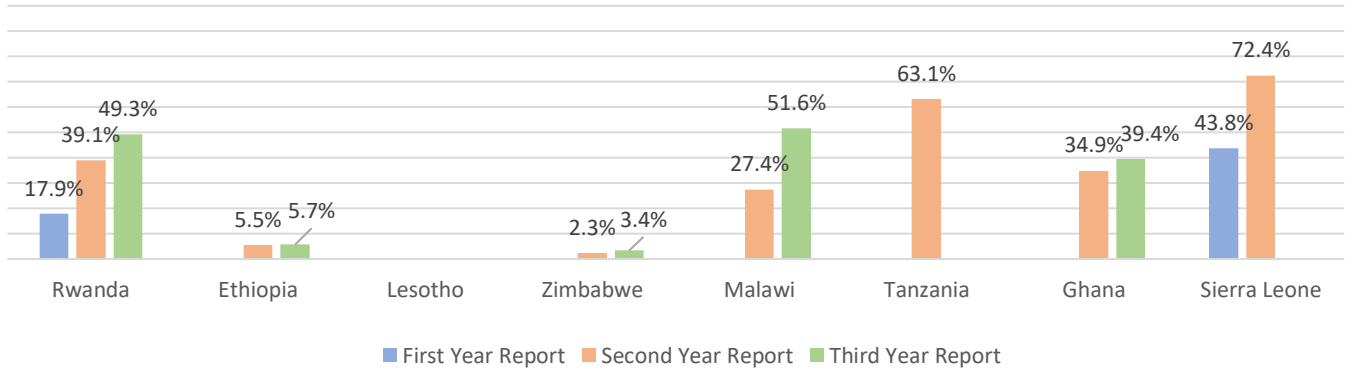
This figure illustrates the percentage of women who took iron tablets/syrup for <60 days, 60-89 days, and 90+ days during their last pregnancy. The women sampled here were women who have had a child in the past five years. The overall iron percentages for each country and year of report are displayed above the columns in the light blue boses. These numbers were obtained by summing together all three iron categories.

Figure 5: Prevalence of Women Who Took Antimalarial Drugs During their Last Pregnancy



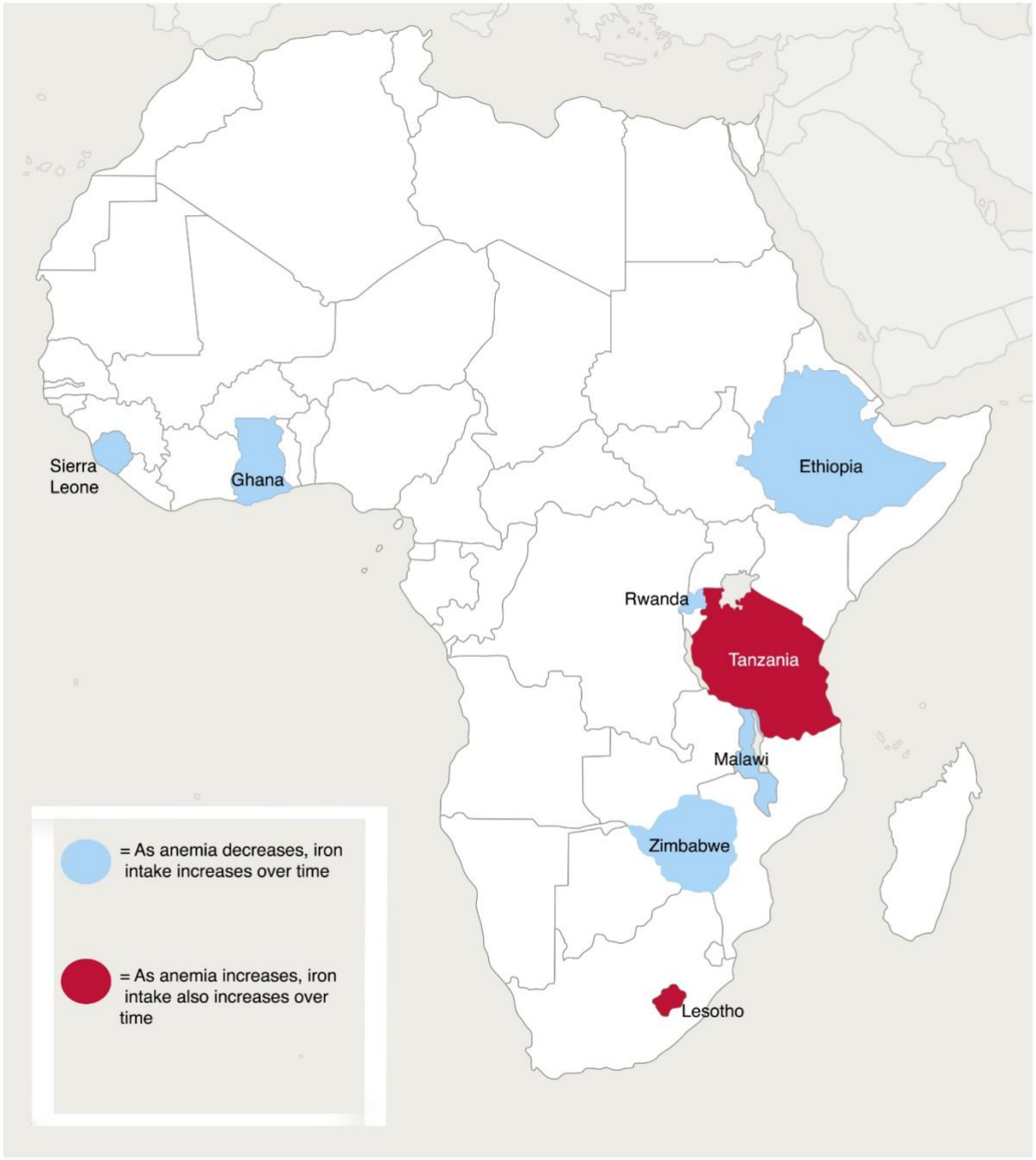
This figure illutrates the percentage of women who reported taking antimalarial drugs during their last pregnancy. The countries with no bars did not contain data on antimalarial drugs published by the DHS. The countries with no data were: Rwanda (2010), Rwanda (2014-2015), Ethiopia (2011), Ethiopia (2016), Lesotho (2009), Lesotho (2014), and Zimbabwe (2015)

Figure 6: Prevalence of Women Who Took Deworming Medication During their Last Pregnancy



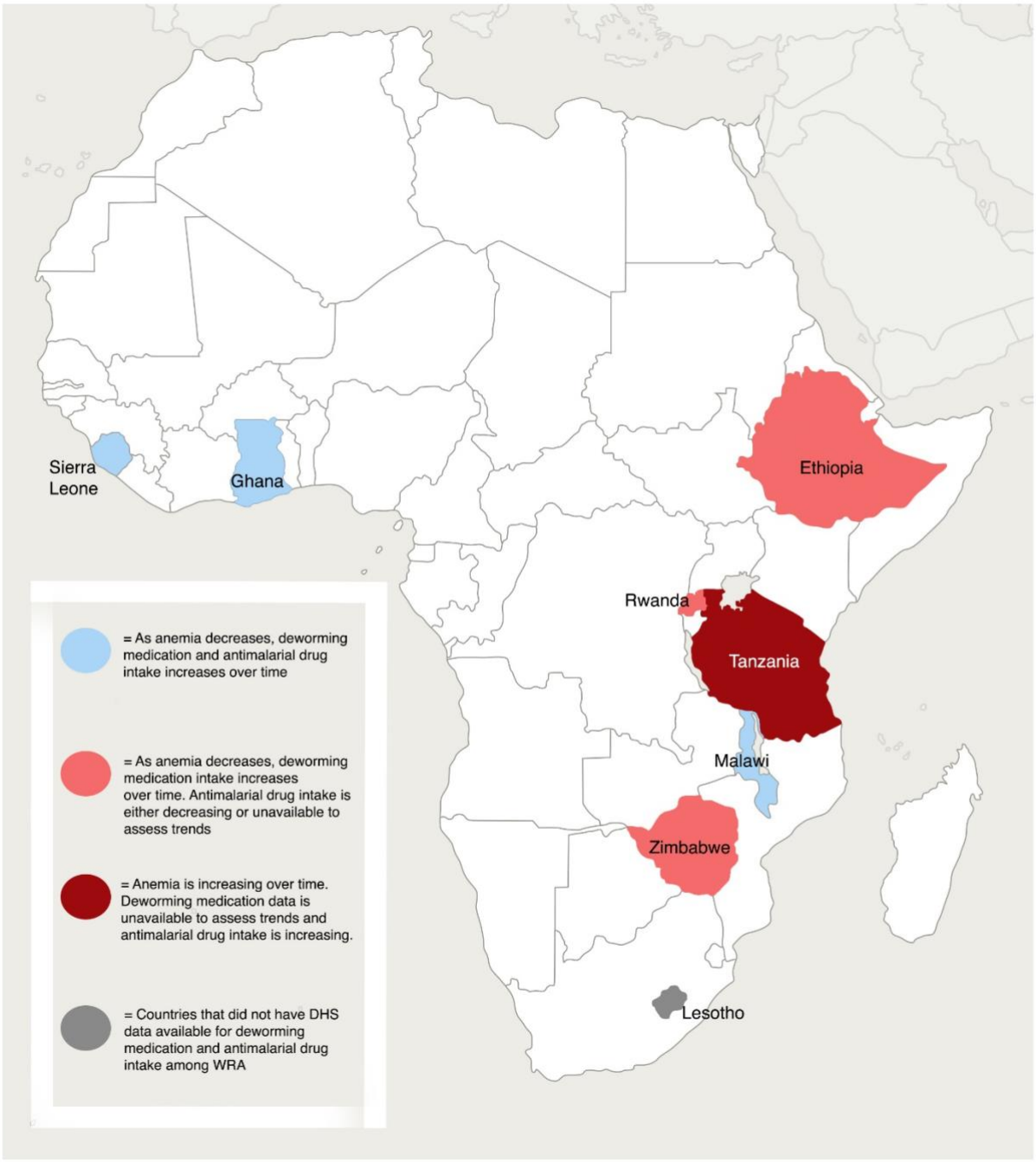
This figure illustrates the percentage of women who reported taking deworming medication during their last pregnancy. The countries with no bars did not contain data on deworming medication published by the DHS. The countries with no data were: Ethiopia (2005), Lesotho (2009), (Lesotho (2014), Zimbabwe (2005-2006), Malawi (2004), Tanzania (2010), and Ghana (2003).

Figure 7: Countries with Hypothesized Relationship Present (Decreasing Anemia with Increasing Iron Use)



This figure examines trends between anemia among WRA and iron tablet/syrup intake during the women's last pregnancy. The hypothesized relationship between anemia and iron is that as anemia decreases, iron intake should increase. Anemia prevalence data includes pregnant and non-pregnant WRA. Iron tablet/syrup prevalence data was available for women who have had a child in the last five years.

Figure 8: Countries with Hypothesized Relationship Present (Decreasing Anemia with Increasing Antimalarial Drug and Deworming Medication Use)



This figure examines trends between anemia among WRA and antimalarial drug and deworming medication intake during the women's last pregnancy. Not all countries that had data on anemia in WRA had data on women who took antimalarial drugs and deworming medication. An association is indicated by a decrease in anemia, while antimalarial drug/deworming medication intake increases. Anemia prevalence was available for all WRA (pregnant and non-pregnant). Antimalarial drug prevalence and deworming medication prevalence was available for women who have had a child in the last two years

Chapter 4-Discussion

4.1-Main Findings

The results did not completely align with the hypothesis that there is an association between anemia in WRA and iron tablet/syrup intake, anti-malarial drug intake, and deworming medication. Six of the eight countries supported the hypothesis that anemia prevalence would decline if iron intake increased. Only three of the eight countries indicated the hypothesized relationship between anemia and iron intake, deworming medication and antimalarial drug intake, meaning as anemia decreased, the intake of iron, deworming medication, and antimalarial drugs increased. Ghana, Sierra Leone, and Malawi supported the hypothesized relationship that as anemia decreased, there was an increase in iron, deworming medication, and antimalarial drug intake. Anemia decreased over time as deworming medication, antimalarial drugs, and iron intake increased. Zimbabwe, Ethiopia, and Rwanda indicated a decrease in anemia over time as iron intake increased. In Rwanda and Ethiopia, only one report with antimalarial drug data was available so it was not possible to assess trends over time. Zimbabwe had data on antimalarial drugs, but it is decreasing over time as anemia is also decreasing. In both Lesotho and Tanzania, anemia is increasing. Lesotho did not contain any data on antimalarial drugs and deworming medication in any of the DHS reports that contained data on anemia and iron intake. Tanzania only had data on deworming medication in one report and antimalarial drug intake increased a small amount.

In all countries, the percentage of women who reported taking iron tablet/syrup intake for 90+ days increased over time. Although there was an increase in reported iron intake, anemia prevalence did not steadily decrease. Some countries had a small increase in iron intake for 90+ days among WRA such as Rwanda and Ethiopia. The WHO recommends that pregnant women

should take 30 to 60 mg of elemental iron daily (1). Only Lesotho and Ghana indicated that over 50% of women took iron for more than 90 days. For both of these countries, only one report contained these high numbers, so this prevalence was not a consistent trend that was able to be assessed over time (Figure 4). Women consuming iron tablets for less than 60 days was consistently higher across all countries (Figure 4). All eight countries indicated iron consumption for less than 60 days above 9% among women across all years and reports. It makes sense that anemia is not consistently decreasing because women are taking supplements, but not for a prolonged period of time. Demands for iron are higher during pregnancy, which is why women should be consistently taking supplements over time in order to increase the chance that anemia is avoided/hemoglobin levels are decreased (8). A meta-analysis conducted by the WHO suggests that iron supplementation showed an increase in mean blood hemoglobin concentration by 10.2 g/L in pregnant women (10). Demands for iron are higher during pregnancy, especially in the first trimester when women do not know they are pregnant (9). Based on this information, one suggestion is for all WRA to take iron supplements (even if the dose is lower) in order to reduce the risk of women becoming anemic when they are not even aware they are pregnant. It is not feasible to claim that iron intake is directly related to an increase/decrease among women as there are a variety of factors that are associated with anemia such as Vitamin A deficiencies and malaria (2); however, there are sampling inconsistencies within the DHS data that makes it difficult to state that there is even a pattern between anemia and iron tablet/syrup intake. In Tanzania, the total sample of women that were tested for anemia was 13,064; however, the total sample of women who had a child and were surveyed on iron tablet/syrup intake was only 6,832 (52% of WRA tested for anemia).

Nutrition Policies in Sub-Saharan Africa

Nutrition policies affect health outcomes. Five of the eight country policies described programs for the distribution of iron to pregnant women. No country policies described how deworming medication or antimalarial drugs were distributed. When reviewing these policies, it is reasonable to state that how the countries implement nutritional strategies was associated with anemia prevalence among WRA. For example, the Malawi national nutrition policy states that iron and folic acid would be available to all pregnant women in antenatal clinics. There was a decline in anemia prevalence over time. In contrast, Lesotho's nutrition policy did not specify any recommendations regarding iron, antimalarial drugs, or deworming medication. Lesotho indicated an increase in anemia prevalence over time. Therefore, Lesotho could be advised to include policies on anemia prevention programs. Lesotho, Rwanda, and Tanzania's lack of strategies to intervene in women's antenatal visits and supply iron and folic acid supplementation may be associated with the prevalence of anemia. Lesotho and Tanzania both indicated an increase in anemia prevalence from the first report to the final report. Rwanda indicated an overall decrease in anemia prevalence from the first report to the final report; however, anemia did increase from the first to the second report (there were a total of three reports).

As previously mentioned, five of the eight countries that were included in this paper indicated that there were recommendations in place for pregnant women to take iron supplementation during their pregnancy. Ethiopia states that pregnant women should be receiving iron and folic acid or multiple micronutrient supplementation during their pregnancy (30). Zimbabwe published a national nutrition policy plan for 2014-2018, which described maternal iron and folate supplementation for pregnant women (32). Malawi's National Nutrition Policy from 2007 described the distribution of iron and folate supplementation to pregnant

women. In the National Nutrition Plan for Malawi that focuses on goals for 2018-2022, anemia is targeted to be reduced in all women of reproductive age, not just pregnant women (33). In Ghana's National Nutrition Policy for 2013-2017, it is stated that iron and folate supplementation is to be provided to all women of childbearing age (34). Finally, Sierra Leone published a National Nutrition Policy for 2013-2017 in which they discuss the mandate of iron and folate supplementation to pregnant women (35).

The data that the DHS collects is somewhat inconsistent with what the Nutrition Policies are recommending. For example, as previously mentioned, Zimbabwe published a national nutrition policy plan for 2014-2018, which described maternal iron and folate supplementation for pregnant women. However, the DHS does not collect data on folate supplementation, only iron tablet/syrup intake (16). Malawi, Ethiopia, Ghana, and Sierra Leone also provide recommendations in their Nutrition Policies regarding both iron and folate supplementation to pregnant women; however, the DHS only collects data on iron tablet and syrup intake. The DHS data collection should align with what the Nutrition Policies are recommending to pregnant women. The greater amount of information provided by the DHS increases the analysis that will be able to be conducted when looking at factors that are found to be related to anemia. This information will allow countries to improve their nutrition policies.

Limitations and Strengths

There were several limitations within the DHS reports that made it difficult to make positive associations between anemia prevalence among WRA and iron tablet/syrup intake, antimalarial drug intake, and deworming medication intake. The first limitation within the DHS reports was that the prevalence of anemia is indicative of all WRA, but the prevalence of women who consumed iron tablets/syrup was only available for women who have had a child within the

last five years. The prevalence of women who consumed deworming medication was also only available for women who have had a child within the last five years, and the prevalence of women who consumed antimalarial drugs was only available for women who have had a child within the last two years. It is difficult to make strong associations between anemia and various factors affecting anemia when the denominators are not the same (anemia prevalence data is available for all WRA and supplement intake only available for pregnant women). The fact that the DHS only collects data on supplement intake among pregnant women makes sense as the nutrition policies are only mandating that iron is to be distributed to pregnant women; however, it does result in a weaker analysis of factors associated with interventions targeted towards pregnant women and anemia among pregnant women specifically. The sample of women who took supplements/medication and the sample of women who were anemic are not the same, so it is difficult to state there is an association between the factors. Another limitation within the DHS reports was that data on deworming medication and antimalarial drugs was not available in all reports, which makes the analysis between deworming medication/antimalarial drugs and anemia inconsistent.

Another limitation in conducting this report was that there are many other factors that are not collected within DHS that contribute to anemia. The DHS did not have data on hemoglobinopathies, vitamin B12, and HIV (among WRA). This data availability would increase the ability for researchers to conduct a thorough analysis of anemia contributors when looking at DHS data. The more data available within the DHS provides the opportunity for a larger scale data analysis to occur. This would increase the amount of recommendations health workers could give to countries.

Another improvement that the DHS needs to consider making is indicating malaria prevalence for WRA. Rwanda reported on malaria prevalence for WRA; however, the rest of the Sub-Saharan African countries analyzed only had data available for malaria in children. As mentioned in the background of this paper, malaria is associated with anemia among WRA so it should be included in the DHS in order to examine factors associated with anemia and make proper recommendations for these countries. HIV has also been associated with anemia as stated in the background of this paper. The DHS does provide numbers on HIV; however, they are not stratified for WRA specifically, so it would not be possible to make an association between HIV and anemia among WRA based on DHS data.

DHS data was available for deworming medication, antimalarial drugs, and iron supplements in all years of reports analyzed for Ghana, Sierra Leone, and Malawi so a thorough, accurate analysis was able to be conducted for those three countries

Implications

A primary implication of this analysis is that DHS data collection needs to improve in order to be able to conduct a more representative analysis of what is occurring between anemia and the various interventions discussed in this report. The reports examined in this paper all contained data on iron intake, but the data available for antimalarial drugs and deworming medication intake were inconsistent. When all data were available, it allowed for a thorough analysis of factors contributing to the decrease/increase in anemia. Data availability needs to be improved amongst all reports, so anyone could look at a report and do a similar analysis to the one in this paper.

Another primary implication of this analysis is that the National Nutrition Policies need to include more recommendations for women regarding further supplement intake such as

antimalarial drugs and deworming medication. The Nutrition Policies examined in this report only contained recommendations on iron and folate; however, there are other precautionary measures that countries can be taking to reduce anemia prevalence. The countries that stated in their policies that iron supplementation should be distributed to pregnant women did see a decline in anemia prevalence.

Conclusion & Future Recommendations

The three indicators that were examined in this paper that were investigated to be associated with anemia among WRA were iron tablet/syrup, antimalarial drugs, and deworming medication intake. These factors were not consistently associated with anemia; however, there were limitations in this report such as DHS data inconsistencies and lack of more factors associated with anemia within the DHS reports. These associations were made based on DHS data that had been published as early as 2003. Six of the eight countries did indicate the hypothesized relationship between anemia and iron intake; however, only three of the eight countries indicated the hypothesized relationship between anemia and all three interventions assessed in this paper (antimalarial drugs, deworming medication, and iron supplements). The DHS data was inconsistent in the reports for antimalarial drugs and deworming medication, which needs to be improved if more thorough analyses are to be conducted. The DHS needs to put in place policies that mandate all reports contain the same data. The countries that indicated a section on the distribution of iron to pregnant women showed a decrease in anemia; however, the countries that indicated an increase in anemia (Tanzania and Lesotho) did not state anything regarding iron supplementation to pregnant women. In order for anemia to decrease, given the assumption that iron is one of the primary factors attributed to anemia, all countries need to recommend iron supplementation to pregnant women. If given the resources, countries should

also recommend and distribute other forms of supplementation to pregnant women such as deworming medication, antimalarial drugs, Vitamin A, Vitamin B_{12}, etc. Equal access for pregnant women to healthcare and essential supplements appears to be key when attempting to reduce anemia prevalence.

Another recommendation for the DHS is to use country nutrition policies already in place to aid in data collection. The data collection should capture the population group targeted by the policies. This would aid in stronger associations between anemia in pregnant women specifically and how these interventions are affecting anemia prevalence. This data would provide possible recommendations for countries to implement that would reduce anemia prevalence.

The final recommendation would be for countries to emulate what Malawi is now doing, which is recommending iron to all WRA as women are at risk of anemia as both pregnant and non-pregnant women are susceptible to developing anemia. As recommendations and access to essential supplements within Sub-Saharan African Countries improve, there would be an increased chance that anemia prevalence would decline among WRA.

References

1. WHO. The global prevalence of anaemia in 2011. Geneva: World Health Organization; 2015.

2. Wirth, J. P., Woodruff, B. A., Engle-Stone, R., Namaste, S. M., Temple, V. J., Petry, N., … Aaron, G. J. (2017). Predictors of anemia in women of reproductive age: Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) project. *The American Journal of Clinical Nutrition*, *106*(Suppl 1), 416S–427S. http://doi.org/10.3945/ajcn.116.143073

3. Gebreamlak, B., Dadi, A. F., & Atnafu, A. (2017). High Adherence to Iron/Folic Acid Supplementation during Pregnancy Time among Antenatal and Postnatal Care Attendant Mothers in Governmental Health Centers in Akaki Kality Sub City, Addis Ababa, Ethiopia: Hierarchical Negative Binomial Poisson Regression. *PLoS ONE*, *12*(1), e0169415. http://doi.org/10.1371/journal.pone.0169415

4. Melku, M., Addis, Z., Alem, M., & Enawgaw, B. (2014). Prevalence and Predictors of Maternal Anemia during Pregnancy in Gondar, Northwest Ethiopia: An Institutional Based Cross-Sectional Study. *Anemia, 2014*, 108593. doi:10.1155/2014/108593

5. Rogerson SJ. Management of malaria in pregnancy. Indian J Med Res 2017;146:328-33

6. Guyatt, H., & Snow, R. (2001). The epidemiology and burden of Plasmodium falciparum-related anemia among pregnant women in sub-Saharan Africa. *The American Journal of Tropical Medicine and Hygiene*, *64*(1), 36-44
.
7. Blackwell, A. D. (2016). Helminth infection during pregnancy: insights from evolutionary ecology. *International Journal of Women's Health*, *8*, 651–661. http://doi.org/10.2147/IJWH.S103529

8,. Kavle, Justine A., and Megan Landry. "Community-based distribution of iron–folic acid supplementation in low-and middle-income countries: a review of evidence and programme implications." *Public health nutrition* 21, no. 2 (2018): 346-354.

9. . Brabin, Bernard J., Mohammad Hakimi, and David Pelletier. "An analysis of anemia and pregnancy-related maternal mortality." *The Journal of nutrition* 131, no. 2 (2001): 604S-615S.
10. World Health Organization. "The global prevalence of anaemia in 2011." (2015).

11. National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF International. 2015. Rwanda Demographic and Health Survey 2014-15. Rockville, Maryland, USA: NISR, MOH, and ICF International.

12. National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF International. 2012. Rwanda Demographic and Health Survey 2010. Calverton, Maryland, USA: NISR, MOH, and ICF International.

13. Ministry of Health (MOH) [Rwanda], National Institute of Statistics of Rwanda (NISR), and ICF Macro. 2009. Rwanda Interim Demographic and Health Survey 2007-08. Calverton, Maryland, U.S.A.: MOH, NISR, and ICF Macro.

14. Central Statistical Agency (CSA) [Ethiopia] and ICF. 2016. Ethiopia Demographic and Health Survey 2016. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.

15. Central Statistical Agency [Ethiopia] and ICF International. 2012. Ethiopia Demographic and Health Survey 2011. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistical Agency and ICF International.

13. Central Statistical Agency [Ethiopia] and ORC Macro. 2006. Ethiopia Demographic and Health Survey 2005. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistical Agency and ORC Macro.

14. Ministry of Health [Lesotho] and ICF International. 2016. Lesotho Demographic and Health Survey 2014. Maseru, Lesotho: Ministry of Health and ICF International.

15. Ministry of Health and Social Welfare (MOHSW) [Lesotho] and ICF Macro. 2010. Lesotho Demographic and Health Survey 2009. Maseru, Lesotho: MOHSW and ICF Macro.

16. Zimbabwe National Statistics Agency and ICF International. 2016. Zimbabwe Demographic and Health Survey 2015: Final Report. Rockville, Maryland, USA: Zimbabwe National Statistics Agency (ZIMSTAT) and ICF International.

17. Zimbabwe National Statistics Agency (ZIMSTAT) and ICF International. 2012. Zimbabwe Demographic and Health Survey 2010-11. Calverton, Maryland: ZIMSTAT and ICF International Inc

18. Central Statistical Office (CSO) [Zimbabwe] and Macro International Inc. 2007. Zimbabwe Demographic and Health Survey 2005-06. Calverton, Maryland: CSO and Macro International Inc.

19. National Statistical Office (NSO) [Malawi] and ICF. 2017. Malawi Demographic and Health Survey 2015-16. Zomba, Malawi, and Rockville, Maryland, USA. NSO and ICF

20. National Statistical Office (NSO) and ICF Macro. 2011. Malawi Demographic and Health Survey 2010. Zomba, Malawi, and Calverton, Maryland, USA: NSO and ICF Macro.

21. National Statistical Office (NSO) [Malawi], and ORC Macro. 2005. Malawi Demographic and Health Survey 2004. Calverton, Maryland: NSO and ORC Macro.

22. National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. Tanzania Demographic and Health Survey 2010. Dar es Salaam, Tanzania: NBS and ICF Macro.

23. . Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and ICF. 2016. Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) 2015-16. Dar es Salaam, Tanzania, and Rockville, Maryland, USA: MoHCDGEC, MoH, NBS, OCGS, and ICF.

24. Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF International. 2015. Ghana Demographic and Health Survey 2014. Rockville, Maryland, USA: GSS, GHS, and ICF International.

25. Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF Macro. 2009. Ghana Demographic and Health Survey 2008. Accra, Ghana: GSS, GHS, and ICF Macro.
26. Ghana Statistical Service (GSS), Noguchi Memorial Institute for Medical Research (NMIMR), and ORC Macro. 2004. Ghana Demographic and Health Survey 2003. Calverton, Maryland: GSS, NMIMR, and ORC Macro.

27. Statistics Sierra Leone (SSL) and ICF International. 2014. Sierra Leone Demographic and Health Survey 2013. Freetown, Sierra Leone and Rockville, Maryland, USA: SSL and ICF International.

28. Statistics Sierra Leone (SSL) and ICF Macro. 2009. Sierra Leone Demographic and Health Survey 2008. Calverton, Maryland, USA: Statistics Sierra Leone (SSL) and ICF Macro.

29. Republic of Rwanda National Food and Nutrition Policy. (2014). 1-46.

30. UNICEF. (June 2013-June 2015). Government of the Federal Democratic Republic of Ethiopia. 1-56.

31. Lesotho, G. o. (2013). Lesotho Health Sector Strategic Plan 2012/13-2016/17. 1-51.

32. Republic of Rwanda National Food and Nutrition Policy. (2014). 1-46.

33. Goverment of Malawi Department of Nutrition, H., and AIDS. (2018). National Multi-Sector Nutrition Strategic Plan 2018-2022. 1-103.

34. National Nutrition Policy fo Ghana 2013-2017. (2013). 1-39.

35. Leone, G. o. S. (2013). Government of Sierra Leone NATIONAL FOOD AND NUTRITION SECURITY. 1-117.

36. Centre, T. F. a. N. (2014). Strategic Plan 2014-2018. 41.

37. WHO. Global nutrition targets 2025: anaemia policy brief (WHO/NMH/NHD/14.4). Geneva: World Health Organization; 2014