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Effects of Antenatal care on Low Birth Weight of Children in Rwanda:

Evidence from the Rwanda Demographic Health Survey data 2014/2015

By

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Declaration

I, hereby, affirm that this dissertation entitled "***Effects of Antenatal care on Low Birth Weight of Children in Rwanda: Evidence from the Rwanda Demographic Health Survey data 2014/2015***" is my own study. This scientific study was not previously published in any worldwide journal nor presented in any other institution for the academic reason or any other scientific reason.

Signed ………………………………………… Date …………………………………….

Emmanuel Biracyaza

Dedication

First and foremost, the current thesis is dedicated to Fr. Prof. Luc Moës living in the Monastery of Maredsous in Belgium. He provided the possible resource and financial assistance so that I'd become a good professional who will effectively provide the health care for everyone with the Public Health concerns. This Father loves and encourages me with no bounds. He always teaches me the value of hard-working. He encourages me for doing doctoral program as the professional in health domain. My dedication is also offered to Fr. Dr. Donat Rusengamihigo who always encourages me in all my studies and teaches me that I have to contribute to vulnerable people living in different settings expressly in our country. Besides, my mother "Consolee Nyiracyiza" who raised, loved and taught me since my childhood is devoted.

Moreover, I am devoting this thesis to my friends especially Dr. Heather Evans for caring and praying for me during all my studies of Master program at University of Rwanda. I lastly dedicate this dissertation to Prof. Eugene Rutembesa for helping me in all my studies so that I'd increase my skills and experiences in health settings.

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List of acronyms and abbreviations

ANC	**:**	Antenatal Care
CHMS	**:**	College of Medicine and Health Sciences
LBW	**:**	Low Birth Weight
MRCT	**:**	Mother-To- Child Transmission
NISR	**:**	National Institute of Statistics of Rwanda
NBW	**:**	Normal Birth Weight
RDHS	**:**	Rwanda Demographic and Health Survey
SDG	**:**	Sustainable Development Goal
SPH	**:**	School of Public Health
WHO	**:**	World Health Organization

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ABSTRACT

Background: Pregnant women and their children's health remain the global unfinished agenda in the most countries of the world especially in low- and middle-income countries. Low birth weight (LBW) subsequently has the harmful effects on the lifestyle of the child basically on his psychosocial and physiological development. Antenatal care is an important prospect characterized by vital interventions for pregnant women. This study aimed at identifying the effects ANC visits on birth weight babies of Rwanda in 2015.

Methods: Cross-sectional study design was conducted for analyzing the effects of antenatal care on low birth weight children using the Rwanda Demographic Health Survey 2014/2015.

Results: Results indicated that socio-demographic data were significantly associated with the low birth weight children. It was found that the pregnant women who attended four recommended ANC visits had lower low birth weight children than who attended less than who attended no and less than four antenatal care visits [OR=0.62; 95%CI(0.46-0.82), $p<0.001$]. The risk of having low birth weight children for the women who took no medical drugs for malaria were less likely to have low birth weight children compared to who took them [OR=0.32; 95%CI (0.13-0.83), p=0.018]. The marital status for the pregant women was found to be the risk factor of low birth weight children. The pregnant women who got married and/or living with the partners had a greater risk to have low birth weight children than the women who were single [OR=1.86; 95%CI(1.25-2.76); *p*=0.002].

Conclusion: Completing ANC visits is appropriate way for reducing the birth weight of the children. To improve the maternal and child health is basically needed focusing on the improvement and management of the socio-demographic status of the pregnant. Promoting health education related to antenatal care, its recommended package and their effects on health of mothers and child needs to be prioritized.

Keywords: ANC; Birth weight; Infant; Maternal; SDGs; Pregnancy

CHAPTER I: GENERAL INTRODUCTION

1.1.Background

Antenatal care (ANC) globally remains an important health intervention that has a significant contribution to pregnant women and their babies' health and wellbeing (1). The estimate of 15.5% of low birth weight worldwide was reported (2) and the high prevalence (95.6%) of low birth weight children occurred in the developing countries (3). These health interventions have significant advantages for promoting health of both mothers and children before, during and after delivery. They also contribute to the reduction to morbidity and mortality of mothers and children (4,5). There is a need of reinforcing the antenatal care for promoting mother and child health (6,7). Among the public health burdens, neonatal, infant and child mortality associated with malnutrition and stunting are documented to be highly prevalent in the developing countries. These issues were reported to be associated with various factors that need to be controlled using the appropriate interventions including ANC (8). These burdens, that mainly occur in most countries from the developing world, significantly caused low birth weight (9). The prior studies documented that the children develop LBW when they weigh less than 2,5 kilograms at birth (8). The epidemiological findings from the preceding studies documented that the children weighing less than 2.5kilograms are approximately 20 times likely to die than who weigh 2.5 kilograms and more (10,11).

It was found that low birth weight was highly prevalent in developing countries and it had the devastated effects on the life expectancy and socio-economic development of the families. The prior studies indicated that birth weight lower than 2.5kilogram was the burden and affect to the range of poor health outcomes (12). The preceding studies documented that in 2013, there was an estimation of 16% (22 million) of the global babies who had LBW. The similar studies confirmed that 96% of these children were born to the mothers from developing countries. Considering the previous results, LBW remains a foremost public health burden which weakens development of families and nations due to its harmful effects on quality of life (13). The previous research demonstrated that LBW is the significant determinant of developing the public health problems like asphyxia, amniotic fluid aspiration, hypoglycemia and hyponatremia. The prior studies documented that the children whose weight changed from 1,500grams to 2,500grams were 5 to 10 times more likely to be died than who weighed 2.5 kilogram and more (14,15). The earlier research documented that more than 20 million global children that represented 15.5% of all births had

LBW. About 95.6% of these cases were babies from developing countries (9,16). It was previously revealed that the major factors were significant associated with LBW. The factors contributing to the LBW were maternal factors consist of socio-economic status, food consumption behaviors, calories intake, urinary tract infections, smoking behaviors, genital infections and psychological distress (13,16). The other studies indicated that ANC contributes to the women's weight gain and regulation of maternal weight through each visit. They confirmed that the ANC contributes to the normalization of weight of the pregnant woman because ANC is the intervention that contributes to the growth of the fetal and maternal tissues and fluids (17).

Antenatal care is taken as the routine health management of presumed healthy pregnant women without the symptomatology or screening, so as to diagnose and detect the diseases or complicating symptoms. This health intervention plays a great role to the provision of the information about lifestyle, pregnancy and delivery (18). Based on the findings from the previous studies, it is scientifically known attending regularly the four recommended ANC care visits and/or more is very important for decreasing the risk to have morbidity and mortality of pregnant women and child; but who do not attend ANC services regularly remain at high risk to have high maternal and child morbidity and mortality (19). Antenatal care (ANC) is mostly debated in the sub-Saharan African countries. Prior studies showed that two-thirds of all worldwide pregnant women attended at least one antenatal care during pregnancy (20). Currently, to attend 4 required ANC visits within the developing world remains the barrier that has been linked to the high mortality and morbidity of infant health issues and maternal complications (21).

For achieving the full life-saving potential that ANC consists for both mothers and children, the pregnant women are required to attend four ANC that provide to them the basic and essential health interventions offering the essential interventions constituted of the recommended package of various interventions which contribute to health of pregnant and health of baby (16). The package provided to pregnant women consists of many interventions such as identification and management of obstetric complications such as preeclampsia, tetanus toxoid immunization, intervention for preventing malaria, and identifying and controlling the health infectious diseases that include sexual transmissible diseases (STDs) and Human Immunodeficiency Virus (22). Antenatal visit has evidently found to be an opportunity for promoting the use of the skilled

attendance at birth and healthy behaviors such as the breastfeeding, early postnatal, and planning for the optimal pregnancy spacing (20). Amongst health services delivered to the pregnant women during ANC, the fundamental rudiments of a focused approach to ANC are surveillance of the health issues amongst pregnant woman and their babies, management of complications occurring in the pregnant period, particularly pre-eclampsia, treatment of underlying or concurrent illness, screening for health conditions and diseases, mental health problems and intra-partner violence or domestic violence.

The previous studies also reported that the ANC interventions compromise of the interventions such as the tetanus injections, de-worming, iron and folic acids, interventions related to malaria prevention during pregnant period and insecticide treated bed-nets (22,23). The ANC care visit is the important part for the pregnant women because the pregnant women are provided the health education and counseling that make mothers to become healthier. These influences on the pregnant women also have the positive effect on the fetus and the babies at birth. The interventions offered in the ANC visits are important in developing healthy behaviors and they compromise of the emergency preparedness plan to intensify the maternal awareness, improving the newborn needs and self-care (22). The past studies documented that these interventions were characterized of the need for physiological and psychosocial health support during and after pregnancy to promote health behaviors in their households particularly focusing on the diet and health lifestyle (24) safety, injury preventions, the health education and adherence support for preventive interventions. These interventions that consist of iron supplementation, tetanus injection, use of the condoms and use of the insecticide treated nets (ITNs) for supporting the care seeking a behaviors were important in the package of the health ANC (23).

Furthermore, providing the health interventions, the pregnant women and their partners are critical for promoting their physiological, emotional, psychological and social health status of the mothers and caring their babies (22). World Health Organization (WHO) recommended the pregnant women to attend the minimum of four antenatal care visits for obtaining the basic health education and interventions that promotes health of the babies. The more they attend ANC services, the more they receive the maximum health package that play crucial role on their health and the health of their babies. During this interventions, she must be supervised by the professional and well-trained

health provider who sufficiently know the appropriate interventions for the maternal and child health (25). ANC is crucial period of the health services that consists of four recommended ANC visits by the pregnant women to health care facility and health specialists (26). In these four antenatal care visits, the health care providers focus on the health education and counseling for pregnant women. They provide the education related to adequate nutrition during and after delivery, vitamin intake, proper vaccination, changing behaviors such risk behaviors such as smoking and place of delivery. It was found that the pregnant period is one of the most sensitive period that needs to be reinforced by emphasizing on the health surveillance and medical testing for promoting psychophysiological health of the pregnant women that has the significant effect on the child during birth (12,22).

In the antenatal care, the pregnant woman is provided health education and counseling, medical care and supplementary nutrition for enhancing the babies and mother's health. The guidelines of WHO has shown that all pregnant women are expected to visit health facility at least four antenatal visits for getting the counseling, medical care and supplementary food for the promotion of wellness of the mother and babies (1,27). There are still public health problems among the life of women and children. More efforts and investments from national and international partners are mostly needed to sustain and accelerate progress targeting to promote health of child and mother by lessening the morbidity and mortality of the child and mother. Using these efforts are the effective steps for reducing and eliminating the health issues related to SDGs (12).

Antenatal care is defined as the routine of pregnant women provided between the conception and the onset of labor. This interventions plays the great role in provision of health care that prevent the potential factors associated with the morbidity and mortality of mothers and children (28). WHO recommended that the first ANC visit takes place in the first trimester of the pregnant women such as the gestational age of <12 weeks and an additional seven visits are recommended (29). ANC was documented to be very important to pregnant women since it is the preventing measure of maternal and child mortality. It also has the importance in preventing and reducing the health complications and helping to foster a virtuous relationship between the husband and wife, mother and child and father and child (30). It was found that more than 80% of pregnant women who attend at least one ANC visit were educated (18). On the other hand, it was found that some

pregnant women develop health complications that include the hemorrhage, hypertensive diseases, pregnancy related infections, pre-eclampsia and eclampsia. Antenatal care services were found to become an effective predictor for managing these health complications. It also contributes to women prepared for the delivery and understanding warming signs during the pregnancy and childbirth women prepared for delivery and understand warning signs during pregnancy. These health care offered during pregnancy are the source of micronutrients supplementation, treatments for pregnancy for pregnancy induced hypertension for preventing pre-eclampsia and eclampsia (31).

Furthermore, the timing of initiation of the first antenatal care visit is paramount for ensuring the optimal care and health outcomes for both pregnant woman and child. The previous studies indicated that there was a change in the preterm and type of obstetric outcome, as a greater proportion of deaths and morbidities caused by the health complications during pregnancy. These complication were for pre-existing medical conditions, namely indirect conditions, in a phenomenon designated as the obstetric changes (22). It was scientifically found that the ANC interventions attended early become the best opportunity for appropriately screening and medical testing the health problems in which the pregnant women are exposed to have in and/or after pregnancy (32). During the pregnancy, the pregnant women who are suitably provided ANC services at health facilities gain weight. The ANC plays the important role to manage the assessment of gestational age for allowing accurate treatments of preterm labor. Within the ANC visit, the services provided consist of screening for genetic and congenital disorders, provision of folic acid supplementation to reduce the risk of neural tube defects and screening and treatments for iron deficiencies anemia and sexual transmissible infections (STIs) that are checked for netter health of the mother and new-born (19,33).

Additionally, antenatal care services provided at the health facilities by the health providers are potentially the tactic to capture Non-Communicable Diseases (NCDs) which are the health concern in these years. These diseases that lead to disabilities, morbidity and mortality include screening diabetes and cardiovascular diseases. After assessing the these diseases, the health providers offer to pregnant women the health guidance on modifiable lifestyle risks factors such as smoking, alcohol and drug consumption, nutritional problems, and occupational acquaintances (34,35). All these attentional conditions may be detected, treated and preserved if early, timely, and high-

quality ANC is provided, but beyond the content the ANC interventions need to be available, accessible, and acceptable for achieving the SDGs goal of reducing maternal and child mortality in 2030 (29,36).

The previous studies conducted in Rwanda documented that the health facilities which provide the intervention in group had a 23% increase in the number of institutional deliveries. Similar studies also stated that the increase of the number of preventive care visits by children aged 23 months or younger (56%). This increase also include the children aged 24 to 59 months. However, attending the recommended four or more ANC visits was still at low level compared to the accessibility being targeted (33). Basing on the increasing of the impacts of LBW due to due low access to ANC services provision, the governments, international organizations and non-government organizations have taken number of steps over the period of time to reduce child and maternal mortality (16). In Rwanda, the health care is provided at health facility during or after being pregnant so as to promote health of both child and mother. Within these groups, the pregnant women categorized into groups for facilitating them to be followed-up. They attend all their ANC visits at the health centers together while participating actively in their health assessments (37).

1.2. Problem statement

Low birth weight (LBW) is the worldwide public health concern that subsequently affects health of children (16,38). This health concern is defined as the outcome of birth and pregnancy that is discussed caused by various factors including the maternal health issues and birth complications (2). These health burden highly occur in LMICs (9). This public health burden that affects the mothers, their children, families and the nation is highly prevalent in LMICs (28). ANC coverage was an important indicator used for assessing the progress in achieving the goal of SDGs about the reduction of infant and maternal mortality. It also reduces the risks to have the LBW for babies and also prevent the neonatal, infant mortality and maternal mortality as well as the malnutrition and stunting issues to child (39). The previous studies have indicated that there the significant influence of ANC on increasing of birth weight for the children (28,36). The previous empirical studies confirmed the positive effects and impact of ANC on the low birth weight (40). It was stated that maternal health production function explained that early onset of antenatal care, prenatal care and having a minimum number of ANC and prenatal care visits are very important for health

improvement of both mother and unborn child (26). In Rwanda, there is no study conducted for exploring the effects of ANC on low birth weight of children. The current study aimed at examining the effects of antenatal care on low birth weight of Rwandan children.

1.3. Objectives

1.3.1. Overall objective

The main objective of the current study was to examine the effect of antenatal care on low birth weight of children of Rwanda using the secondary data analysis of Rwanda Demographic and Health Survey 2014/2015.

1.3.2. Operational objectives

- To determine the prevalence of low birth weight (LBW) among the Rwandan children in 2015;
- To examine the description of the pregnant women using socio-demographic and economic status;
- To explore the risk factors of the low birth weight in Rwandan children in 2015

1.4. Rationale of the study

Current study was conducted for increasing the accessing to the antenatal care was documented to be practiced but there was no scientific evidence that was conducted to indicate the its effect on low birth weight nor contributing determinants to the reduction of children and maternal morbidity and deaths in Rwanda. The national reports indicated that the antenatal care has provided countless counseling and health education. The previous reports only reported that the number who were born with normal weight increased in 2015. The current study has been important for identifying the effects of antenatal care (ANC) on LBW. Within this study, the associated factors were demonstrated association with socio-demographic and economic of standardizing the birth weight of the child. Through the findings from this research, the investigators indicated how the pregnant women achieve the goal of SDGs-III related to reduction of infant and maternal mortality and morbidity by completing the four ANC visits and more. These help the investigators to provide the recommendations to the policy makers.

CHAPTER II: RESEARCH METHODS

2.1. Study design

Secondary Data Analysis of the Cross-sectional study design, this study based on the 2014/2015 Rwanda Demographic Health Survey for exploring the effects of ANC on birth weight children.

2.2. Study settings and population

The study included all mothers who were aged 15-49years during the collection of data for the current RDHS. Rwanda is the small country located in Sub-Saharan African region. There was an increase of the ANC visits due to the improvement of the health system and health financing (40). This health system contributes more to the achievement of the SDGs-III that target for reducing the morbidity and mortality of mothers and children worldwide specifically in LMICs. Rwanda is located in Central Africa and bordered on the North by Uganda, on the East by Tanzania, on the South by Burundi and on the West by the Democratic Republic of Congo. The total area of Rwanda was approximately 26,338 km^2, the Rwandan population density around 416 people per km^2 and the total population is roughly 10.8 million. The majority (43%) of the Rwandan population young who were aged 15 years or less. The women accounted for about 52.6 % of the population and about 84% of Rwandans resided in the rural setting and the activity highly to prevalent was agricultural activities that accounted 71% (41).

2.3. Data collection and sampling techniques

RDHS 2014/2015 collected data at national level using household-based survey data on birth weight retrospectively RDHS 2014/2015 collected national level household-based survey data on birth weight from the mothers. RDHS in which we have been analyzing in this study used the stratified sampling, two stages cluster sampling designs. The first stage was characterized by selecting samples from the master sampling frame constructed from enumeration whereas the second stage involved the systematic sampling of the households listed from each cluster, to ensure that the adequate numbers of the completed individuals were obtained. The data from the selected participants from the population were gathered using the face to face interviews. All the participants were aged 15 to 49 years. They were all interviewed basing on the measurement of DHS program. Birth weight was recorded in RDHS using metric measurement (in grams) for all participants from all the stratum of the country.

2.4. Dependent variable

The outcome of the current study was birth weight of the children born in the years of 2011-2015. Birth weight data from the mothers who had children during data collection of RDHS data were used in this study. Within this study, birth weight information from the RDHS was classified using the measurement of weight. LBW was demarcated as one <2,500 grams. The category of birth weights was LBW (<2500 grams) and normal weight (≥2,500 grams) (42). This study used birth weight as the dependent as the outcome of antenatal care within this study. The determinants consisted of the socio-demographic including the maternal age, educational background of the pregnant women, maternal occupation, family size, head of household, type of the residence, type of health facility number of ANC visits, sex of child, Iron and folic acid (IFA) consumption, consumption of iron, tetanus and the Household Wealth Index (HWI).

2.5. Independent variables

This study used different independent variables that were selected basing on the previous epidemiological studies, reviewing the suitable published demographic and epidemiological studies and the available information provided in the demographic health surveys (DHS) datasets with the consideration of the protentional confounders. The independent variables selected for the participants included maternal age, maternal education, ANC visits, place of delivery, marital status, maternal occupation, type of the residence, household wealth index, paternal occupation, tetanus injection during the pregnancy, nutritional status, intake iron during the pregnancy, sex of child, sex of household head, wanted pregnancy when became pregnant, blood pressure taken during pregnancy, provided anti malaria drugs during pregnancy, urine sample taken during pregnancy, heard counseling or health education related to nutrition. Concerning to the independent variables, maternal age was categorized into the classes of <19 years, 20-34 years and 35-49 years. Although pregnant women who attend no or one ANC visits were considered to have inadequate, who attended 2 to 3 ANC visits were considered to have intermediate, and who attended 4 to 7 were taken as who attended adequate, the recent studies have recommended to pregnant women for attending 7 and more ANC visits for obtaining the extremely adequate health care that effectively contribute to health of mother and unborn (43,44). In Rwanda, it was previously found that the adequate antenatal care visits are four and more visits at health facility (45). Mothers who took iron tablets, tetanus injection, blood pressure sample, and urine sample during pregnancy were reordered as "**yes**" or "**no**".

2.6.Data analyses

The statistical analysis was based on both descriptive and analytical analysis. In descriptive statistical analysis, socio-demographic and package of antenatal services were performed using the percentage, mean, median, inter-quantile range, frequencies and the confidence intervals (CIs). In the referential analysis, the independent variables were analyzed using the low birth weight as the outcomes and then the odd ratios (ORs) were used as the measure of associations between LBW and related risk factors including socio-demographic factors and package used in the ANC services. The ORs were computed after considering the potential confounders. As the birth weight of the children was the numeric factors, we also performed normal distribution for the birth weight data and presented them on the histogram. As the numeric variable was changed into categorical, the chi-square was used for assessing the association between low birth weight and the risk factors.

Bivariate analyses odd ratio was computed for indicating the determinants of low birth weight. The multiple logistic regression model was computed for estimating the odd ratios as the measure of the associations between LBW and the associated risk factors considered LBW. RDHS 2014/2015 data are used for an in-depth assessment of ANC coverage and coverage gap. The data focus mainly on children under-five years and women aged 15-49 years. A total of 30,058 household and 30,058 women were successfully recruited to be interviewed and represented the total population. A subset dataset containing women aged 15-49 years were used in this analysis. Of interest in this manuscript is the most recent ANC service used by women (aged 15-49) with a live birth within the past five years. For all the statistical tests used in this study, 95% CI and significance level of 5% were used. So, we adjusted sampling based on the RDHS data that were widely used and consistent data for assessing maternal and child health statistics at the national level using STATA version 13.

2.7. Conceptual framework
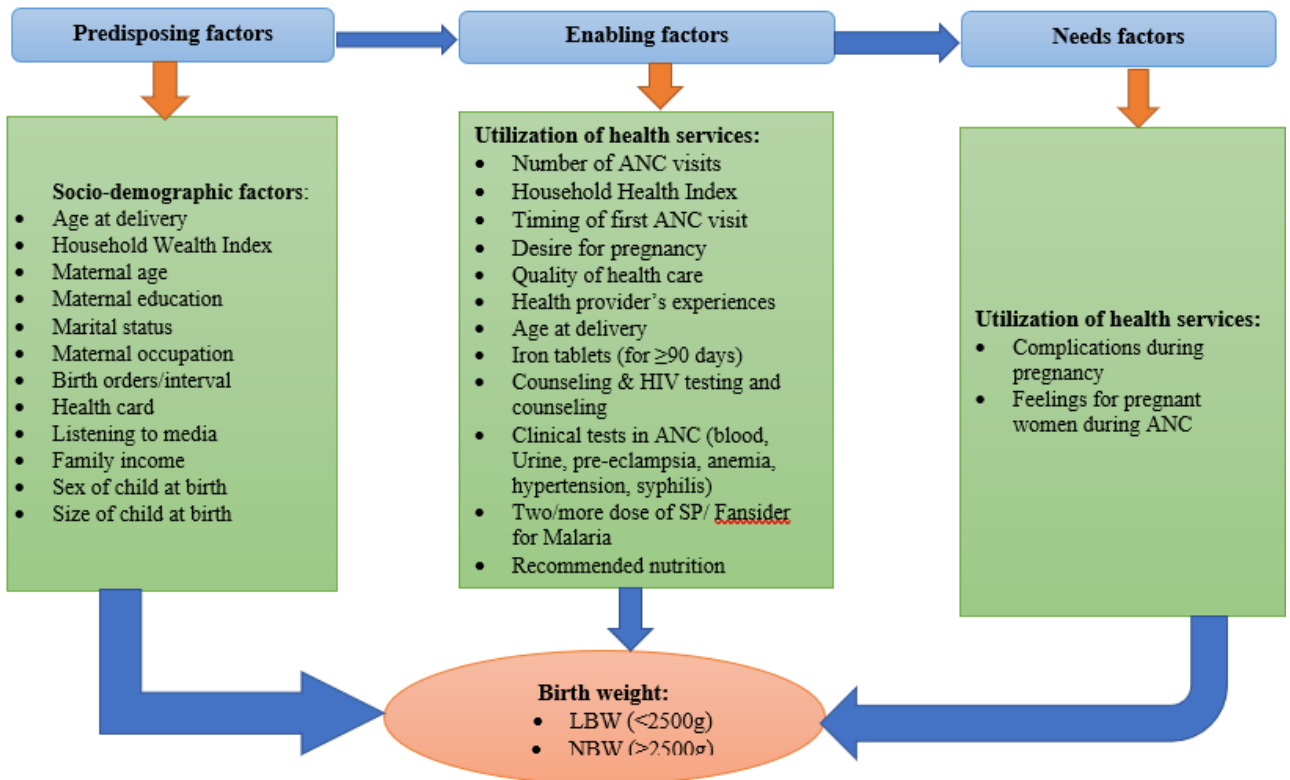
Figure 1: Conceptual framework

The conceptual framework of this study was designed using the Andersen healthcare utilization Model also called Anderson's Behavioral Model that indicate the possible factors of the health care services utilization (46,47). The factors indicated in the previous studies included socio-environmental, predisposing, health system, need and ANC visits for indicating their influences on birth weight of the new born. The current model groups the determinants in a hierarchical order, from proximal to distal depending on how directly the determinants affects the behaviors of an individuals to utilize health services. Through this model, all the identified factors were classified into four foremost groups which were external environment, health system, predisposing factors, enabling factors, needs or resources in financial and material means. All these possible determinants were designated based on different studies from different settings that have scientifically documented the influences of ANC on birth weight (**Figure 1**).

2.8. Accessibility to RDHS

Data used in this study were electronically accessed. To get the full access, first registration was completed on the DHS website. A request was submitted by creating a project title and a description of the analysis with the suggested data, thereby requesting access to survey datasets. After RDHS approval, ANC as the dependent variable and independent variables including socio-demographic and clinical were accessed in the STATA system file format. Website of Demographic and Health Survey (DHS) indicated the DHS dataset of 35 sub-Saharan African countries including Rwanda. We accessed the dataset of Rwandan DHS 2014/2015 using the website of DHS https://dhsprogram.com and then we extracted RDHS for starting the analysis of our study.

2.9. **Limitations**

The study was limited to the missing of some variables related to ANC visit such as HIV status of pregnant women, maternal gestational age, prenatal depression, receiving the supplementary vitamins like vitamin A during pregnant period, maternal weight gain during pregnancy, eclampsia, gestational diabetes, antiretrovirals (ART) for HIV positive women and reducing transmission of HVI from mother to child.

CHAPTER III: RESULTS

3.1.   Socio-demographic and economic status of mothers during pregnancy

The results indicated the average of birth weight babies was 3846.11grams with standard deviation of 1840.46grams (t-test=115.58; *p*<0.0001, 95% CI: 3805.39-3886.84). As indicated in the *Table 1,* the average birth weight babies were 2012.35 grams (SD=355.63 grams; IQR=300, Median=2100grams). The results reported the mean birth weight for the normal weight babies was 3457.17 grams (SD=601.28 grams; IQR=800; Median=3400grams). The significant difference of LBW babies and NBW babies was found (1444.82 grams; *p*<0.05, 95% CI: 1426.43-1463.2). The mean average of the maternal age was found to be 36.8 (SD=7.4; 95%CI=36.71-36.88). The results indicated that the mean of family size in the pregnant women was 5.73 (SD=2 and 95% CI=5.71-5.76). Majority (61.32%) of the pregnant women were aged 35-39 years. About the marital status, results indicated that the majority (79.55%) were married and living with the partners. Concerning the maternal education, the findings indicated that the majority (67.9%) were primary. For the occupation of the pregnant women, it was found that the majority (86.11%) was agricultural activities (self-employed) respectively. About the participants' religious belief, the majority (44.92%) were protestant (Table **1**).

Regarding to the information about the households of the participants, the results indicated that the majority (21.55%) were the poorest. It was also found that majority of them (70.09%) were from the families constituted of 4 to 7 family members. So, the average of the family members was 6 members. This study also presented that majority of the participants (79.81%) were residing in the rural setting. The results also indicated the majority 28.17% and 23.36% among who experienced LBW were those from the poorest and poorer households respectively, whereas the majority among children with no LBW were from the richest and richer households (85.81% versus 86.9%). In descriptive statistics, the results indicated that 91.96% of the pregnant women obtained the ANC services at health centers. The results indicated that 91.96% of the pregnant women attained ANC at health centers in Rwanda (**Table 2**).

Table 1: Distribution of the maternal characteristics in Rwanda, 2015

Characteristics	Number	Percentage
Maternal age (years)		
15-19	157	0.52
20-34	11,469	38.16
35-49	18,432	61.32
Mean (SD; 95%CI)	36.8(7.4; 36.71-36.88)*	
Median (Min. Max)	37(15; 49)**	
Type of residence		
Urban	6,069	20.19
Rural	23,989	79.81
Marital status		
Single	1146	3.81
Married/cohabiting	23,911	79.55
Widowed/separated/Divorced	5,001	16.64
Maternal education		
Illiterate	6,778	22.55
Primary	20,409	67.9
Secondary	2,279	7.58
Higher	592	1.97
Maternal occupation		
Unemployed	1,512	5.03
Employed	818	2.72
Self-employed	25,880	86.11
Services / clerical	1,846	6.14
Religion		
Catholic	11,729	39.07
Protestant	13,484	44.92
Adventist	3,774	12.57
Muslim	666	2.22
Jehovah witness	192	0.64
Traditional	213	0.71

*Notes: **SD**: Standard deviation, **Min** : Mimimum ; **Max** : Maximum ; **CI** : Confidence interval*

Table 2: Characteristic of the households of the pregnant women

Characteristics	Number	Percentage
Residence		
Urban	6,069	20.19
Rural	23,989	79.81
Household wealth index		
Poorest	6,477	21.55
Poorer	6,133	20.4
Middle	6,008	19.99
Richer	5,681	18.9
Richest	5,759	19.16
Family size (persons)		
Less than 4	3,682	12.25
4 to 7	21,069	70.09
More than 7	5,307	17.66
Mean (SD; 95%CI)	5.73(2; 5.71-5.76) *	
Median (Min. Max)	6(1; 22) **	

*Notes: SD: Standard deviation, **Min** : Mimimum ; **Max** : Maximum ; **CI** : Confidence interval*

In addition to the statistical description of the participants, the prevalence of LBW was found to be low (1.5%) and almost all pregnant Rwandan women (98.92%) had at least one ANC visit at health center. The number of pregnant women who attended four ANC visits and more was slightly 44.1% and who attended less than four ANC was 55.9%. This indicated that Rwanda achieved the goal of SDG-III. Besides, the findings showed that during the pregnancy, the pregnant women are provided different health education and measurement for improving health of children including normalizing the birth weight for both mother and the child. Within this period, the results indicated that the majority of the pregnant women (80.5%) were provided at least one tetanus injection before birth, but only 19.5% were not given any Tetanus injection before birth. Before the pregnancy, the results indicated that the majority was not given any tetanus injection. This means that the tetanus injection is mostly attended by the women when they were pregnant during the ANC visits. The results indicated that more than 70.7% of the pregnant women were provided counseling and education related to nutrition. Indeed, the findings indicated that 79.9% of the pregnant women were given iron tablet during the pregnant period and majority (43.83%) had the current pregnancy wanted. This means that to be pregnant was their will. The results also indicated that the majority (73%) of the households of pregnant women were head by the men. The majority (83.4%) of the pregnant women were measured blood pressure (Table **3**).

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Table 3: Child characteristic and the interventions provided during the ANC visits

Characteristics	Number	Percentage
Birthweight		
≤2,500grams	458	1.5
≥2500grams	29,032	98.45
Mean (SD; 95%CI)	3846.12(1840.46; 3805.4-3886.8)*	
Injection of tetanus before birth (n=5,953)		
No injection	1,161	19.5
Yes	4,792	80.5
Tetanus injection before pregnancy(n=2,743)		
No injection	806	29.38
Yes	1,858	67.74
More than 7	52	1.90
Don't know	27	0.98
During pregnancy, was given iron tablet (n=59.54)		
No	1,195	20.07
Yes	4,756	79.9
Don't know	3	0.05
Sex of household head (n=30,058)		
Male	21,942	73
Female	8,116	27
Places of ANC (n=7,853)		
Homes	589	2.0
Provincial/district hospital	2,166	7.2
Health center	4,836	16.1
Privates and other health facilities	262	74.7
Number ANC visits (n=5,955)		
No and less than 4 ANC	3,331	55.9
≥4 ANC	2,624	44.1
Blood pressure taken during pregnancy (n=319)		
No	53	16.6
Yes	266	83.4
Blood sample taken during pregnancy (n=319)		
No	9	2.8
Yes	310	97.2
Heard about health nutrition at Community health workers (CHWs)		
No	908	42
Yes	1,251	58
Heard about counseling or education on health nutrition		
No	893	29.3
Yes	2,159	70.7

*Notice: **SD**: Standard deviation, **Min** : Minimum ; **Max** : Maximum ; **CI** : Confidence interval*

3.2. Risk factors associated with the low birth weight and utilization of ANC services

In the binary logistic regression, the majority of the independent variables were significantly associated with LBW except for ANC occupation of the husband, desire of the husband to have a child, head of the household and health card for the pregnant women seeking health care at health facility. After controlling for the independent variables, most of the demographic and socioeconomic factors and information sources were significantly related to making at least the recommended four ANC visits compared to underutilization of ANC. The results indicated that the risk to have the low birth weight for the pregnant women who attended four or more ANC visits at health facility decreased significantly compared to the pregnant women who attended no or less than four ANC visits. Women residing in rural areas were significantly more likely to have LBW children because the level of attending ANC visits was low compared to the women from the urban settings [OR=1.31; 95% CI (1.025-1.69), p=0.031]. While LBW also decreased significantly with women's education, peaking among those with secondary or higher education [OR=0.29; 95% CI(0.09, 0.93), p=0.036]. Household Wealth was the significant determinant of LBW among pregnant women who attended ANC where the richest and richer were found to be significantly associated with LBW. The results indicated that the sex of the child at birth was significantly associated with the LBW. The females were more likely to have LBW compared to males during the birth [OR=1.3; 95%CI(1.08,1,56), p=0.006]. It was found that the marital status of the pregnant women was associated with the LBW, however there was no significant association between LBW and the pregnant who wanted pregnancy when became pregnant.

Table 4: Relations between LBW, socio-demographic factors and the utilization of antenatal care services during pregnancy, by logistic regression in Rwanda, 2015

Characteristics	Low birth weight		Unadjusted		
	Number	Percent	Odd ratio	95% CI	*p-value*
Type of residence					
Urban	75	16.4	1		
Rural	383	83.6	1.31	1.025-1.69	.031*
Sex of child at birth					
Male	203	44.3	1		
Female	255	55.7	1.3	1.08-1.56	.006*
Household Wealth index					
Poorest	129	28.2	1		
Poorer	107	23.4	.86	0.66.-1.12	.256
Middle	97	21.2	.79	0.608-1.04	.089
Richer	65	14.2	.55	.413-0.75	<.001**
Richest	60	13.1	.502	.037-0.68	<.001**
Marital status					
Single	71	15.5	1		
Married/cohabited	205	44.8	0.22	1.69-2.87	<.001**
Widowed/separated/divorced	9	2	0.123	0.083-0.182	<.001**

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Husband occupation					
No job	19	4.1	1		
Employed	5	1.1	1.07	0.37-3.13	.902
Self-employed	0	0.0	0.45	0.08-2.53	.367
Services	31	6.8	1.18	0.40-3.49	.767
Wanted pregnancy when became pregnant					
Wanted then	290	63.3	1		
Wanted later	114	24.9	1.84	0.84-1.31	.673
Wanted no more	54	11.8	1.136	0.84-1.54	.405
Husband's desire children					
Both want same	210	61	1		
Husband wants more	37	10.8	0.8	0.56-1.14	.211
Husband wants fewer	69	20.1	1.07	0.82-1.41	.610
Unaware	28	8.1	0.99	0.802-1.232	.956
Place of delivery					
Household	16	3.5	1		
Public hospitals	176	38.4	1.29	0.29-5.76	.741
Health center	257	56.1	0.34	0.18-0.64	<.01*
Privates health facilities	9	2	0.32	0.18-0.57	<.001*
Maternal age					
15-19	12	2.6	1		
20-34	342	74.7	2.69	1.48-4.9	<.01*
35-49	104	22.7	14.58	7.85-27.1	<.001**
Family size					
Less than 6	297	64.8	1		
6 members and more	161	35.2	0.49	0.41-0.59	<.001*
Health card					
No	8	2	1		
Yes, seen	364	87.5	0.32	0.15-0.68	.003*
Yes, no seen	16	3.8	0.47	0.19-1.17	.104
No longer has health card	28	6.7	0.36	0.15-0.84	.019*
Household head					
Male	351	76.6	1		
Female	107	23.4	1.22	0.66-1.02	.074
Maternal education					
Illiterate	69	15.1	1		
Post-primary/vocational	335	73.1	0.54	025-1.34	.105
Secondary and above	54	11.8	0.29	0.09-0.93	.036*

Notice: (*) Indicates the significance level ta %%; (**) Estimates the significance level at 1%; Unmarked p-values were not fond to be the significant risk factors of LBW in Rwanda

Results indicated that the children whose mothers attended four and more recommended ANC were less likely to have low birth weight than the children whose mothers attended no and less than four recommended ANC visits during pregnancy. About the package provided to the pregnant women, the results indicated that there was the significant association between low birth the factors including antenatal care visit, obtaining immunization with recommended iron vaccines, does of tetanus and diphtheria, taking coarten for treating malaria, attending ANC visits at health center and not taking the drugs fir Malaria duding pregnant period. But there was no significant association between LBW and the factors such as the iron and folic acid. The pregnant women who were given education about complications faced by the pregnant women were not significantly associated with LBW. The pregnant women who were provided education and counseling were not significantly associated with LBW children. The pregnant women whose blood pressure, blood sample taken, urine sample and quinine for Malaria were taken were not significantly associated with the LBW.

Table 5: Bivariate analysis of the risk factors of low birth weight among Rwandan children in 2015

Characteristics	Low birth weight		Unadjusted		
	Number	Percent	Odd ratio	95% CI	*p-value*
Utilization of Antenatal care services during pregnant (n=458)					
No and less than 4 ANC	211	46.1	1		
Four ANC and more	247	53.9	0.15	0.05-0.5	.002*
During pregnancy, Immunized with recommended dose of Tetanus and diphtheria (n=458)					
No	49	10.7	1		
Yes	409	89.3	0.29	0.08-0.157	<.001*
In pregnancy, provided blood pressure taken (n=329)					
No	53	16.6	1		
Yes	266	83.4	0.82	0602-1.108	.193
In pregnancy, provided urine sample taken (n=329)					
No	138	43.3	1		
Yes	181	56.7	0.87	1.05-1.05	.130
In pregnancy, who provided blood sample taken (n=329)					
No	9	2.8	1		
Yes	310	97.2	1.042	0.53-2.06	.905
Told about pregnancy complications (n=316)					
No	59	18.6	1		
Yes	257	81.1	1.09	0.82-1.46	.546
In pregnancy, consumption of recommended dose of Iron and folic acid (n=322)					
No	67	20.8	1		
Yes	255	79.2	0.9	0.68-1.86	.441
During pregnancy, given coartem for malaria treatment (n=321)					
No	277	86.3	1		
Yes	44	13.7	2	1.42-2.76	<.001**
During pregnancy, took quinine for malaria (n=321)					
No	317	98.8	1		
Yes	4	1.2	1.09	0.39-3.01	0.871
During pregnancy, took other drug for malaria (n=321)					
No	315	98.1	1		
Yes	6	1.9	4.1	1.7-10.2	.002*
Utilization of antenatal care services at health center (n=318)					
No	10	3.1	1		
Yes	308	96.9	.47	0.25-0.89	.020*
During pregnancy, not provided medical drug for malaria taken (n=321)					
No	53	16.5	1		
Yes, no drug taken	268	83.5	0.51	0.37-0.69	<.001*

Notice: (*) Indicates the significance level ta %%; (**) Estimates the significance level at 1%; Unmarked p-values were not fond to be the significant risk factors of LBW in Rwanda

3.3. Multiple logistic regression analyses of the risk factors of LBW in Rwanda

Table **6** indicates that the results of multivariate logistic regression analyses on the factors of LBW among the pregnant women. It was statistically found that the socio-demographic factors such as the marital status of the pregnant women, place of delivery, sex of child, utilization of the antenatal services at the health facility, being provided the coartem for malaria among the pregnant women during antenatal care, and being given no medical drug for malaria treatment were significantly associated with LBW. But the results showed that taking recommended doses of iron folic acid (IFA) tablet and tetanus injection were not significantly associated with the LBW.

Table 6: Relations utilize between low birth weight, utilization of antenatal care services and socio-demographic factors during pregnancy, by logistic regression in Rwandan children, 2015

Characteristics	Low birth weight		Adjusted odd ratio	95% CI	p-value
	Number	Percent			
Type of residence					
Urban	75	16.4	1	1	
Rural	383	83.6	1.06	0.68-1.63	.808
Maternal education					
Illiterate	69	15.1	1		
Primary/vocational	335	73.1	1.01	0.66-1.54	.956
Secondary/higher	54	11.8	0.99	0.57-1.76	.999
Maternal age					
15-19	12	2.6	1		
20-34	342	74.7	0.77	0.41-1.46	.428
35-49	104	22.7	0.78	0.39-1.53	.467
Provided Tetanus injection during pregnancy					
No	49	10.7	1		
Yes	409	89.3	1.25	0.76-2.04	.377
Utilization of Antenatal care services					
No and less than ANC	211	46.1	1		
4 ANC and more	247	53.9	0.62	0.46-0.82	.001*
Family size					
Less than 6	297	64.8	1		
6 members and more	161	35.2	1.02	0.75-1.38	.918
Household Wealth Index					
Poorest	129	28.2	1		
Poorer	107	23.4	0.95	0.65-1.38	.772
Middle	97	21.2	0.93	0.63-1.39	.728
Richer	60	13.1	0.87	0.57-1.33	.528
Richest	129	28.2	0.74	0.43-1.27	.268

			aOR	95%CI	p-value
Marital status					
Single	71	15.5	1	1	
Married/cohabiting	346	75.5	1.86	1.25-2.76	.002*
Widowed/divorced/separated	41	9.0	1.65	1.10-2.45	.015*
During pregnancy, given coartem for malaria					
No	277	86.3	1	1	
Yes	44	13.7	0.57	0.40-0.80	<.001*
During pregnancy, no drug for malaria taken					
No	53	16.5	1	1	
Yes, no drug taken	268	83.5	0.32	0.13-0.83	.018*
Place of delivery					
Household	16	3.5	1	1	
Public hospitals	176	38.4	1.03	0.22-4.77	.969
Health center	257	56.1	0.31	0.15-0.66	.002*
Privates	9	2.0	0.30	0.16-0.58	<.001*
Sex of child at birth					
Male	203	44.3	1	1	
Female	255	55.7	1.57	1.18-2.08	.002*
Provided tetanus injection during pregnancy					
No	49	15.2	1		
Yes	273	84.8	0.25	0.76-2.04	0.337
Antenatal care visits at health center					
No	10	3.2	1		
Yes	308	96.8	1.9	0.87-4.09	0.109
Household head					
Male	351	76.6	1	1	
Female	107	23.4	1.12	0.8-1.55	.519

*Notice: * Indicates statistical significance at p-value <.05; ** Indicates significance at 1%, Unmarked p-values were not fond to be the significant risk factors of LBW in Rwanda*

The results indicated that the children females were more likely to have low birth weight [aOR=1.57; 95%CI (1.18-2.08), p=0.002] compared to children males born in Rwanda. The mothers whose place of delivery was at health center and private health institutions were less likely to have LBW children than the mothers who place of delivery was in the households of the pregnant women or cohabitants. The results indicated that the mothers whose place of delivery was health center were 0.31 less likely to have LBW children [aOR=0.31; 95%CI(0.15-0.66), p=.002] and whose place of delivery was private institution had 0.3 risk to have LBW children [aOR=0.3; 95%CI(0.16-0.58), p<0.001] than the mothers whose place of delivery was households. Similarly, the pregnant women who were provided the coartem for Malaria treatment were less

likely to have LBW children compared to mothers who were not provided these treatments during the pregnancy [aOR=0.57; 95%CI(0.4-0.8), *p*<0.001]. The mothers who were given no drugs for malaria were at lower risk [aOR=0.32; 95%CI(0.13-0.83), *p*=0.018] of having a LBW child than mothers who were received medical drugs for malaria during pregnancy.

Mothers who had four and more ANC visits were at lower risk to have the LBW children compared to the women who had no ANC visit and less than four antenatal care visits at health facility. The results indicated that the women who were provided four and more ANC services during pregnancy were 0.62 less likely to have LBW babies [aOR=0.62; 95%CI(0.46-0.82), *p*<0.01] than the pregnant women who had no and less than four ANC visits. Married and cohabiting pregnant women were 1.86 times at greater risk to have LBW children [aOR=1.86; 95%CI(1.25-2.76), *p*=0.002] compared to single pregnant women. Mothers who were widowed, divorced and separated from their husbands were more likely to have LBW children compared to the women who were single during pregnancy. The results indicated that the widowed, separated and divorced pregnant women had 1.65 greater risk to have LBW babies [aOR=1.65; 95%CI(1.10-2.45), *p*=0.015] than women who were single during pregnancy. Not using the tetanus injection during pregnancy and attending ANC services at health center were not significantly associated with the LBW children.

CHAPTER IV. DISCUSSIONS

The results of the current study revealed that the LBW remains a public health burden at the national level. This health challenge, mostly prevalent in rural areas, was found to be at low prevalence, ranging from as low as 1.52% in 2015, in Rwanda due to the improvement of ANC visits, which was at higher level in health facilities especially in health centers. These results were relevant with the previous studies that documented that the improvement of the antenatal services contribute to the birth weight babies (40). Among these low birth babies, only 55.93% of pregnant who attended no and less than 4 ANC visits. Within this study, the strong correlation between ANC and LBW was discovered. The results of the study revealed that the inadequate ANC visits for the pregnant women. Although a large majority of pregnant women in Rwanda received ANC, some of them did not meet all of the accepted standards for ANC. These results were relevant with the previous studies that indicated there was a provision of the inadequate ANC services in Rwanda (48).

The results indicated that about 94.57% including the majority who completed the recommended ANC visits had normal weight babies. These findings are relevant with the previous studies that indicated that ANC visits were found to be significant maternal risk factors for birth weight babies since it normalize the birth weight of the child and his mother due to the preventions, interventions and health education that are effectively provided in each visit (49,50). Several previous studies have found that a husband residence, household wealth index, family size, maternal age, utilization of tetanus injections and iron tablets consumption are significantly risk factors of LBW (39,51). In contrast, we found that the LBW was not significantly associated with maternal age, iron consumption, tetanus injections, type of the residence, family size and the household wealth index of the pregnant women in Rwanda.

In the present research, mothers who attended four and more ANC visits had less risk to have LBW children than the pregnant who attended no and less than four ANC visits that are recommended ANC visits. These results were supported by the findings from the prior studies that indicated that the more the pregnant attend ANC visits especially more than four, the more their children do no develop LBW (37,52). The results discovered that Rwandan pregnant women attended well the ANC visits and this had an important contribution to pregnant women, children, and their families. These results are supported by the findings from the recent study conducted in Rwanda that

discovered that the country of Rwanda is at the appreciable level to attend the ANC visits (53). Results confirmed that the wide range of maternal factors including maternal education, type of residence and number of ANC visits, especially at health center were significantly associated factors contributing to the reduction of the risk of LBW.

The results revealed that the pregnant women who were provided ANC services at health centers and private health institutions had less risk to have the LBW children than the pregnant women who were provided the services in the households. These results were supported by the findings from the previous studies (21,54,55). Results revealed that the pregnant women who were provided coartem for malaria treatment were 0.57 times likely to have LBW children compared to the pregnant women who were provided the coartem for malaria treatment (52,56). It was found that the pregnant women who received no drug for malaria treatment had 0.32 risk to have LBW children compared to the women who received the drugs for malaria (17). These results were similar to the previous studies that documented that children born to educated pregnant women and pregnant women with high wealth index who attend the ANC have been less likely to develop LBW compared to other pregnant women (8,24). The results of the current study revealed that the marital status of the pregnant women are the risk factors of LBW. It was found that the pregnant women who were married or living with the cohabitants had 1.86 risk to have LBW than the women who were single. They also indicated that the pregnant women who divorced or separated had 1.65 risk to have LBW children. These results challenged the previous studies that indicated that pregnant women who were single had greater risk to have LBW children than others (57,58). Therefore, attending ANC appropriately is the best way of managing the risk determinants of LBW in Rwanda. The results of this study are relevant to the previous studies that conformed that ANC services are crucial for prevention of LBW for the pregnant women who appropriately attend ANC visits and are provided the recommended package for the pregnant women (59–61).

CONCLUSION

Antenatal care services for pregnant women are the fundamental for the child and maternal health. This integral part of primary health care among children becomes even more important in countries with extremely high infant and maternal mortality and morbidity like Rwanda. However, there is significant reduction due to the strong health system. Then, the staff of the medical settings should deliver affordable interventions to the mothers for normalizing the birth weight of the children. Nevertheless, almost prior studies discovered that infant malnutrition and stunting were associated with low socio-demographic and economic factors, yet ANC remains the appropriate intervention for preventing maternal and child health issues. The developmental programs that are implemented within ANC system like policies for promoting nutrition and strategies for preventing the violence against men and children are effective policies of improving birth weight of the children. There is a need of ensuring the continuation of follow-up even in the post-natal period need to be reinforced so as to prevent infant malnutrition in Rwandan settings. Information on anthropometric measurement and increased awareness of the importance of regular ANC visits is also desirable.

Recommendations

The investigators of this study recommended the increase the policies for promoting nutritional and sustainable infrastructures for antenatal care that compromise all essential package that should be provided in all ANC visits. Health planners were recommended to provide strong health among the highly educated and richest people for increasing their accessibility to ANC visits at health centers.

Key findings

- ANC remains an important intervention on birth weight babies and for improving child health;
- Rwanda is one the worldwide countries achieving the SDGs related to attending at recommended ANC visits for the pregnant women. The national prevalence of attending was higher than recommended by WHO, however there is a need to increase accessibility to antenatal;
- An improved health system reinforces antenatal care policy for reducing the morbidity and mortality for both infant and pregnant mothers.
- Health system is achieving the purpose of ANC including to prepare for birth and parenthood, prevent, detect, alleviate, or manage the health problems during pregnancy that affect mothers and babies;
- Government of Rwanda must broadcast ANC related programs on media channels and open-up more health facilities in rural and urban settings;
- Promoting private clinics and hospitals for providing antenatal services especially to poor pregnant women and these efforts certainly play the crucial role on standardizing birth weight for both babies and women;
- Increasing ANC services positively prevents low birth weight. These interventions also prevent deficiencies concerns consisting of malnutrition and stunting that remain the national burden.

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