RISK FACTORS OF ANEMIA AMONG WOMEN OF REPRODUCTIVE AGE IN RWANDA

A SECONDARY DATA ANALYSIS OF RWANDA DEMOGRAPHIC AND HEALTH SURVEY (RDHS) 2014/2015

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DECLARATION

I, DIEUDONNE HAKIZIMANA, HEREBY DECLARE THAT THE THESIS HAS BEEN WRITTEN BY ME WITHOUT ANY EXTERNAL UNAUTHORIZED HELP, THAT IT HAS BEEN NEITHER PRESENTED TO ANY INSTITUTION FOR EVALUATION NOR PREVIOUSLY PUBLISHED IN ITS ENTIRETY OR IN PARTS. ANY PARTS, WORDS OR IDEAS, OF THE THESIS, HOWEVER LIMITED, WHICH ARE QUOTED FROM OR BASED ON OTHER SOURCES, HAVE BEEN ACKNOWLEDGED AS SUCH WITHOUT EXCEPTION.

ABSTRACT

BACKGROUND

Anemia among Women of Reproductive Age (WRA) continues to be among the public health problems in Rwanda and has long-term consequences to health, social and economic development if not addressed. Its increases portray challenges in existing approaches to alleviate its burden; new approaches, based on scientifically identified risk factors to which interventions should be targeted are needed. However, those evidences are scarce. This study was conducted to assess the variations of anemia among WRA in Rwanda and identify its risk factors, in order to inform the policy makers, the appropriate interventions to address it in Rwanda.

METHODS

This is a quantitative, cross-sectional study using secondary data analysis of Rwanda Demographic and Health Survey (RHDHS) 2014-2015. The outcome for this study was anaemia status and 6680 WRA who had haemoglobin results and anemia status were included in this study. Logistic regression was used for bivariate and multivariate to test the association between anemia and exposures. Multivariable analysis used backward stepwise multiple logistic regression. Significant variables were assessed using odds ratio (OR), their 95% confidence interval (CI) and p-value <0.05. Adjusted Wald test was used to assess the significance of each variable in the model. Stata v.13 was used for analysis and sampling weights were applied in all steps of the analysis.

RESULTS

The prevalence of anemia among WRA was 19.2%; 15.7 had mild anemia, 3.4% had a moderate anemia and 0.2% had severe anemia. The risk factors for anemia among WRA are province of residence : Southern province (OR: 1.52 with 95% CI: 1.19 - 1.95 and p value of <0.001) and Eastern provinces (OR: 1.49 with 95% CI: 1.15 - 1.92 and p value of 0.002), economic status (wealth index level) where the risk decreases with the improvement of the economic status among poorer (OR: 0.78 with 95% CI: 0.64 - 0.95 and p value of 0.013), among middle (OR: 0.73 with 95% CI: 0. 0.59 - 0.90 and p value of 0.003), among richer (OR: 0.61 with 95% CI: 0.49 - 0.76

and p value of <0.001), the richest (OR: 0.72 with 95% CI: 0.57 - 0.90 and p value of 0.003) compared to the poorest. Moreover, the risk of anemia is increased among separated/widowed (OR: 1.35 with 95% CI: 1.08 - 1.68 and p value of 0.008). Furthermore, having history of malaria is anemia risk factor (OR: 1.77 with 95% CI: 1.31 - 2.38 and p value of <0.001) and sleeping under mosquito offer a protective effect (OR: 0.86 with 95% CI: 0.74 - 0.99 and p value of 0.038). Additionally, women with normal BMI has a reduced risk (OR: 0.73 with 95% CI: 0.57 - 0.94 and p value of 0.013), as well as for those with obesity (OR: 0.45 with 95% CI: 0.28 - 0.71 and p value of <0.001) compared to underweight. Use of hormonal contraceptives reduce anemia risk (OR: 0.60 with 95% CI: 0.50 - 0.73 and p value of <0.001) while the use of Intra Uterus Device increases the risk (OR: 1.94 with 95% CI: 1.03 - 3.67 and p value of 0.041).

CONCLUSION

Anemia is increasing in Rwanda; innovative interventions to address it are necessary including improving the distribution and access to mosquito nets by the community members, use of Community Health Workers to offer iron supplementation, and emphasis to programs aiming to improve nutrition and economic status of WRA.

Key words: Anemia, Women of Reproductive Age, malaria, prevalence, associated factors

RESUME

CONTEXTE

L'anémie parmi les femmes en âge de procréer est un problème de santé publique au Rwanda et a des conséquences à long terme en matière de santé, sur le développement social et économique si rien n'est fait. Sa croissance montre des défis dans les stratégies mis en place. Ainsi, la nécessité des nouveaux stratégies basées sur les épreuves scientifiques est incontournable. Toutefois, ces épreuves sont rares. Cet étude a été fait pour identifier les variations de l'anémie parmi les femmes en âge de procréer and identifier les facteurs de risque pour informer les décideurs, les mesures approprier pour adresser l'anémie au Rwanda.

METHODES

C'est une étude quantitative qui a utilisée l'analyse secondaire des données de l'enquête démographique et de sante (EDS) effectué au Rwanda en 2014/2015. La variable dépendante était l'état de l'anémie et 6680 femmes en âge de procréer ont été considéré dans l'étude. Nous avons effectué une régression logistique pour calculer les rapports de cote (odds ratios) ajustés pour les associations entre l'anémie et les facteurs de risques identifiés. L'analyse a été fait à l'aide de Stata v.13; les poids d'échantillonnage ont été appliqué durant l'analyse, l'analyse multivariée a aidé d'identifier les facteurs de risques. Les rapports de cote (odds ratios), Intervalle de confiance et la valeur de probabilité ont été rapportés pour chaque variable.

RESULTS

La prévalence d'anémie est de 19.2% ; 15.7 ont une anémie simple, 3.4% ont une anémie modérée and 0.2% ont une anémie sévère. Les facteurs de risqué pour l'anémie sont : la province de résidence : Province du Sud (OR: 1.52 avec 95% IC: 1.19 - 1.95 and valeur p : <0.001) et la province de l'Est (OR: 1.49; 95% IC: 1.15 - 1.92 valeur p: 0.002), niveau économique (index de pauvreté) où le risque est réduit avec la réduction de la pauvreté parmi les pauvres (OR: 0.78 avec 95% IC: 0.64 - 0.95, valeur p of 0.013), parmi ceux de la classe moyenne (OR: 0.73 avec 95% IC: 0. 0.59 - 0.90 valeur p of 0.003), parmi les riches (OR: 0.61 avec 95% IC: 0.49 - 0.76 valeur p

<0.001) et parmi les plus riches (OR: 0.72 avec 95% CI: 0.57 - 0.90 valeur p 0.003) en comparant avec les plus pauvres. Le risqué d'anémie est aussi augmenté parmi les veuves ou les femmes divorcées (OR : 1.35 avec 95% IC : 1.08 - 1.68 valeur p of 0.008). L'histoire de paludisme augmente le risque d'anémie (OR : 1.77 avec 95% IC : 1.31 - 2.38 valeur p <0.001) et l'utilisation de moustiquaire a un effet protectif (OR : 0.86 avec 95% IC : 0.74 - 0.99 valeur p 0.038). Les femmes avec état nutritionnel normale ont un risque réduit d'anémie (OR : 0.73avec 95% IC : 0.57 - 0.94 valeur p 0.013), ainsi que les obèses (OR : 0.45 avec 95% IC : 0.28 - 0.71 valeur p <0.001) en comparaison avec les malnutris. L'utilisation des contraceptives hormonale diminue le risque d'anémie (OR : 0.60 avec 95% IC : 0.50 - 0.73 valeur p <0.001) tan disque l'utilisation du dispositif intra utérine l'augmente (OR : 1.94 avec 95% IC : 1.03 - 3.67 valeur p 0.041).

CONCLUSION

L'anémie s'augmente au Rwanda. Des interventions sont requises pour y faire face comme l'amélioration de la distribution et accès aux moustiquaires dans la communauté, utilisation des agents de santé communautaire pour distribuer les suppléments en fer aux femmes ainsi que le renforcement des programmes visant à améliorer l'état nutritionnel et économique des femmes.

Mot clés : anémie, prévalence, femmes en âge de procréer, paludisme, les facteurs de risque

DEDICATION

"This work is dedicated to my lovely wife, Virginie UWINGABIRE and to my son, Ryan Wise SHAMI, and to our both parents and family members. Without their caring support, it would not have been possible to complete this work. May God bless and keep you always".

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LIST OF SYMBOLS AND ACRONYMS

%	**:** Percentages
ANC	: Ante natal care
BCC	: Behavior Change Communication
BMI	: Body Mass Index
CHW	: Community Health Workers (CHWs)
CI/IC	**:** Confidence Interval /Interval de Confiance
FP	: Family Planning
HIV	: Immunodeficiency Virus
IEC	: Information Education and Communication
IUD	**:** Intra Uterus Device
LLITNs	: Long Lasting Insecticide Treated Nets
MDGS	**:** Millennium Development Goals
MINECOFIN	**:** Ministry of Economic and Finance - Rwanda
MOH	**:** Ministry of Health - Rwanda
NISR	**:** National Institute of Statistics of Rwanda
OR	**:** Odds ratio
RDHS	**:** Rwanda Demographic and Health Survey
SPH	**:** School of Public Health
UR	**:** University of Rwanda
WHO	**:** World Health Organization
WRA	**:** Women of Reproductive Age

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CHAPITER I. INTRODUCTION

I. 1. DEFINITIONS OF CONCEPTS

a. Anemia

Anemia is defined by the World Health Organization (WHO) as "*a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic need*." Commonly, anemia is the final outcome of a nutritional deficiency of iron, folate, vitamin B12, and other nutrients (1,2).

b. Women of reproductive age

This is related to all women who are in the period in which a woman is able to conceive. In general, women aged from 15-49 are considered as WRA in most of the countries including in Rwanda (3).

c. Demographic and Health Surveys (DHS)

Demographic and Health Surveys (DHS) are nationally-representative household surveys that provide data for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition. There are two main types of DHS Surveys: **Standard DHS Surveys** which have large sample sizes (usually between 5,000 and 30,000 households) and typically conducted about every 5 years, to allow comparisons over time, and **Interim DHS Surveys** which focus on the collection of information on key performance monitoring indicators but may not include data for all impact evaluation measures such as mortality rates (4). The **Standard DHS Survey** was used in in this study.

I.2. CONTEXT

Rwanda is among the few countries that have been able to meet most of the Millennium Development Goals (MDGs) by improving the maternal and child health and other health indicators (5). However, the nation's Women of Reproductive Age (WRA) continue to face heavy burden of anemia consequences.

Policies and strategies to reduce anemia exist in Rwanda. They include those ranging from the provision of Iron Folic Acid (IFA) and deworming for pregnant women. Other strategies include promotion of complementary feeding for dietary diversity, prevention of infections including distribution and promotion of Long-lasting insecticidal treated nets (LLITNs) household use, and promotion of hygiene and sanitation in general. Apparently, these strategies played a role in the reduction in anemia prevalence among WRA, from 25.6% to 17.6% in 2005 and 2007/2008, respectively (6). However, anemia prevalence remained the same since with a very slight reduction of 0.3% in 2010. Recently, anemia prevalence in WRA has increased from 17.3 to 19.2% (7).

This observation is worrying. If not addressed, the health consequences will cascade into social and economic development. Effects of anemia in WRA will slow down the effort made to improve people's lives and other development initiatives (8). However, there still gaps in available evidence about the risk factors of anemia among WRA to which innovative interventions should be targeted. Thus, there is a need to develop scientific evidences for proper interventions and planning aimed at reducing prevalence of anemia. This is the basis upon which this work has been done.

I.3. BACKGROUND TO THE STUDY

Anemia, is one of the most common form of malnutrition with devastating consequences among WRA. Evidence have demonstrated that anemia among WRA contributes to increased risk of maternal mortality. It is argued that maternal anemia is associated with 20% of maternal deaths (9,10); increased risk of blood loss during delivery and post-partum subjecting women to many risks (11).

In addition, anaemic pregnant women are at greater risk of giving birth prematurely or have low birth weight babies and this is known to increase risk of neonatal morbidity and mortality (12). Furthermore, anemia can also cause cognitive loss in those who survive it, and because anaemic people have general fatigue, the weakness impacts heavily their productivity at work (10,13).

Other reports have argued that anemia is associated with increased healthcare expenditures especially when the condition coexists with several major disorders; patients with anemia have twice the average annualized costs of non-anaemic patients with the same condition (14). In addition to high costs, the median value of productivity losses due to iron deficiency is about US $4 per capita or 0.9% of gross domestic product (GDP). The absolute losses in some cases is estimated at close to US $5 billion annually (15).

Global inequalities in anemia exists depicting important difference between developing and developed countries in terms of anemia prevalence as well as its risk factors. High prevalence in most developing countries portray the failures of existing approaches to alleviate anemia burden; new approaches based on local scientific evidence are needed to address it, however, those evidences are scarce (16).

I.4. PROBLEM STATEMENT

Surprisingly, although it's a preventable condition, anemia continues to be a global public health problem responsible for significant morbidity in WRA. The anemia prevalence was estimated to be 27% globally in 2013, an equivalent of 1.93 billion people. In 2010 the prevalence was 32.9%, contributing to 68.36 million years lived with disability, and 8.8% of all total conditions recorded in 2010. Developing countries account for 89% of anemia burden among the people affected (17,18).

Global stratified data among WRA revealed that the prevalence of anemia was 29.4% for all WRA and at 38.2% for pregnant women in 2011. Correspondingly, 528.7 million (95% CI: 440.3—629.4) WRA had anemia worldwide, 496.3 million (95% CI: 409.3—595.1) were non-pregnant women, and 32.4 million (95% CI: 28.4—36.2) were pregnant women (19).

Although not considered as a major and important public health problem, anemia, remains a significant problem in the developed world. Data reported in 2011 show that the prevalence of anemia among WRA was estimated to be around 16% in high income countries, increased from 14% in 1995 (20).

In the United States of America (USA), anemia prevalence among WRA was estimated to be 11.90% in 2011 (20). This figure had increased from 8.7% recorded in 1995, with variations among age, economic status, ethnicity and health conditions (20,21,22). Such increase in WRA was attributed mainly to the increase in chronical diseases, especially cancers, and increased number of old adults (22,23).

A comparative report of anemia among WRA in six European countries revealed that the prevalence of anemia in some countries was far higher than is typically found in developed countries. The highest overall rate of anemia was in Uzbekistan (60%), and the lowest was in Armenia (12%). 47% of WRA in Turkmenistan, 38% in the Kyrgyz Republic, and 36% in Kazakhstan, were diagnosed as having some degree of anemia (2).

Developing countries, comprising mainly of Asian and Sub-Saharan African countries are the homes of high burden of anemia among WRA in the World. Evidence shows that challenges still exist in reducing anemia among WRA in low and middle income countries; inequality is remarkable especially among the poor. In general, developing countries account for 89% of all anemia-related disability, and iron-deficiency anemia remains the dominant cause of anemia (18).

In India, anemia prevalence was estimated at 50% of the population; women are more affected compared to men. About 20%-40% of maternal deaths are due to anemia and almost one in every two women (56%) suffers from some form of anemia (24).

In Africa, a high prevalence of anemia among WRA has been recorded among different countries. For example, the proportion of women with anemia is 60.6% and 60.3% in Gabon and Gambia, respectively. In Namibia, the prevalence is 20.7%, while in Ethiopia it is 16.6% (25). Other studies, found higher prevalence of anemia in Nigeria to be 62.6% among pregnant women, and 36.1% in North Western Zone of Tigray Ethiopia. All these studies show that prevalence of anemia in WRA varies among countries (26,27).

Studies in East and Central African countries reveal high prevalence of anemia. In recent survey, the proportion of anemic women in Tanzania was 40.1%, followed by Democratic Republic of Congo (38.4%), Uganda (23%) and Burundi (18.5%) (25). In Kenya, DHS did not include anemia measurements, however the prevalence of anemia was estimated to be 25% in 2011 (20), but other studies have recorded as high as 50% in some populations (28).

In Rwanda, compared to other East African Countries, the prevalence of anemia among WRA is lower. Currently, the national average in Rwanda is 19.2% and is considered as a mild public health problem according to WHO criteria (12,7). However, this is marked with variations among districts where some have anemia prevalence as high as 30%. Specifically, in 11 of Rwanda's 30 districts which equals to 36.7% of all districts, the prevalence of anemia is above the national average. Gisagara, Kirehe and Ngoma districts have 36.6%, 31.2% and 30.3%, respectively (7). Other studies including one conducted in Huye found anemia prevalence among women as high as 37% (29). In another study about the prevalence and risk factors of anemia among Human

Immunodeficiency Virus (HIV)-infected women was 29% among HIV-positive women compared with 8% in HIV-negative women (30).

Iron deficiency is considered to be the common cause and its supplementation is among the common recommended strategies globally. (19). Despite public health interventions to provide iron to reduce anemia and its consequences, challenges in implementation of that strategy still persist in most of developing countries (13).

In Rwanda, 80% of Rwandan women were recorded to take iron tablets or syrup during pregnancy. 68% of women took iron for fewer than 60 days, 7% of women took iron for a period between 60 -89 days and only 3% percent took iron tablets or syrup for the recommended 90 or more days (7). In addition to that, conflicting results exist regarding the iron deficiency prevalence in Rwanda. some studies found that 86% of women had iron-deficiency in Rwanda while others found low prevalence of iron deficiency among WRA varying between 16.5% to 21% (29,31).

In general, anemia continues to be among health conditions with high burden. While understanding risk factors of anemia and potential mechanisms are crucial to our ability to intervene to reduce this burden, more information about risk factors is necessary in developing countries including Rwanda for innovative and evidence based interventions.

I.5. PURPOSE OF THE STUDY

Anemia among WRA is increasing in Rwanda (7). However, there is a paucity of conclusive studies on risk factors among WRA. Most of the anemia related studies conducted were among children or for a WRA sub population (32,33,30). To our knowledge no published study with advanced analysis for Rwanda exists regarding risk factors of anemia among WRA. Most of the sources of information about anemia among WRA are descriptive (31).

This study was carried out to address the gap in evidence for risk factors of anemia among WRA in Rwanda. On the basis of this study, recommendations have been formulated to address the anemia among WRA in Rwanda. In addition, the study generated useful information that will help in identifying specific interventions needed to address anemia in WRA in Rwanda to improve people lives, especially maternal health.

I. 6. RESEARCH QUESTIONS

This study was conducted to answer the following questions:

- What characteristics of WRA in Rwanda are associated with anemia?
- What are the risk factors of anemia among women of reproductive age in Rwanda on which interventions could be designed?

I.7. RESEARCH OBJECTIVES

1.7.1. General Objective

- To assess the variations of anemia among WRA in Rwanda and identify risk factors, in order to inform the policy makers in Rwanda the appropriate interventions measures.

1.7.2. Specific objectives

- To determine the variations of anemia among WRA in Rwanda according to their background characteristics.
- To identify the risk factors of anemia among WRA in Rwanda.
- To formulate recommendations to address anemia among WRA in Rwanda.

CHAPITER II. LITTERATURE REVIEW

II. 1. OVERVIEW OF THE TOPIC

II.1. 1. Generalities about anemia

Anemia is defined as a low level of hemoglobin in the blood, as evidenced by fewer numbers of functioning red blood cells. Hemoglobin in red blood cells is an oxygen-carrying protein that binds oxygen through its iron component. Hemoglobin transports oxygen to most cells in the body for the generation of energy. When hemoglobin levels are low, less oxygen reaches the cells to support the body's activities; this affect the vital function of organs like the heart and lungs. In addition to that, because of oxygen's role in generating energy in the body and hemoglobin's role in transporting oxygen, one of the first symptoms of anemia is feeling tired (34).

As specific physiologic needs vary with a person's age, gender, residential elevation above sea level (altitude), smoking behaviour, and different stages of pregnancy, the following criteria were set by the World Health Organisation (WHO) to be used to diagnose anemia in different population:

*Table 1**: Hemoglobin levels to diagnose anemia at sea level in g/l** (1)*

Population	**Non-Anemia***	**Anemia***		
		Mild[a]	**Moderate**	**Severe**
Children 6-59 months of age	110 or higher	100 – 109	70 – 99	Lower than 70
Children 5-11 months of age	115 or higher	100 – 114	80 – 109	Lower than 80
Children 12-14 months of age	120 or higher	110 – 119	80 – 109	Lower than 80
Non- pregnant women (15 years of age and above)	**120 or higher**	**110 – 119**	**80 – 109**	**Lower than 80**
Pregnant women	**110 or higher**	**100 – 109**	**70 – 99**	**Lower than 70**
Men (15 years of age and above)	130 or higher	110 -129	80 – 109	Lower than 80

*Hemoglobin in gram per litre

a: mild is a misnomer: iron deficiency is already advanced by the time anemia is detected. The deficiency has consequences even when no anemia is clinically apparent.

There are many types of anemia and all are very different in their causes and treatments depending on the factors associated to it and impact its mechanism to develop. There are three main categories of the causes of anemia classified in poor, insufficient, or abnormal red blood cell production; excessive red blood cell destruction; and thirdly, excessive red blood cell loss (34).

II.1.2. Classification of anemia as a problem of public health significance

For the purpose of public health surveillance, WHO has categorized the anemia prevalence to decide if anemia is a public health problem and the level of the problem for interventions. The following is the table of anemia public health significance according to the prevalence in the population:

*Table 2**: Category of public health significance for anemia** (12).*

Prevalence of anemia (%)	**Category of public health significance**
<4.9	No public health problem
5.0–19.9	Mild public health problem
20.0–39.9	Moderate public health problem
≥40.0	Severe public health problem

II.1.3. Micronutrients deficiency and supplementations: iron, folic acid and vitamin A

Micronutrients anemia is known the most common being iron deficiency, which is defined as a condition in which there are no mobilizable iron stores and in which signs of a compromised supply of iron to tissues, including the erythron, are noted. The more severe stages of iron deficiency are associated with anemia, resulting in insufficient red blood cell production (13).

When iron-deficient occurs, haemoglobin concentrations are reduced to below-optimal levels. Iron deficiency anemia is considered to be present when individual haemoglobin levels are below normal population level by gender and age living at the same altitude. Anemia is the most common indicator used to screen for iron deficiency, therefore the terms anemia, iron deficiency, and iron deficiency anemia are sometimes used interchangeably (13,35).

However, other micronutrients also play a big role in anemia. Folic acid and vitamin A is also among the frequent micronutrients deficiencies observed among WRA with important health consequences. Physiologically, folic Acid (vitamin B12) are necessary for cell growth and repair and essential for the formation and maturation of cells, especially red blood cells. Deficiency of folate leads to slowing of cell synthesis and impaired cell proliferation. This, in turn, leads to abnormal cells and shortened lifespan of circulating red blood cells and thus impacting anemia. Thus, their supplementation can improve hematologic indicators and enhance the efficacy of iron supplementation and thus prevent anemia (35).

Iron supplementation is the most common strategy currently used to treat existing iron deficiency anemia, or as a preventive public health measure to control iron deficiency in populations at high risk like in pregnant women. Dosage schedules for iron supplementation to prevent iron deficiency anemia depends on different factors including the physiological needs and the level of its prevalence in the population.

It is recommended that in areas with high prevalence of anemia, above 40%, WRA should be given 60 mg/day of iron and 400 μg/day of folic acid for 3 months and with a universal supplementation of the same dose to pregnant women soon after gestation starts, but no later than the third month, and continuing for the rest of pregnancy (13). Also, it is recommended that other micronutrients supplementations like those of folic acid and vitamin A supplementation be given to women during the pregnancy as well as in the postpartum (36). However, this study focused on anemia in general among WRA with little details of variables about iron supplementations.

II.2. SUMMARY OF FACTORS ASSOCIATED WITH ANEMIA IN WRA

The anemia determinants are multi-factorial ranging from socio-demographic factors including other physiological factors, mother's health status, health conditions, health seeking behaviours.

II.2.1. Socio-demographic factors

Studies conducted in different European and African countries found that area of residence does influence anemia. Women residing in rural areas were more likely to be anaemic than women living in urban areas. Education/literacy and an economic status were found to be associated with anemia in many studies where women with any postsecondary education were less frequently anemic than were women with less education (2,27,37).

Although there are variations of distribution of anemia according to age categories, some studies have found no statistical significance, or have found weak association between age and anemia (38,39). Moreover, other studies in East African found that poverty (wealth quintile, and pregnancy were among the factors that were associated with anemia (38,37).

II.2.2. Women health status

Various studies have found that high prevalence of anemia is associated with health status conditions of women and factors including the number of children by mothers, like women having parity 1 and 4, and mother's nutrition status using BMI in kg/m^2 were found to be associated with anemia (40,19,24,41).

Lactating mothers have also been found having higher anemia risks (42). Other studies have linked prevalence and risk factors of anemia to Human Immunodeficiency Virus (HIV). Anemia increased with HIV stage and associated with lower body mass index and other opportunistic infections (30).

II.2.3. Health conditions and health seeking behaviours

Iron deficiency is considered to be the most common of all associated factors of anemia accounting for greater than 60% of all anemia globally (20). In Ethiopia, increased prevalence of anemia among women was due to lack of iron supplementation during pregnancy, and meal frequency of less than two times per day (27), but conflicting reports exist especially among pregnant women (35). Other studies have demonstrated that use of hormonal contraceptive reduced the risk for anemia (38,42). This is not so for Intra Uterus Devises, which is known to increase the risk of anemia (43).

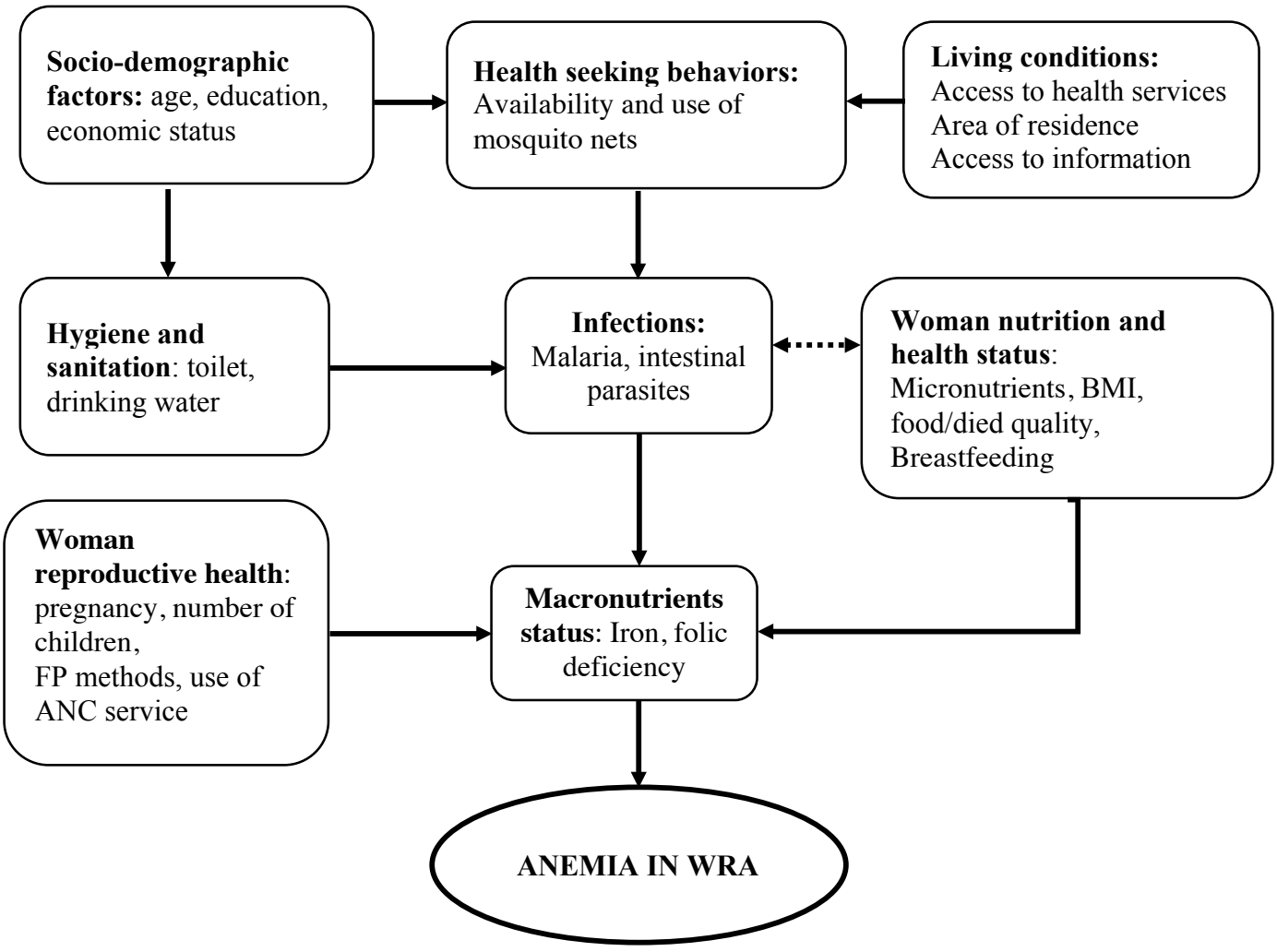
The use of malaria infection preventions measures like using Long Lasting Insecticide Treated Nets (LLITNs) for malaria prevention, having toilet facilities, and drinking untreated water were found to be associated with anemia prevalence as were deworming and access to health facilities (44,38,41,37). Moreover, access to information has been found also to influencing the use of health services including those related to anemia prevention and control (7).

Smoking and altitude do also influence the variations in haemoglobin level and thus anemia level in the population (1). Other risk factors including hemoglobinopathies, chronic kidney diseases, and other gynaecological diseases have found to be associated with anemia (17,18). However, they are not considered in this study because they are not part of the DHS data collection upon which this study draws information (7).

II.3. CONCEPTUAL FRAMEWORK

According to the factors that are considered to be influencing anemia among WRA, the following framework was adopted which contains different variables that were included in this study in order to assess the risk factor of anemia among WRA in Rwanda.

Figure 1: CONCEPTUAL FRAMEWORK



II.4. HYPOTHESES

This study has been conducted in order to assess the following two hypotheses:

- Prevalence in anemia status vary among provinces, rural and urban areas.
- The anemia among WRA in Rwanda is associated with woman education level, economic status, use of antenatal care, iron supplementation, high level of hygiene, clean drinking water, nutrition status of women, and access to information and health services

CHAPITER III. METHODS

III.1. STUDY DESIGN AND SOURCE OF DATA

This is a quantitative, cross-sectional study using secondary data analysis of Rwanda Demographic and Health Survey (RHDHS) 2014-2015.

III.2. DESCRIPTION OF THE SAMPLE (STUDY PARTICIPANTS)

The study population are women aged 15-49 years in Rwanda who were study participants in Rwanda Demographic and Health Survey (RHDHS) 2014-2015. For the sampling strategies, the DHS used a multistage cluster sampling strategy. The sample was stratified by district to make estimates of results at each district. For the first stage of sampling, villages were considered as primary sampling units and were selected with probability proportionate to population size with oversampling of urban to have representation. For the second stage sampling, all households that were in villages selected were listed/mapped and then sampled using a systematic random sampling to have the final households in which data collection was done (7); 6680 WRA were included in the sample for this study.

III.3. DATA COLLECTION AND PROCESSING

Being a secondary data analysis, there was no primary data collection. This study used Rwanda Demographic and Health Survey (RHDHS) 2014-2015, which was implemented from November 9, 2014, to April 8, 2015 by Rwanda's National Institute of Statistics (NISR), Ministry of Health (MOH), and other partners including ICF International technical assistance through the USAID-funded DHS Program.

The dataset was downloaded from the DHS program after approval from relevant authorities (Attached in appendix). Subsequently, the data were extracted from the DHS dataset and all WRA (15-49 years) having available data about anemia status and levels were extracted with their variables that were under study, which were described in the conceptual framework. Women with missing information about anemia status were not considered.

III.4. ETHICAL CONSIDERATIONS

Before conducting the RDHS 2014/ 2015, a clearance from the Rwanda National Ethics Committee and the MEASURE DHS Project were obtained and data set and results were reviewed and approved by the National Institute of Statistics of Rwanda and the Ministry of Health. This requirement fulfilled all ethical considerations (7). In addition to that, as the study participants in RDHS 2014/2015 already provided their informed consent, additional informed consent was not necessary for this secondary data analysis. Moreover, it was not possible to identify study participants in the data set, so there were no associated potential risks to confidentiality violations.

III.5. DESCRIPTION OF MAIN VARIABLES

III.5.1. Outcome variable

In this study, the outcome variable is the anemia status for a WRA. The anemia status was measured using the standards as described in RDHS 2014/2015, which are not very different with those recommended by WHO (1,7). After adjustment for altitude and for smoking status using formulas in CDC, 1998, pregnant women with haemoglobin level above 10.9 g/dl and non-pregnant WRA with haemoglobin level above 11.9 g/dl were considered as not anemic while those pregnant women with haemoglobin level equal or below to 10.9 g/dl and non-pregnant WRA with haemoglobin level equal or below to11.9 g/dl were considered as anemic.

In general, women with anemia and women with no anemia were considered as the outcome status. However, for the purpose of describing in details the variations of different levels of anemia according to different characteristics of WRA, three levels of anemia severity were also distinguished in descriptive analysis

- Mild anemia: 10.0-10.9 g/dl for pregnant women and 10.0-11.9 g/dl for non-pregnant women;
- Moderate anemia (7.0-9.9 g/dl);
- Severe anemia (less than 7.0 g/dl)

III.5.2. Independent variables

The independent variables used in the study are classified in socio demographic factors, mothers' health and reproductive health status factors, health conditions and behaviours factors and living conditions factors.

III.5.2. 1. Socio demographic characteristics factors

The following social and demographic characteristics of WRA were considered in the study:

- *Age of the woman*: the age was put into categories of 5 years' intervals: 15-19 years, 20-24 years, 25 – 29 years, 30 -34 years, 35 – 39 years, 40 -44 years and 45 – 49 years.
- *Province*: all five provinces were considered: Kigali city, South, West, North, East.
- *Type of residence*: this is related to living in rural or urban areas as per classification of areas of residences according to RDHS.
- *Educational attainment*: this is the level of education for the WRA classified as no education, incomplete primary, complete primary, incomplete secondary, complete secondary and higher.
- *Wealth index/ Economic status:* this is related to economic status classified as poorest, poorer, middle, richer, richest as categorized in RDHS. The classification criteria and explanations in RDHS were maintained in this study (7).
- *Marriage status*: classified as not married/single, married/living together, and Separated/widowed.

III.5.2. 2. Mothers' health status and reproductive factors

- *Pregnancy status*: classified as not pregnant or unsure and those pregnant.
- *Children ever born*: this is related to the number of children that the woman has had. They were categorised in those who had no child, those having 1-2 children, 3-4 children, 5-6 children and those with more than 7 children.

- *Period of the last birth*: those were categorized into those who had birth in less or equal to one year and those with last birth in 2-3 years, those who had birth in 4-5 years, those who had no birth or who had birth in more than 5 years and pregnant women considered as separate group of category.
- *Breastfeeding status*: those are the women who were breastfeeding in survey period. They are classified in those who were breastfeeding and those who were not breastfeeding.
- *Body Mass Index (BMI):* this is related to the nutrition status of the mother. The WHO recommended categories were used: Underweight: <18.5, Normal:18.50 - 24.99, overweight: 24.99 - <30, Obese: ≥30.00 (45).

III.5.2. 3. Health seeking behaviors factors

- *Frequency of reading newspaper or magazine:* classified as not at all, less than once a week, and at least once a week.
- *Frequency of listening to radio:* classified as not at all, less than once a week, and at least once a week.
- *Frequency of watching television:* classified as not at all, less than once a week, and at least once a week.
- *Have mosquito bed net for sleeping:* This is related to the WRA household who have mosquito bed net for sleeping for preventing malaria infection. It is categorized into 2 categories: those who had mosquito bed net for sleeping and those who did not.
- *Respondent slept under mosquito bed net:* this is related to the WRA who slept under mosquito bed net last night before the survey. It is categorized into 2 categories: those who responded that they slept under mosquito bed and those who did not slept under mosquito bed net mosquito bed net.

III.5.2. 4. Factors related to the health services uses

- *Use of family planning (FP) methods*: this is related to the contraceptive method used by the WRA. They were classified into categories of those who use none, natural method, barriers or permanent method (those were classified into one category as considered not having no direct relation to anemia), category of those using hormonal method (including

short and long-term methods), those using Intra Uterus Device (IUD) and pregnant women considered as separate group of category.

- *Use of ante natal care (ANC) on the last recent pregnancy*: this is related to the use of ANC services during the last pregnancy. It is classified in category of those who had no ANC visit on the last pregnancy within 5 years, those who had 1- 3 ANC visits on the last pregnancy within 5 years, those who had 4 or more ANC visits on the last pregnancy within 5 years and those who had no pregnancy or had their last pregnancy in more than last 5 years.
- *Use of iron during the last pregnancy:* this is related to have been received or bough iron during the last recent pregnancy. This was categorized as having not received or bough iron during the last recent pregnancy, having received or bough iron during the last recent pregnancy and those who did not had any pregnancy or those who had the last in more than 5 years.
- *Malaria history during the last pregnancy*: this is related to have taken any malaria drug during the last pregnancy. It was categorized into those who took no malaria drug during their last pregnancy, those who took malaria drug during their last pregnancy and those who had no birth or who had birth in more than 5 years.
- *Intestinal parasites history during the last pregnancy*: this is related to have taken any intestinal parasites drug during the last pregnancy. It was categorized into those who took no intestinal parasites drug during their last pregnancy, those who took any intestinal parasites drug during their last pregnancy and those who had no birth or who had birth in more than 5 years.

III.5.2.5. Living conditions factors

- *Toilet type use in household:* toilet type in the household reflect the hygiene and sanitation status of the household (38). This variable is related to the type of the toilet use by the household and were divided into 4 categories: those with no toilet, who use bush or field, those with pit latrine without slab/open pit, pit latrine with slab, those with ventilated improved pit latrine (vip) and those with other types of latrines, during the categorisation, those not of the de jure resident were treated as separate category.

- *Source of drinking water:* this is related to the water used in household for drinking. There were put into different sources of drinking water categories: protected spring, unprotected spring, those who uses public tap/ standpipe, those who uses piped to yard/plot, those who uses river/ dam/lake/ponds/stream/canal/irrigation, those who uses protected well, those who used unprotected well and those who uses other water sources. Those not of the de jure resident were treated as separate category.
- *Access to health facility:* this related to the appreciation of study participants about getting medical help for self: distance to health facility. It was classified into two categories: those who consider as a big problem and those who not consider as big problem.

III.6. DATA ANALYSIS

All the data were analysed using Stata version 13. Variables under study were extracted from the RDHS dataset. Descriptive analysis was conducted to describe anemia among WRA according to their social and demographic characteristics, mother's health status, health conditions and behaviors factors as well as living conditions factors as described in the section about study variables above.

The descriptive analysis results were presented in frequency and percentage (n and %) for anemia status with WRA with any anemia and those without anemia according to independent variables. In addition to that, variations of anemia levels according to independent variables in study were also analyzed in descriptive analysis step and reported in order to provide details about variations of distribution of anemia levels.

A bivariate analysis using logistic regression was conducted to test association between the anemia among WRA and independent variables that were described in conceptual framework. Variables were considered to be statistically significant if the p-value was <0.05. Collinearity among the significant variables was tested using Spearman's Correlation coefficient and those collinear variables with $r \geq 0.5$ were not retained to be put in multivariate analysis model.

A multivariable analysis was conducted using backward stepwise multiple logistic regression to have a predicting model of significant risk factors for anemia among WRA in Rwanda but also to

ensure control of potential confounders. Significant variables were assessed using odds ratio (OR), their 95% confidence interval (CI) and p-value <0.05. Adjusted Wald test was used to assess the significance of each variable in the model. Hosmer-Lemeshow was used to check for the goodness fit of the final model. In addition to that, given the fact that the use of cluster sampling in RDHS has effects on study results, sampling weights were applied during all steps of the analysis.

CHAPITER IV. RESULTS

IV.1. RESULTS OF DESCRIPTIVE ANALYSIS AND ANEMIA PREVALENCE

Different characteristics were used to describe the study participants according to the anemia status. Study participants with any anemia were described in general with more details about different levels of anemia: mild, moderate and severe anemia as well as the proportions of those who were not anaemic.

A total of 6680 women were included in the analysis (weighted N). As described in table 3, the general prevalence of anemia among WRA is 19.2% and most of those who are anaemic have mild anemia with a prevalence of 15.7%; 3.4% had a moderate anemia and 0.2% had severe anemia.

IV.1. 1. Socio demographic characteristics factors and anemia status

As shown in table 3, 1386 (20.7%) of the study participants were aged 15-19 years old; 1646 (24%) were from Eastern province with almost same proportion from Southern provinces. Moreover, around 42.9% did complete primary school and only 2.8% had higher education level. Furthermore, 3434 (51.4%) were married or living together with their husbands, and regarding the economic status, 1306 (19.6%) and 1556 (23.3%) were poorest and richest respectively (table 3).

Regarding the anemia status, the proportion of anemia prevalence varies with age categories where it varies between 18% to 19.6% in WRA aged from 15-19 years, up to those aged 30 – 34 years. The anemia prevalence is higher among old WRA where it is 19.7% and 24.2% in WRA aged 40-44 years and 45 – 49 years respectively. The proportions of mild, moderate and severe anemia according to age categories follow that trends of variations between age groups.

Moreover, there was a variation of anemia prevalence by geographic area where two provinces had a prevalence above the national average. A high anemia prevalence was observed in Southern province with a prevalence of 22.9%, followed by the Eastern province with a prevalence of 21,8%. The other remaining provinces had a prevalence below the national average with 14.8% in Kigali city, 15.3% in Northern province and 18% in Western province. Although the different

levels of anemia followed the same trends regarding the province levels of anemia, there is a slight difference in severe anemia where the western province has a higher severe anemia prevalence of 0.3% while other provinces have a prevalence of 0.2% except northern province which has no severe anemia.

In addition to that, the table 3 also shows a slight variation of anemia prevalence among WRA according to the area of residence where the prevalence is higher in rural area at 19.9% compared to the urban area where the prevalence is 16.4%. Moreover, mild anemia is 16.3% in rural and 13.3% in urban. Moderate and severe anemia are almost the same in rural and urban with 2.9 % in urban and 3.5% in rural for moderate anemia and 0.2% for severe anemia in both rural and urban.

Furthermore, anemia prevalence is higher among WRA with no education with a prevalence of 22.5% and 20.3% in those WRA who did not complete primary. However, a higher prevalence is also observed among WRA with higher education where the prevalence is 20.7%. The prevalence is relatively low among those who completed secondary school (16.2%) and those who completed the primary school (16.8%).

Interestingly, the prevalence of mild anemia decreases with the increase of education level where it's 16.4% among those with no education as well as in those with incomplete primary. The moderate and severe anemia are almost the same among those with no education and with higher education with moderate anemia of 5.6% and severe anemia of 0.5% among those with no education and a moderate anemia of 4.9% and severe anemia of 0.5% among those with higher education.

Besides that, anemia prevalence also varies with the wealth index of WRA where a higher anemia prevalence of 24.7% is observed among the poorest WRA, followed by those considered as poorer with prevalence of 20.1%. Moreover, the prevalence is 18.9% among those considered as being in middle category, with a prevalence of 16.1% and 16.6% among the richer and richest respectively. In general, the same trends of decrease with the increase of economic level is also observed according to different anemia levels.

Regarding the marriage status, anemia is more prevalent among those WRA who separated with their husbands or widows with a prevalence of 24.9% followed by the 19.1% among single WRA and lastly 18.2% among married or living together with husbands. Although the same trends of variations are observed regarding the prevalence of mild anemia among those groups, the moderate anemia differ and is higher (3.5%) among married women or living together with their husbands compared to 2.7% among the WRA who still single. In addition to that, although having a high prevalence of anemia in general, separated and widow WRA have low prevalence of severe anemia compared to married women or living together where the severe anemia is 0.3%.

Table 3:Socio demographic characteristics of respondents by anemia levels

VARIABLES/	**ANEMIC**				**NOT ANEMIC**	**Total Weighted N**
	Any anemia	**Mild**	**Moderate**	**Severe**		
	n (%)	n (%)	n (%)	n (%)	n (%)	**N (%)**
Age in 5-year groups						
15-19	260 (18.8)	228 (16.5)	31 (2.2)	1 (0.1)	1126 (81.2)	1386 (20.7)
20-24	240 (19.6)	189 (15.4)	48 (3.9)	3 (0.2)	985 (80.4)	1225 (18.3)
25-29	209 (18.1)	172 (14.9)	36 (3.1)	1 (0.1)	944 (81.9)	1153 (17.3)
30-34	184 (18)	143 (14)	38 (3.7)	3 (0.3)	840 (82)	1024 (15.3)
35-39	154 (19.4)	127 (16)	27 (3.4)	0 (0)	641 (80.6)	795 (11.9)
40-44	121 (19.7)	97 (15.8)	21 (3.4)	3 (0.5)	493 (80.3)	614 (9.2)
45-49	117 (24.2)	92 (19)	23 (4.8)	2 (0.4)	366 (75.8)	483 (7.2)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Province of residence						
Kigali city	133 (14.8)	107 (11.9)	24 (2.7)	2 (0.2)	766 (85.2)	899 (13.5)
South	367 (22.9)	284 (17.7)	80 (5)	3 (0.2)	1238 (77.1)	1605 (24)
West	259 (18)	226 (15.7)	28 (1.9)	5 (0.3)	1183 (82)	1442 (21.6)
North	167 (15.3)	147 (13.5)	20 (1.8)	0 (0)	921 (84.7)	1088 (16.3)
East	359 (21.8)	284 (17.3)	72 (4.4)	3 (0.2)	1287 (78.2)	1646 (24.6)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**

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VARIABLES/	ANEMIC				NOT ANEMIC	Total Weighted N
	Any anemia	Mild	Moderate	Severe		
	n (%)	n (%)	n (%)	n (%)	n (%)	N (%)
Type of place of residence						
Urban	217 (16.4)	176 (13.3)	39 (2.9)	2 (0.2)	1108 (83.6)	1325 (19.8)
Rural	1068 (19.9)	872 (16.3)	185 (3.5)	11 (0.2)	4287 (80.1)	5355 (80.2)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Educational attainment						
No education	179 (22.5)	130 (16.3)	45 (5.6)	4 (0.5)	618 (77.5)	797 (11.9)
Incomplete primary	580 (20.3)	470 (16.4)	105 (3.7)	5 (0.2)	2283 (79.7)	2863 (42.9)
Complete primary	244 (16.8)	213 (14.7)	29 (2)	2 (0.1)	1208 (83.2)	1452 (21.7)
Incomplete secondary	189 (18.1)	161 (15.4)	28 (2.7)	0 (0)	855 (81.9)	1044 (15.6)
Complete secondary	55 (16.2)	46 (13.5)	8 (2.4)	1 (0.3)	285 (83.8)	340 (5.1)
Higher	38 (20.7)	28 (15.2)	9 (4.9)	1 (0.5)	146 (79.3)	184 (2.8)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Wealth index/ economic status						
Poorest	323 (24.7)	246 (18.8)	75 (5.7)	2 (0.2)	983 (75.3)	1306 (19.6)
Poorer	265 (20.1)	216 (16.4)	44 (3.3)	5 (0.4)	1051 (79.9)	1316 (19.7)
Middle	236 (18.9)	202 (16.2)	33 (2.6)	1 (0.1)	1013 (81.1)	1249 (18.7)
Richer	202 (16.1)	175 (14)	26 (2.1)	1 (0.1)	1051 (83.9)	1253 (18.8)
Richest	259 (16.6)	209 (13.4)	46 (3)	4 (0.3)	1297 (83.4)	1556 (23.3)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Marriage status						
Not married	485 (19.1)	414 (16.3)	68 (2.7)	3 (0.1)	2058 (80.9)	2543 (38.1)
Married/living together	625 (18.2)	495 (14.4)	121 (3.5)	9 (0.3)	2809 (81.8)	3434 (51.4)
Separated /widows	175 (24.9)	139 (19.8)	35 (5)	1 (0.1)	528 (75.1)	703 (10.5)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**

IV.1.2. Mothers' health status and reproductive factors and anemia status

The table 4 indicates that 6189 (92.6%) of the study participants were not pregnant or unsure, 2327 (34.8%) had no children while 1834 (27.7%) have had 1-2 children. Moreover, 870 (13%) had their last birth in less than 1 years, and 4787 (71.7%) were still breastfeeding. Additionally, 410 (6.1%) of WRA in the study were underweight, 4774 (71.5%) had normal nutrition status while 1229 (18.4%) were overweight.

Besides that, the table 4 also demonstrates that anemia is more prevalent among pregnant women (23.4%) as compared to 18.9% among those who are not pregnant or were not sure that they are pregnant or not. However, mild and severe anemia are more prevalent among those who are not pregnant or those who are not sure that they are pregnant or not with a prevalence of 15.8% for mild anemia and 0.2% for severe anemia.

Moreover, anemia is almost the same regarding the number of children ever born per WRA, varying from 18% among those with 0-2 children to 21% among those with more than 7 children. Same trends of variations are observed in different anemia levels except for severe anemia where there was no severe anemia among those who had 3-4 children. Moreover, anemia is more prevalent among women who had their last birth in less than 1 year with a prevalence of 20.3%. Anemia among those WRA who were still breastfeeding is the almost the same as the national average of 19.2%.

In addition to that, WRA who are underweight have a high anemia prevalence of 26.1% compared to 19.1% among those with normal, 19% among overweight and 12% among obese. However, although the same trends of variations are observed according to level of anemia, moderate anemia make an exception where it's more prevalence among overweight (3.9%) compared to 3.7% among underweight. The table 4 below provides details about anemia status by mothers' health status and reproductive factors.

Table 4: Anemia status by mothers' health status and reproductive factors

VARIABLES/	ANEMIC				NOT ANEMIC	Total Weighted N
	Any anemia n (%)	**Mild** n (%)	**Moderate** n (%)	**Severe** n (%)	n (%)	**N (%)**
Currently pregnant						
No or unsure	1170 (18.9)	976 (15.8)	181 (2.9)	13 (0.2)	5019 (81.1)	6189 (92.6)
Yes	115 (23.4)	72 (14.7)	43 (8.8)	0 (0)	376 (76.6)	491 (7.4)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Number of children ever born						
Had no children	456 (19.6)	384 (16.5)	69 (3)	3 (0.1)	1871 (80.4)	2327 (34.8)
1-2 children	331 (18)	263 (14.3)	64 (3.5)	4 (0.2)	1503 (82)	1834 (27.5)
3-4 children	247 (19.5)	204 (16.1)	43 (3.4)	0 (0)	1019 (80.5)	1266 (19)
5-6 children	153 (19.5)	117 (14.9)	33 (4.2)	3 (0.4)	633 (80.5)	786 (11.8)
7 or more	98 (21)	80 (17.1)	15 (3.2)	3 (0.6)	369 (79)	467 (7)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Birth history in past years						
No birth/birth in >5 years	676 (19.5)	570 (16.4)	100 (2.9)	6 (0.2)	2796 (80.5)	3472 (52)
Had last birth in <=1 year	177 (20.3)	140 (16.1)	32 (3.7)	5 (0.6)	693 (79.7)	870 (13)
Had last birth last 2-3 years	225 (18.2)	193 (15.6)	32 (2.6)	0 (0)	1011 (81.8)	1236 (18.5)
Had last birth last 4-5 years	92 (15.1)	73 (11.9)	17 (2.8)	2 (0.3)	519 (84.9)	611 (9.1)
Currently pregnant	115 (23.4)	72 (14.7)	43 (8.8)	0 (0)	376 (76.6)	491 (7.4)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Currently breastfeeding						
No	919 (19.2)	748 (15.6)	162 (3.4)	9 (0.2)	3868 (80.8)	4787 (71.7)
Yes	366 (19.3)	300 (15.8)	62 (3.3)	4 (0.2)	1527 (80.7)	1893 (28.3)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**

Table 4 continues to next page

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VARIABLES/	ANEMIC				NOT ANEMIC	Total Weighted N
	Any anemia	Mild	Moderate	Severe		
	n (%)	n (%)	n (%)	n (%)	n (%)	N (%)
Body mass index						
Underweight: <18.5	107 (26.1)	91 (22.2)	15 (3.7)	1 (0.2)	303 (73.9)	410 (6.1)
Normal:18.50 - 24.99	912 (19.1)	747 (15.6)	154 (3.2)	11 (0.2)	3862 (80.9)	4774 (71.5)
Overweight: 24.99 - <30	234 (19)	185 (15.1)	48 (3.9)	1 (0.1)	995 (81)	1229 (18.4)
Obese: ≥30	32 (12)	25 (9.4)	7 (2.6)	0 (0)	235 (88)	267 (4)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**

IV.1. 3. Health seeking behaviours factors and anemia status

The table 5 indicates that 5631 (84.3%) have at least one mosquito net in their household and 4496 (67.3%) reported having slept under mosquito nets the last night before the survey. Moreover, 4099 (61.5%) of WRA listen to radio at least once a week while 1079 (16.2%) do not listen to it at all and 4916 (73.7%) do not read any new paper or magazine.

Regarding anemia status, anemia is more prevalent among those who do not have mosquito net in household as it's 22.1% and 21.5% among those who did not sleep under mosquito net the last night before the survey as compared to 18.7% among those who slept under mosquito net last night before the survey (table 5).

Regarding the access to information, anemia was more prevalent among those who do not listen to radio (21.6%) as compared to those who listen to it, and it's also higher among those who do not read newspaper or magazine (19.7%) as compared to those who read them, and those who do not watch television have an anemia prevalence of 19.9%, higher compared to those who watch it. The table 5 below provides details about anemia status by health seeking behaviors factors.

Table 5: Anemia status by health seeking behaviors factors

VARIABLES/	ANEMIC				NOT ANEMIC	Total Weighted N
	Any anemia	Mild	Moderate	Severe		
	n (%)	n (%)	n (%)	n (%)	n (%)	N (%)
Frequency of reading newspaper or magazine						
Not at all	969 (19.7)	787 (16)	171 (3.5)	11 (0.2)	3947 (80.3)	4916 (73.7)
Less than once a week	235 (17.4)	198 (14.7)	37 (2.7)	0 (0)	1116 (82.6)	1351 (20.2)
At least once a week	78 (19.4)	61 (15.1)	16 (4)	1 (0.2)	325 (80.6)	403 (6)
Total	**1282 (19.2)**	**1046 (15.7)**	**224 (3.4)**	**12 (0.2)**	**5388 (80.8)**	**6670 (100)**
Frequency of listening to radio						
Not at all	233 (21.6)	186 (17.2)	45 (4.2)	2 (0.2)	846 (78.4)	1079 (16.2)
Less than once a week	292 (19.6)	238 (16)	49 (3.3)	5 (0.3)	1198 (80.4)	1490 (22.3)
At least once a week	758 (18.5)	624 (15.2)	129 (3.1)	5 (0.1)	3341 (81.5)	4099 (61.5)
Total	**1283 (19.2)**	**1048 (15.7)**	**223 (3.3)**	**12 (0.2)**	**5385 (80.8)**	**6668 (100)**
Frequency of watching television						
Not at all	755 (19.9)	617 (16.2)	131 (3.4)	7 (0.2)	3044 (80.1)	3799 (57)
Less than once a week	330 (18.8)	276 (15.7)	51 (2.9)	3 (0.2)	1430 (81.3)	1760 (26.4)
At least once a week	195 (17.6)	150 (13.6)	42 (3.8)	3 (0.3)	912 (82.4)	1107 (16.6)
Total	**1280 (19.2)**	**1043 (15.6)**	**224 (3.4)**	**13 (0.2)**	**5386 (80.8)**	**6666 (100)**
Have mosquito bed net for sleeping						
No	232 (22.1)	186 (17.7)	43 (4.1)	3 (0.3)	817 (77.9)	1049 (15.7)
Yes	1053 (18.7)	862 (15.3)	181 (3.2)	10 (0.2)	4578 (81.3)	5631 (84.3)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
WRA slept under mosquito bed net						
No	469 (21.5)	375 (17.2)	90 (4.1)	4 (0.2)	1715 (78.5)	2184 (32.7)
Yes	816 (18.1)	673 (15)	134 (3)	9 (0.2)	3680 (81.9)	4496 (67.3)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**

IV.1. 4. Factors related to the health services uses and anemia status

As indicated in table 6, more than 1565 (23.4%) of the study participants were using hormonal contraceptives, and only 52 (0.8%) were using IUD. 1676 (25.1%) have had 1 – 2 ANC visits during their last pregnancy. Moreover, 291 (4.4%) had malaria history during their last pregnancy and took malaria drug while 2683 (40.2%) did not take any malaria drug during their last pregnancy (table 6).

A higher anemia prevalence is observed among WRA using IUD as a contraceptive method where it's 28.8% compared to those using hormonal contraceptives where the prevalence is only 13.7%. The same trends are observed according to anemia levels except for the severe anemia where there's no WRA who use IUD with severe anemia. Furthermore, the table 5 also indicates that there's a high prevalence of anemia among WRA who reported taking malaria drugs during their last pregnancy where the prevalence is 28.8%.

Regarding the information about having had ante natal care (ANC) visits, a high prevalence of 25.8% is observed among those who did not had any ANC visit while the prevalence of around 18.5% is almost the same among those who had visits 1-3 visits and those who had 4 or more visits. Moreover, WRA who reported not having received or bought iron on their last pregnancy or who don't remember it had almost the same prevalence of around 18.6% as those who received or bought iron on their last pregnancy. Same prevalence is also observed for those who reported taking drugs for intestinal parasites during their last pregnancy (table 6).

Table 6: Anemia status by factors related to the health services uses

VARIABLES/	ANEMIC				NOT ANEMIC	Total Weighted N
	Any anemia	Mild	Moderate	Severe		
	n (%)	n (%)	n (%)	n (%)	n (%)	N (%)
Use of FP methods						
None, natural, Barriers, permanent	940 (20.6)	781 (17.1)	147 (3.2)	12 (0.3)	3632 (79.4)	4572 (68.4)
Hormonal	215 (13.7)	182 (11.6)	32 (2)	1 (0.1)	1350 (86.3)	1565 (23.4)
IUD	15 (28.8)	13 (25)	2 (3.8)	0 (0)	37 (71.2)	52 (0.8)
Pregnant	115 (23.4)	72 (14.7)	43 (8.8)	0 (0)	376 (76.6)	491 (7.4)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Use of ANC services during last pregnancy						
No ANC visit on last birth	8 (25.8)	6 (19.4)	2 (6.5)	0 (0)	23 (74.2)	31 (0.5)
1-3 ANC visits on last birth	312 (18.6)	245 (14.6)	63 (3.8)	4 (0.2)	1364 (81.4)	1676 (25.1)
4 or more ANC visits on last birth	235 (18.5)	189 (14.9)	44 (3.5)	2 (0.2)	1035 (81.5)	1270 (19)
No birth/birth in >5 years	730 (19.7)	608 (16.4)	115 (3.1)	7 (0.2)	2973 (80.3)	3703 (55.4)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Given or bought iron during last pregnancy						
Not given or bought	119 (18.8)	94 (14.8)	22 (3.5)	3 (0.5)	514 (81.2)	633 (9.5)
Given or bought iron	436 (18.6)	346 (14.8)	87 (3.7)	3 (0.1)	1908 (81.4)	2344 (35.1)
No birth/birth in >5 years	730 (19.7)	608 (16.4)	115 (3.1)	7 (0.2)	2973 (80.3)	3703 (55.4)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**

Table 6 continues to next page

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VARIABLES/	ANEMIC				NOT ANEMIC	Total Weighted N
	Any anemia	Mild	Moderate	Severe		
	n (%)	n (%)	n (%)	n (%)	n (%)	N (%)
Malaria history during the last pregnancy/ use of malaria drug during last pregnancy						
No malaria drug	469 (17.5)	367 (13.7)	96 (3.6)	6 (0.2)	2214 (82.5)	2683 (40.2)
Took malaria drug	84 (28.9)	70 (24.1)	13 (4.5)	1 (0.3)	207 (71.1)	291 (4.4)
No birth/birth in >5 years	732 (19.8)	611 (16.5)	115 (3.1)	6 (0.2)	2974 (80.2)	3706 (55.5)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Took drugs for intestinal parasites during the last pregnancy						
No drug taken	281 (18.6)	224 (14.8)	52 (3.4)	5 (0.3)	1232 (81.4)	1513 (22.6)
Took drug	273 (18.7)	215 (14.7)	57 (3.9)	1 (0.1)	1190 (81.3)	1463 (21.9)
No birth/birth in >5 years	731 (19.7)	609 (16.4)	115 (3.1)	7 (0.2)	2973 (80.3)	3704 (55.4)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**

V.1. 5. Living conditions factors and anemia status

Anemia prevalence varies by living conditions. Anemia is more prevalent among those who do not have toilet or use bush or field up where it's around 30.7% and decrease up to 15.8% among those with ventilated improved pit latrine. Additionally, the higher prevalence is also observed among those who use wells as source of drinking water where it's 30.7% and 30% among those who use protected and unprotected well respectively.

Furthermore, there is no high variation of anemia among those who considerer access to health facility as a problem compared to those who consider it as a problem where the anemia prevalence is estimated to be around 20% and 19% respectively. The table 7 below provides details about living conditions factors and anemia.

Table 7: Anemia status by living conditions factors

VARIABLES	ANEMIC				NOT ANEMIC	Total Weighted N
	Any anemia	Mild	Moderate	Severe		
	n (%)	n (%)	n (%)	n (%)	n (%)	N (%)
Type of toilet used						
No toilet/bush/field	64 (30.8)	39 (18.8)	24 (11.5)	1 (0.5)	144 (69.2)	208 (3.1)
Pit latrine without slab/open pit	324 (20.7)	263 (16.8)	58 (3.7)	3 (0.2)	1238 (79.3)	1562 (23.4)
Pit latrine with slab	757 (18.2)	626 (15)	123 (3)	8 (0.2)	3404 (81.8)	4161 (62.3)
Ventilated improved pit latrine (vip)	59 (15.8)	49 (13.1)	9 (2.4)	1 (0.3)	315 (84.2)	374 (5.6)
Other types	59 (22.3)	50 (18.9)	9 (3.4)	0 (0)	205 (77.7)	264 (4)
Not resident in household	22 (19.8)	21 (18.9)	1 (0.9)	0 (0)	89 (80.2)	111 (1.7)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Source of drinking water						
Protected spring	393 (19.3)	313 (15.4)	77 (3.8)	3 (0.1)	1645 (80.7)	2038 (30.5)
Unprotected spring	162 (19.9)	136 (16.7)	23 (2.8)	3 (0.4)	654 (80.1)	816 (12.2)
Public tap/standpipe	317 (18.3)	268 (15.5)	46 (2.7)	3 (0.2)	1415 (81.7)	1732 (25.9)
Piped to yard/plot	135 (17.9)	107 (14.2)	27 (3.6)	1 (0.1)	619 (82.1)	754 (11.3)
River/dam/lake/ponds/stream/canal/irrigatio	130 (17.7)	99 (13.5)	29 (3.9)	2 (0.3)	606 (82.3)	736 (11)
Protected well	47 (31.1)	35 (23.2)	12 (7.9)	0 (0)	104 (68.9)	151 (2.3)
Unprotected well	36 (30)	29 (24.2)	6 (5)	1 (0.8)	84 (70)	120 (1.8)
Other water sources	43 (19.4)	40 (18)	3 (1.4)	0 (0)	179 (80.6)	222 (3.3)
Not resident in household	22 (19.8)	21 (18.9)	1 (0.9)	0 (0)	89 (80.2)	111 (1.7)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**
Distance to health facility- getting medical help for self						
Big problem	286 (20)	230 (16.1)	53 (3.7)	3 (0.2)	1142 (80)	1428 (21.4)
Not a big problem	999 (19)	818 (15.6)	171 (3.3)	10 (0.2)	4253 (81)	5252 (78.6)
Total	**1285 (19.2)**	**1048 (15.7)**	**224 (3.4)**	**13 (0.2)**	**5395 (80.8)**	**6680 (100)**

IV.2. RESULTS OF BIVARIATE ANALYSIS

A bivariate analysis was performed to identify the independent factors that are associated to anemia among WRA. A p value of 0.05 was considered as the cut off to identify independent variables that are associated with the outcome.

IV.2.1. Results of bivariate analysis for socio demographic characteristics factors and anemia status

A shown in table 8, the bivariate analysis showed that age category of 45 – 49 years was associated with anemia with p value: 0.01 compared to 15-19 years old category. Province was associated with anemia in WRA where Southern province (p value: <0.001) and Eastern province (p value: 0.002) were statistically significant associated to the anemia in WRA compared to Kigali city. In addition to that, type of residence (urban compared to rural area) was also associated to anemia in WRA (p value: 0.002).

Moreover, education attainment in WRA was also associated to the anemia (p value: 0.010) where those completing primary school (p value :0.001), not completing secondary school (p value: 0.027) and completing secondary school (p value: 0.014) were associated to anemia in WRA compared to those with no education.

When compared wealth index levels to poorest, wealth index was also associated with anemia with p value :0.006 for poorer, for middle, richer and richest, the p value was <0.001 for each. Moreover, marriage status was also among the independent variables which were significantly associated with anemia with p value of 0.001 for separated or widowers as compared to WRA who are single. The table 8 below show the detailed results of bivariate analysis of socio-demographic factors:

Table 8: Bivariate analysis for socio demographic characteristics factors

Variables	Anemic n (%)	Not anemic n (%)	Unadjusted OR	95% CI	P value
Age in 5-year groups					
15-19 (n=1.386)	260 (18.8)	1126 (81.2)	1		
20-24 (n=1.225)	240 (19.6)	985 (80.4)	1.06	[0.86 - 1.30]	0.605
25-29 (n=1.153)	209 (18.1)	944 (81.9)	0.96	[0.77 - 1.18]	0.668
30-34 (n=1.024)	184 (18)	840 (82)	0.95	[0.76 - 1.18]	0.652
35-39 (n=795)	154 (19.4)	641 (80.6)	1.05	[0.83 - 1.32]	0.699
40-44 (n=614)	121 (19.7)	493 (80.3)	1.07	[0.83 - 1.37]	0.62
45-49 (n=483)	117 (24.2)	366 (75.8)	1.37*	[1.06 - 1.77]	0.017
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Province of residence					
Kigali city (n=899)	133 (14.8)	766 (85.2)	1		
South (n=1.605)	367 (22.9)	1238 (77.1)	1.52***	[1.24 - 1.87]	<0.001
West (n=1.442)	259 (18)	1183 (82)	1.13	[0.90 - 1.40]	0.289
North (n=1.088)	167 (15.3)	921 (84.7)	0.95	[0.74 - 1.20]	0.647
East (n=1.646)	359 (21.8)	1287 (78.2)	1.39**	[1.12 - 1.72]	0.002
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Type of place of residence					
Urban (n=1.325)	217 (16.4)	1108 (83.6)	1		
Rural (n=5.355)	1068 (19.9)	4287 (80.1)	1.27**	[1.09 - 1.49]	0.002
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Educational attainment					
No education (n=797)	179 (22.5)	618 (77.5)	1		
Incomplete primary (n=2.863)	580 (20.3)	2283 (79.7)	0.88	[0.72 - 1.07]	0.196
Complete primary (n=1.452)	244 (16.8)	1208 (83.2)	0.70**	[0.56 - 0.88]	0.001
Incomplete secondary (n=1.044)	189 (18.1)	855 (81.9)	0.76*	[0.60 - 0.97]	0.027
Complete secondary (n=340)	55 (16.2)	285 (83.8)	0.65*	[0.47 - 0.92]	0.014
Higher (n=184)	38 (20.7)	146 (79.3)	0.9	[0.61 - 1.32]	0.592
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			

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Variables	Anemic n (%)	Not anemic n (%)	Unadjusted OR	95% CI	P value
Wealth index/ economic status					
Poorest (n=1.306)	323 (24.7)	983 (75.3)	1		
Poorer (n=1.316)	265 (20.1)	1051 (79.9)	0.76**	[0.63 - 0.93]	0.006
Middle (n=1.249)	236 (18.9)	1013 (81.1)	0.70***	[0.58 - 0.86]	<0.001
Richer (n=1.253)	202 (16.1)	1051 (83.9)	0.58***	[0.47 - 0.72]	<0.001
Richest (n=1.556)	259 (16.6)	1297 (83.4)	0.60***	[0.50 - 0.73]	<0.001
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Marriage status					
Not married (n=2.543)	485 (19.1)	2058 (80.9)	1		
Married/living together (n=3.434)	625 (18.2)	2809 (81.8)	0.94	[0.82 - 1.08]	0.411
Separated/widowed (n=703)	175 (24.9)	528 (75.1)	1.40**	[1.14 - 1.72]	0.001
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			

IVI.2.2. Results of bivariate analysis for mothers' health status and reproductive factors and anemia status

In addition to the social demographic characteristics which were statistically significantly, pregnancy status was also statistically associated with anemia with p value of 0.026 as well as those who had their last birth in less than 1 year with p value of 0.009, compared to those who had no birth or who had birth in more than 5 years. Body mass index was also significantly associated to anemia (p value <0.05 for all categories of nutrition status) compared to those underweight. The table 9 below shows details of bivariate analysis for mothers' health status and reproductive factors:

Table 9: Bivariate analysis for mothers' health status and reproductive factors

Variables	Anemic	Not anemic	Unadjusted OR	95% CI	P value
	n (%)	n (%)			
Currently pregnant					
No or unsure (n=6.189)	1170 (18.9)	5019 (81.1)			
Yes (n=491)	115 (23.4)	376 (76.6)	1.31*	[1.03 - 1.66]	0.026
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Number of children ever born					
Had no children (n=2.327)	456 (19.6)	1871 (80.4)			
1-2 children (n=1.834)	331 (18)	1503 (82)	0.91	[0.77 - 1.07]	0.235
3-4 children (n=1.266)	247 (19.5)	1019 (80.5)	0.99	[0.83 - 1.19]	0.939
5-6 children (n=786)	153 (19.5)	633 (80.5)	0.99	[0.80 - 1.23]	0.931
7 or more (n=467)	98 (21)	369 (79)	1.08	[0.84 - 1.39]	0.558
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Birth history in past years					
No birth/birth in >5 years (n=3.472)	676 (19.5)	2796 (80.5)			
Had last birth in <=1 year (n=870)	177 (20.3)	693 (79.7)	1.06	[0.87 - 1.28]	0.580
Had last birth last 2-3 years (n=1.236)	225 (18.2)	1011 (81.8)	0.92	[0.77 - 1.10]	0.368
Had last birth last 4-5 years (n=611)	92 (15.1)	519 (84.9)	0.72**	[0.56 - 0.92]	0.009
Currently pregnant (n=491)	115 (23.4)	376 (76.6)	1.26	[0.99 - 1.61]	0.062
Total (N=6.189)	**1285 (19.2)**	**5395 (80.8)**			
Currently breastfeeding					
No (n=4.787)	919 (19.2)	3868 (80.8)			
Yes (n=1.893)	366 (19.3)	1527 (80.7)	1.01	[0.87 - 1.16]	0.916
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Body mass index					
Underweight: <18.5 (n=410)	107 (26.1)	303 (73.9)			
Normal:18.50 - 24.99 (n=4.774)	912 (19.1)	3862 (80.9)	0.66***	[0.52 - 0.84]	<0.001
Overweight: 24.99 - <30 (n=1.229)	234 (19)	995 (81)	0.66**	[0.50 - 0.86]	0.002
Obese: ≥30.00 (n=267)	32 (12)	235 (88)	0.38***	[0.24 - 0.59]	<0.001
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			

IV.2.3. Results of bivariate analysis for health seeking behaviours factors and anemia

As shown in table 10 below, listening to radio at least once a week was associate to anemia in WRA (p value: 0.031) compared to those who were not listening to radio. Moreover, having mosquito bed net for sleeping (p value: 0.012) and sleeping under mosquito bed net the last night before the survey (p value: 0.001) were found to be also associated with anemia in bivariate analysis. The table 10 below provide detailed information about analysis of health seeking behaviors factors and anemia status.

Table 10: Bivariate analysis for health seeking behaviors factors and anemia status

Variables	**Anemic** n (%)	**Not anemic** n (%)	**Unadjusted OR**	**95% CI**	**P value**
Frequency of reading newspaper or magazine					
Not at all (n=4.916)	969 (19.7)	3947 (80.3)			
Less than once a week (n=1.351)	235 (17.4)	1116 (82.6)	0.86	[0.73 - 1.01]	0.064
At least once a week (n=403)	78 (19.4)	325 (80.6)	0.97	[0.75 - 1.27]	0.833
Total (N=6.670)⁺	**1282 (19.2)**	**5388 (80.8)**			
Frequency of listening to radio					
Not at all (n=1.079)	233 (21.6)	846 (78.4)			
Less than once a week (n=1.490)	292 (19.6)	1198 (80.4)	0.88	[0.72 - 1.08]	0.236
At least once a week (n=4.099)	758 (18.5)	3341 (81.5)	0.82*	[0.69 - 0.98]	0.031
Total (N=6.668)⁺	**1283 (19.2)**	**5385 (80.8)**			
Frequency of watching television					
Not at all (n=3.799)	755 (19.9)	3044 (80.1)			
Less than once a week (n=1.760)	330 (18.8)	1430 (81.3)	0.93	[0.80 - 1.08]	0.348
At least once a week (n=1.107)	195 (17.6)	912 (82.4)	0.86	[0.72 - 1.03]	0.093
Total (N=6.666)⁺	**1280 (19.2)**	**5386 (80.8)**			

+ Missing values

+ Missing values

Table 10 continues to next page

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Variables	Anemic	Not anemic	Unadjusted OR	95% CI	P value
	n (%)	n (%)			
Have mosquito bed net for sleeping					
No (n=1.049)	232 (22.1)	817 (77.9)			
Yes (n=5.631)	1053 (18.7)	4578 (81.3)	0.81*	[0.69 - 0.96]	0.012
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
WRA slept under mosquito bed net					
No (n=2.184)	469 (21.5)	1715 (78.5)			
Yes (n=4.496)	816 (18.1)	3680 (81.9)	0.81**	[0.71 - 0.92]	0.001
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			

IV.2.4. Results of bivariate analysis for factors related to the health services uses and anemia status

As shown in table 11 below, the use of hormonal contraceptives as family planning methods was also found to be associated with anemia with p value of <0.001 compared to those who were using any, natural method, barriers or permanent methods. Moreover, having taken malaria during the last pregnancy was found also to be associated with anemia in WRA with p value <0.001 compared to those who did not.

Table 11: Bivariate analysis for factors related to the health services uses and anemia status

Variables	Anemic	Not anemic	Unadjusted OR	95% CI	P value
	n (%)	n (%)			
Use of FP method					
None. Natural. Barriers or permanent (n=4.572)	940 (20.6)	3632 (79.4)			
Hormonal (n=1.565)	215 (13.7)	1350 (86.3)	0.61***	[0.52 - 0.73]	<0.001
IUD (n=52)	15 (28.8)	37 (71.2)	1.59	[0.87 - 2.89]	0.131
Currently pregnant (n=491)	115 (23.4)	376 (76.6)	1.18	[0.93 - 1.50]	0.179
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			

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Variables	Anemic n (%)	Not anemic n (%)	Unadjusted OR	95% CI	P value
Use of ANC services during last pregnancy					
No ANC visit on last birth (n=31)	8 (25.8)	23 (74.2)			
1-3 ANC visits on last birth (n=1.676)	312 (18.6)	1364 (81.4)	0.71	[0.31 - 1.63]	0.419
4 or more ANC visits on last birth (n=1.270)	235 (18.5)	1035 (81.5)	0.71	[0.31 - 1.62]	0.412
Had no birth or birth in >5 years (n=3.703)	730 (19.7)	2973 (80.3)	0.76	[0.34 - 1.74]	0.521
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Given or bought iron during last pregnancy					
Not given or bought (n=633)	119 (18.8)	514 (81.2)			
Given or bought iron (n=2.344)	436 (18.6)	1908 (81.4)	1	[0.79 - 1.27]	0.994
Had no birth in last 5 years (n=3.703)	730 (19.7)	2973 (80.3)	1.07	[0.86 - 1.35]	0.543
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Malaria history during the last pregnancy/ use of malaria drug during last pregnancy					
No malaria drug (n=2.683)	469 (17.5)	2214 (82.5)			
Took malaria drug (n=291)	84 (28.9)	207 (71.1)	1.91***	[1.43 - 2.55]	<0.001
Had no pregnancy in last 5 years (n=3.706)	732 (19.8)	2974 (80.2)	1.16*	[1.02 - 1.33]	0.029
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			
Took drugs for intestinal parasites during the last pregnancy					
No drug for intestinal parasites (n=1.513)	281 (18.6)	1232 (81.4)			
Took drug for intestinal parasites (n=1.463)	273 (18.7)	1190 (81.3)	1	[0.83 - 1.22]	0.970
Had no pregnancy in last 5 years (n=3.704)	731 (19.7)	2973 (80.3)	1.08	[0.92 - 1.26]	0.378
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			

IV.2.5. Results of bivariate analysis for *living conditions factors and anemia status*

Type of the toilet used by the WRA ($p < 0.05$ for all types of toilets compared to those without toilet or who use bushes or field, except those who were not residents in the household) were also

found to be associated with anemia. Furthermore, those who use protected well (p value 0.001) and those who use unprotected wells (p value 0.007) were also found to be associated with anemia in bivariate analysis. The table 12 below shows the results of bivariate analysis for living conditions factors:

Table 12: Bivariate analysis for living conditions factors

Variables	Anemic	Not anemic	Unadjusted OR	95% CI	P value
	n (%)	n (%)			
Type of toilet used					
No toilet/bush/field (n=208)	64 (30.8)	144 (69.2)			
Pit latrine without slab/open pit (n=1.562)	324 (20.7)	1238 (79.3)	0.59**	[0.42 - 0.83]	0.002
Pit latrine with slab (n=4.161)	757 (18.2)	3404 (81.8)	0.50***	[0.36 - 0.69]	<0.001
Ventilated improved pit latrine (vip) (n=374)	59 (15.8)	315 (84.2)	0.42***	[0.27 - 0.65]	<0.001
Other types (n=264)	59 (22.3)	205 (77.7)	0.64*	[0.42 - 0.99]	0.042
Not resident in household (n=111)	22 (19.8)	89 (80.2)	0.57	[0.32 - 1.01]	0.052
Total (N=6.569)⁺	**1285 (19.2)**	**5395 (80.8)**			
Source of drinking water					
Protected spring (n=2.038)	393 (19.3)	1645 (80.7)			
Unprotected spring (n=816)	162 (19.9)	654 (80.1)	1.03	[0.84 - 1.27]	0.769
Public tap/standpipe (n=1.732)	317 (18.3)	1415 (81.7)	0.94	[0.79 - 1.12]	0.472
Piped to yard/plot (n=754)	135 (17.9)	619 (82.1)	0.92	[0.74 - 1.14]	0.431
River/dam/lake/ponds/stream/ canal/irrig (n=736)	130 (17.7)	606 (82.3)	0.9	[0.71 - 1.14]	0.366
Protected well (n=151)	47 (31.1)	104 (68.9)	1.86**	[1.27 - 2.71]	0.001
Unprotected well (n=120)	36 (30)	84 (70)	1.79**	[1.17 - 2.76]	0.007
Other water sources (n=222)	43 (19.4)	179 (80.6)	1.01	[0.70 - 1.44]	0.974
Not resident in household (n=111)	22 (19.8)	89 (80.2)	1.06	[0.65 - 1.73]	0.823
Total (N=6.568)⁺	**1285 (19.2)**	**5395 (80.8)**			
+ Missing values					
Distance to health facility- getting medical help for self					
Big problem (n=1.428)	286 (20)	1142 (80)			
Not a big problem (n=5.252)	999 (19)	4253 (81)	0.94	[0.81 - 1.10]	0.436
Total (N=6.680)	**1285 (19.2)**	**5395 (80.8)**			

The other independent variables including number of children ever bon from the WRA, breastfeed status, use of ante natal care, having been given or bough iron on last pregnancy, having took drugs for intestinal parasites during the last pregnancy, reading newspaper or magazine or watching television and considering getting medical help for self-distance to health facility as a problem were found not to be associated with anemia in WRA in bivariate analysis.

IV.3. RESULTS OF MULTIVARIATE ANALYSIS – FINAL MODEL

Independent variables that were significant in bivariate analysis were used in multivariate analysis after checking their collinearity. The results of multivariate analysis as the final model demonstrated that province was associated with anemia where WRA in Southern province (OR: 1.52 with 95% CI: 1.19 - 1.95 and p value of <0.001) and Eastern provinces (OR: 1.49 with 95% CI: 1.15 - 1.92 and p value of 0.002) have greater risks of anemia compared to the WRA in Kigali city.

Moreover, it was also indicated that economic status (wealth index level) is associated with the anemia in WRA where the risk decreases with the improvement of the economic status. Comparing to the poorest, risk of anemia in WRA is reduced among poorer (OR: 0.78 with 95% CI: 0.64 - 0.95 and p value of 0.013), among with middle wealth index (OR: 0.73 with 95% CI: 0. 0.59 - 0.90 and p value of 0.003), among richer (OR: 0.61 with 95% CI: 0.49 - 0.76 and p value of <0.001) as well as among the richest (OR: 0.72 with 95% CI: 0.57 - 0.90 and p value of 0.003).

In addition to that, the risk of anemia is the same among not married and married women or living together with their husbands (OR: 1.13 with 95% CI: 0.94 - 1.36 and p value of 0.185). However, the risk of anemia is increased among separated/widows WRA as compared to WRA who are not married (OR: 1.35 with 95% CI: 1.08 - 1.68 and p value of 0.008).

Furthermore, malaria was found to be among the risk factors of anemia among WRA as the results have demonstrated that those WRA who took malaria drug during their last pregnancy (and thus had malaria history) had a greater risk of anemia (OR: 1.77 with 95% CI: 1.31 - 2.38 and p value of <0.001) compared to those who did not take malaria drug.

Moreover, the risk of anemia for those who reported sleeping under mosquito net the night before the survey was reduced (OR: 0.86 with 95% CI: 0.74 - 0.99 and p value of 0.038) compared to those who did not sleeping under mosquito net the night before the survey.

Besides that, nutrition status of women was associated with anemia. Comparing to underweight WRA, women with normal BMI has a reduced risk of having anemia (OR: 0.73 with 95% CI: 0.57 - 0.94 and p value of 0.013), as well as for those with obesity (OR: 0.45 with 95% CI: 0.28 - 0.71 and p value of <0.001). However, there is not different of risk of anemia between underweight WRA and overweight WRA (OR: 0.8 with 95% CI: 0.61 - 1.07 and p value of 0.129).

Moreover, use of contraceptives is also associated with anemia in WRA where the risk of anemia is reduced among those using hormonal contraceptives (OR: 0.60 with 95% CI: 0.50 - 0.73 and p value of <0.001) compared to those who do not use any contraceptive or who use natural, barriers or permanent contraceptive methods. However, the risk of anemia is increased among those using Intra Uterus Device (OR: 1.94 with 95% CI: 1.03 - 3.67 and p value of 0.041). The table 13 summarizes those findings of the multivariate analysis as the final model:

Table 13: Results of multivariate analysis by any anemia – final model

Variables	Anemic n (%)	Adjusted Odd ratio	95%CI	P value
Province				
Kigali city (n=899)	133 (14.8)	1		
South (n=1.605)	367 (22.9)	1.52***	[1.19 - 1.95]	<0.001
West (n=1.442)	259 (18)	1.1	[0.84 - 1.44]	0.493
North (n=1.088)	167 (15.3)	0.97	[0.74 - 1.29]	0.852
East (n=1.646)	359 (21.8)	1.49**	[1.15 - 1.92]	0.002
Wealth index				
Poorest (n=1.306)	323 (24.7)	1		
Poorer (n=1.316)	265 (20.1)	0.78*	[0.64 - 0.95]	0.013
Middle (n=1.249)	236 (18.9)	0.73**	[0.59 - 0.90]	0.003
Richer (n=1.253)	202 (16.1)	0.61***	[0.49 - 0.76]	<0.001
Richest (n=1.556)	259 (16.6)	0.72**	[0.57 - 0.90]	0.003
Marriage status				
Not married (n=2.543)	485 (19.1)	1		
Married/living together (n=3.434)	625 (18.2)	1.13	[0.94 - 1.36]	0.185
Separated/widowed (n=703)	175 (24.9)	1.35**	[1.08 - 1.68]	0.008
Use of FP method				
None, natural, barriers or permanent (n=4.572)	940 (20.6)	1		
Hormonal (n=1.565)	215 (13.7)	0.60***	[0.50 - 0.73]	<0.001
IUD (n=52)	15 (28.8)	1.94*	[1.03 - 3.67]	0.041
Currently pregnant (n=491)	115 (23.4)	1.17	[0.90 - 1.50]	0.241
Malaria history/took malaria drug during last pregnancy				
No malaria drug (n=2.683)	469 (17.5)	1		
Took malaria drug (n=291)	84 (28.9)	1.77***	[1.31 - 2.38]	<0.001
Had no pregnancy in last 5 years (n=3.706)	732 (19.8)	1.12	[0.95 - 1.32]	0.174
Body Mass Index (BMI)				
Underweight: <18.5 (n=410)	107 (26.1)	1		
Normal:18.50 - 24.99 (n=4.774)	912 (19.1)	0.73*	[0.57 - 0.94]	0.013
Overweight: 24.99 - <30 (n=1.229)	234 (19)	0.8	[0.61 - 1.07]	0.129
Obese: ≥30.00 (n=267)	32 (12)	0.45***	[0.28 - 0.71]	<0.001
Respondent slept under mosquito bed net				
No (n=2.184)	469 (21.5)	1		
Yes (n=4.496)	816 (18.1)	0.86*	[0.74 - 0.99]	0.038
N weighted		6680		

V. DISCUSSION AND CONCLUSION

V.1. DISCUSSION OF THE RESULTS

This cross-sectional study using secondary data analysis of RDHS 2014/2015 was able to identify the risk factors of anemia among WRA in Rwanda**.** The RDHS has an advantage of being a national representative study and uses standardised and tested questionnaires which improves its validity (7). The study included all WRA who participated in the study and who had the haemoglobin results with anemia levels results and the risks factors that have been identified to be influencing anemia in WRA in other settings were compared are compared to those found in this study (20,38). In addition to that, the study has a national representation as study participants were selected from all districts in Rwanda to ensure representation.

V.1.1. Anemia prevalence

The study findings showed that anemia in WRA is increasing over time in Rwanda compared to the previous DHS data. This pattern is different to other East African countries where there has been a reduction of anemia in WRA over the past years (25). Moreover, anemia was more prevalent among old women, as well as in pregnant women compared to those who were not pregnant. This is in line with other studies which found a high prevalence of anemia on those groups (27).

Besides that, the anemia prevalence was higher and also almost the same among WRA with no education and those who did not complete primary as well as among those with high education. However, that difference has not been statistically significant and thus education level has not been found to be a risk factor of anemia among WRA in Rwanda in this study. Such findings are different to the other studies which found that education level was associated to the anemia. Studies conducted in Tanzania and in Ethiopia concluded that women with poor education had a higher risk of being anemic compared to those with improved educational (46,38). An explanation of such differences is being the fact that there's a relation between education and wealth status and thus, those with primary education may have an improved economic status and thus reduce the risk of anemia.

In addition to that, although the use of antenatal care was considered to be among the factors influencing anemia in WRA as well as having given or bought iron in other studies, (27,47), our study did not find them as risk factors of anemia in Rwanda; this may be explained by the fact that although 80% of Rwandan women take iron tablets or syrup during pregnancy, only 3% take it for the recommended period of 90 days which reduce the iron effect (13,7). Studies have demonstrated that daily iron intervention provides more protection against a decline in the storage iron pool in pregnant women than does an intermittent schedule (48).

Additionally, such questions in DHS are asked to women who had birth during their last 5 years and thus, taking iron over the past years may not still has effect to the actual anemia status because the iron supplementation requires continuous effect (48) and the DHS don't specify when the iron were taken. On the other hand, as it is well known that pregnant women have a high risk of anemia and iron is provided to pregnant women who attend antenatal care (13). Thus, having taken iron may offer a protective effect to anemia and thus reduce that increased risk with effect of not being found as risk factor.

Furthermore, high prevalence of anemia was found among WRA who use water from wells as drinking water as well as those who do not have toilets or who uses bush of field as toilet. Although those factors were not statistically significant. Such high prevalence in those sub groups may be explained by the fact that such population have also low social economic status in most of the cases. Moreover, in order studies, type of the toilet has been found to be associated with the anemia risks including the in a study conducted in Tanzania (38).

In connection to that, the low level of hygiene that accompany the absence of the toilet as well as the high risks of contaminations of water in wells put those people at high risks of having various infections such as intestinal parasites like hookworms among others, and those also have been found to be among anemia risk factors in many studies including the one conducted in Nigeria (49). In our study, intestinal parasites were not a risk factor of anemia because the information was based not on real time but in the past history of the last pregnancy and thus could not influence much the situation during the survey.

V.1.2. Risk factors of anemia among WRA

The study found that factors of being in Eastern and Southern provinces, economic status, having separated with husband or widowed, use of hormonal or IUD as contraceptive method, nutrition status of the women, having malaria history as well as sleeping under mosquito net were associated with anemia among WRA in Rwanda.

Geographic area has been associated with anemia among WRA in other studies as it was in our findings. In Tanzania, the study about anemia found similar results of variations of anemia according to geographic characteristics (38) and same results were concluded in another study conducted in Ethiopia (46). In our findings, the women in Eastern province and Southern province have an increased risk of anemia. This may be explained by the fact that they are the provinces in Rwanda considered to be malaria endemic and malaria has been found to be causing anemia in populations (20).

A part from that, the recent RDHS 2014/2015 has found that women in Eastern province tend to not take iron supplementation during their pregnancy as compared to other provinces. Moreover, the districts with top high prevalence of anemia among WRA are found in Southern province- Gisagara district, and in Eastern province - Kirehe with and Ngoma (7) and those factors may explain also why geographic location is associated to anemia in WRA. However, more investigations still needed to assess those variations between the districts.

Wealth index in WRA was found to be a significant factor associated to anemia among WRA in Rwanda where the risks are reduced the more the economic status is increased. Such findings are not different from those found in other settings (38,22,46). Anemia is a multifactor problem, and wealth index status also is associated with different factors that may impact anemia directly or indirectly. Evidences shows that improved economic status is associated with improved hygiene and low infection morbidity rate, improved access to information, education and to health services as well as to the fact of having the facilities likes good toilet, treated water (50).

All those factors have been found to be associated with anemia in other studies unless they were not associated with anemia in WRA in our study. Thus, WRA with improved economic status have

lower risks of anemia as they are able to use available preventive measures compared to those who are poor. For example, people with lowest economic status have also low access in terms of possession of mosquito net where only 53% of people with low economic status have access to an ITN in the household in Rwanda (7). As malaria is known to be among the risk factors of anemia, this also increase their risks of having anemia (19).

Besides that, the use of hormonal contraceptives has been found to be reducing the risk of anemia among WRA compared to those who are not using any method or those using natural, barriers or permanent methods. Such findings are similar with those found in similar studies conducted in Tanzania and in other settings (46,38). Amenorrhea is one the common side effect of hormonal contraceptives where a woman may even pass a long time without having her period (43,51). Thus, this reduces the risk of anemia as there will be no blood loss over that period and thus the haemoglobin level will be stable. However, more investigations are still needed to understand the real physiological mechanisms.

A part from that, our study found that women using IUD have a greater risk of anemia compared to those who are not using any method or those using natural, barriers or permanent methods. Those findings are similar to those of the study conducted in some settings but those studies about significant difference of anemia risk among those using IUD compared to others non-users recommended also further investigations (43). Although such non-conclusive findings, some reasons may be the fact that women using IUD have extended time of their periods as well as the quantity of blood during their periods especially during the first months of stating using it which impact their haemoglobin level (51). Thus, with such increased needs in haemoglobin replacement, when associated with other factors, the risk may increase. Additionally, there has been also an increase in IUD use among women in Rwanda over the past years from 0.2% in 2010 to 0.7% in 2015 (7,6).

Furthermore, nutritional status of WRA was found to be a risk factor of anemia and those findings are similar with other different studies conducted in other settings. In a study conducted among Serbian non-pregnant women, BMI was found to be associated with anemia (52). However, other studies did not find BMI associated to anemia (38,46). This may be due to the fact that anemia itself is one form of malnutrition and the most common cause is the iron deficiency which in most

of the case associated with other types of malnutrition (13). Thus, women who are underweighted have a greater risk of iron deficiency, infections which have been found to be increasing anemia risks (49). Thus, those with normal nutrition status have lower risks of having anemia as it's for the obese WRA as their nutrition status is improved and thus have lower risks of having nutrition deficiencies including iron deficiency unless obesity is associated with health conditions like non-communicable diseases where studies have found that anemia risk is increased (22). However, our study found that there was no difference of anemia risks between those overweighed WRA and underweighted. This stills needs further investigations.

In this study, it was found that widowers and women who separated with their husbands have a greater risk of anemia compared to those who are not married and those married or living together with their husbands. This may be explained by the social economic status of the widows in Rwanda as some may have little support while they have to sustain their family. In addition to that, many widows have an increased age compared to those married unless the factor age was not found to be associated with anemia in this study as it was in other studies (38). In addition to that, another explanation is that the recent RDHS 2015/2015 found that 14% of widows are HIV positive. As other studies found higher anemia prevalence among HIV positive, an association between the 2 factors may be possible (30). However, further investigations to elicit that are necessary.

Malaria was found to be among the associated factors of anemia among WRA. The study found that women who took malaria drug during the last pregnancy had a greater risk of having anemia compared to those who did not take any malaria drug. This is explained by the fact that malaria has been found to be causing anemia in a population and thus taking malaria drug shows that they had malaria and thus at risk of anemia. This may suggest the explanations of the increase of anemia among WRA as malaria morbidity has increased in past years in Rwanda and evidences demonstrated that women are at greater risk of malaria especially when pregnant (53). Thus, with the increase of number of people with malaria, WRA with malaria also increased which may explain the increase of the anemia prevalence among WRA in Rwanda over the last years.

In connection to that, our study also demonstrated that use of mosquito nets reduces the risk of anemia. Such findings are in line with those found in Kenya where the use of mosquito net has been found to be lowering the risk of anemia (54). The use of mosquito nets prevents WRA from

having malaria which is among the factors that contributed to anemia as demonstrated elsewhere (55). Thus, the increase of anemia prevalence among WRA may also be explained by the low utilisation of mosquito net with the increase of malaria morbidity in the population.

V.2. CONCLUSION

Anemia is a public health problem among WRA and recent evidences have demonstrated that it's increasing. Anemia prevalence among WRA in Rwanda is 19.2%, 15.7% of WRA have mild anemia, 3.4% have moderate anemia while 0.2% have severe anemia.

Referring to our hypothesis, they are variations of anemia status between provinces where Eastern and Southern provinces have a higher risk of anemia. However, the variation between rural and urban is not statistically significant. Moreover, our study confirmed the hypothesis that the anemia among WRA in Rwanda is associated with economic status, the nutrition status of the WRA. However, our study found that there's no association between anemia among WRA in Rwanda and education level, use of antenatal case, iron supplementation, hygiene: type of toilet and source of drinking water, and access to information as well as the access to health services.

The wealth index level is among the risk factors of anemia in WRA in Rwanda and as the more the economic status improves, the more the risk of anemia reduces. Additionally, type of contraceptive used by WRA is associated with anemia; the used IUD as contraceptive method increases the risk of anemia while the use of hormonal contraceptives reduces the risk.

Besides that, nutrition status of WRA is an important risk factor, WRA with normal BMI and obese have a reduced risk of anemia compared to the underweighted. Moreover, malaria has been found to be associated with anemia where women who suffered malaria have a high risk of anemia and those who use mosquito net reduces the risk of anemia. Furthermore, widows WRA and those who separated with their husbands have an increased risk of anemia compared to other WRA.

Interventions to address anemia problem in Rwanda should take into account those risk factors by enhancing malaria and anemia prevention interventions especially in Eastern and Southern provinces and improving nutrition and social economic status of WRA in general. Special attention

and further investigations are needed to assess in deep the risk factors of anemia among widowers and separated women. In all, evidences from this study guaranty their validity and may serve as base for further researches as well as to better design health interventions addressing anemia among WRA in Rwanda.

V.3. POLICY AND PROGRAMMATIC RECOMMENDATIONS

In order to ensure sustainable health impact, different policy and interventions are available in Rwanda to address anemia problem. Pregnant women are provided with iron supplementations during ante natal care visits, Information, Education and Communication (IEC) activities are conducted to improve the knowledge and good practice about malaria prevention and nutrition in general as well as distribution of Long Lasting Insecticides Treated Nets (LLITNs) to ensure coverage.

Most of those policies and interventions are in same line with the factors found to be associated with anemia in WRA in this study. Their review and improvement will be important including the review and change of existing malaria preventions guidelines related to LLITNs distribution in the population to improve their access, improvement of the management of WRA using IUD as a contraceptive method as well as the underweighted WRA. Those imply a multi-stakeholder's collaboration at national, province and district level as well as involvement of the School of Public Health in Rwanda.

V.3.1. At the national level – Ministry of Health and its stakeholders

At the national level, our study findings show that considerable successes have been achieved. However, considerable concerted effort need to be sustained to lower prevalence of anemia even further.

Among the risk factors associated with anemia in WRA in Rwanda, malaria is one of them. The backbone of its prevention is the universal coverage of LLITNs (55). In Rwanda, its coverage is still a challenge as the household having at least one mosquito net has reduced from 82.7% in 2010 to 80.8% and only 42.8% of household have 1 LLITNs per 2 persons in households. This number

is small for an average family size of 4-7 people (7). Improvement in this regard can be achieved by:

- Allowing the distribution of LLITNs through other channels other than the public sector, such as through social marketing. Involvement of non-government organisations would reduce the risks of having malaria and anemia by increasing LLITNs coverage nationwide as the level effectiveness of mosquito net use in a population depends on the level of their coverage in that population
- Continue and reinforce the Behaviour Change Communication (BCC) interventions in the community to improve knowledge and practices of malaria prevention and management.

A part from that, the other recommendations are the following:

- Regarding the IUD use guidelines, our study provided evidences that IUD is among the risk factors of anemia in WRA. Clinical guidelines should be provided for the use of IUD so that iron supplementation is an additional option for new users of IUD.
- Allocation of more government and Non-governmental resources to Southern and Eastern provinces to prioritize interventions
- Increase research for evidence based decision making, especially for widow and separated WRA for purposes of assessing their specific anemia risk factors.
- Increase operations research to permit assessment of local challenges using local levels and design interventions tailored to local needs.
- Continue to empower women economically through income generating activities to be able to meet challenges of anemia whose solution requires purchases of food supplements

V.3.2. District and provincial level

Results of the current study suggest provincial administration:

- Should continue using the existing health data in their local community and monitor trends for purposes of taking proactive steps when undesirable trends are detected
- Should continue to design innovative ways of sensitization of community members about the nutrition to prevent malnutrition among WRA, known to be a major risk factor of anemia.

- In Eastern and Southern provinces, should enhance community mobilisation activities related to improve the social and economic status in the population, especially for vulnerable people (widowers and women separated from their husbands) to improve their social and economic status.

V.3.3. In clinical practices and service delivery

The following are recommended to contribute towards policy formulation:

- Sustained effort for supplementation of iron. Different opportunities should be used to improve iron supplementation for WRA. For example, as 99% of Rwandan mothers received antenatal care (7), Rwandan mothers attending antenatal care should be counselled to iron supplementation and nutrition subjects in general during their IEC sessions.
- Iron supplementation services could also be decentralised to the community and be provided by the Community Health Workers (CHWs). Decentralised services are known to be most effective in Rwanda and in other countries (56).
- Provide iron supplements to women using IUDs.

V.4. STUDY LIMITATIONS AND IMPLICATIONS FOR FUTURE RESEARCH

Anemia among WRA is a multifactor health conditions. Risk factors associated with anemia have been identified and recommendations have been proposed to address it. However, as any other study, this study doesn't make an exception of having limitations.

Being a secondary data analysis, this study could not be able to exhaust all factors especially those not collected in DHS. Other factors especially qualitative information could provide more insights about the risk factors of anemia in community including those related to variations of diet and food quality in community and their influence to anemia. Additionally, being a cross sectional and secondary data analysis, it is limited in being able to provide cause effect relationship of anemia among women of reproductive age in Rwanda.

Further research about the anemia in Rwanda population are necessary to continue provide information to which interventions should base on to reduce the anemia burden. There still need to assess the prevalence of iron deficiency with a national representative study in order to know the areas that needs special attentions in terms of iron supplementation. Furthermore, the risk factors of anemia among widows stills need further investigations to understand the rationale behind in order to design selected interventions towards them.

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VII. APPENDICES

VII.1. Authors' approval for secondary data analysis

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DHS Download Account Application

To: Dieudonne HAKIZIMANA

Please read the attached file.

You have been authorized to download "Survey" data from the Demographic and Health Surveys (DHS) Program. This authorization is for unrestricted countries requested on your application, and the data should only be used for the registered research or study. To use the data for another purpose, a new research project should be submitted using the "Create A New Project" link in your user account.

All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. The data sets must not be passed on to other researchers without the written consent of DHS. Users are required to submit a copy of any reports/publications resulting from using the DHS data files to: archive@dhsprogram.com.

The files you will download are in zipped format and must be unzipped before analysis. To begin downloading, please login at: http://www.dhsprogram.com/data/dataset_admin/login_main.cfm . If you are approved for a large number of countries/datasets, we recommend that you use the new Bulk Downloading System. For instructions on bulk downloading, please go to: http://userforum.dhsprogram.com/index.php?t=msg&th=5246 .

Following are some guidelines:

After unzipping, please print the file with the .DOC/DOCX extension (found in the Individual and Male Recode Zips). This file contains useful information on country specific variables and differences in the Standard Recode definition. You will also need the DHS Recode Manual: http://dhsprogram.com/publications/publication-dhsg4-dhs-questionnaires-and-manuals.cfm . This manual contains a general description of the recode data file, including the rationale for recoding; a description of coding standards and recode variables, and a listing of the standard dictionary, with basic information relating to each variable.

It is essential that you consult the questionnaire for a country, when using the data files. Questionnaires are in the appendices of each survey's final report: http://dhsprogram.com/publications/publications-by-type.cfm . We also recommend that you make use of the Data Tools and Manuals at: http://www.dhsprogram.com/accesssurveys/technical_assistance.cfm .

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VII.1. SAMPLE OF DISSEMINATION LEAFLET TO CONCERNED STAKEHOLDERS

(ATTACHED)