UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

IMPACT OF ANAEMIA DURING THIRD TRIMESTER OF PREGNANCY ON BIRTH OUTCOMES IN TATALE AND ZABZUGU DISTRICTS, NORTHERN REGION, GHANA

GIDEON NYAABA ABODOON

2019

UNIVERSITY FOR DEVELOPMENT STUDIES

IMPACT OF ANAEMIA DURING THIRD TRIMESTER OF PREGNANCY ON BIRTH OUTCOMES IN TATALE AND ZABZUGU DISTRICTS, GHANA

GIDEON NYAABA ABODOON (BSc Community Nutrition)
UDS/MPHN/0019/17

THIS THESIS IS SUBMITTED TO THE DEPARTMENT OF NUTRITIONAL SCIENCES, SCHOOL OF ALLIED HEALTH SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN PUBLIC HEALTH NUTRITION

NOVEMBER, 2019

DECLARATION

I hereby declare that this thesis is my original work and that no part of it has been presented for another degree in this University or elsewhere.

Signature…… **Date……...**

Gideon Nyaaba Abodoon

Supervisor's declaration

I hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

Signature …… **Date**……...

Dr. Martin Nyaaba Adokiya

ABSTRACT

Anaemia in pregnancy continues to be a major public health problem affecting 45% of pregnant women in Ghana and 47% in the Northern Region. This study examined the impact of anaemia during the third trimester of pregnancy on birth outcomes in Tatale-Sanguli and Zabzugu districts. The study employed a prospective cohort design using simple random sampling technique to sample 359 respondents. The data were collected using a structured questionnaire and analysed using the Statistical Package for Social Sciences version 25.0 and word 2016. The results showed that 77.4% of the respondents were not educated on the signs and symptoms of anaemia. It was revealed that the prevalence of anaemia among respondents was 72% in the study settings. The results showed that the pregnant women who did not have a say in household decision making on household food purchase were at risk of being anaemic [RR = 1.4 (95% CI: 1.9-3.5); p = 0.021] compared to pregnant women who had total control in decision making about the household food purchase. Pregnant women whose husbands were involved in ANC were protective against anaemia [RR= 0.5 (95% CI: 0.3-0.9); p=0.030] compared to pregnant women whose husbands were not involved in ANC. Pregnant women who initiated ANC in the third trimester had a higher risk of anaemia [RR= 2.7 (95% CI: 1.9-4.3); p=0.041] compared to those who initiated ANC in the first trimester. The study found that there was no association between anaemia status of pregnant women at ≥33 weeks of gestation and the 3.1% low birth weight, 2.2% preterm delivery, and 25.1% stunting at Tatale-Sanguli and Zabzugu districts. Based on the results, the study concludes that the anaemia status of pregnant women at ≥33 weeks of gestation did not influence preterm delivery, low birth weight and stunting at the time of the study among the sampled respondents. The study recommends the empowerment of women to increase their decision making autonomy on household food purchase to reduce anaemia.

ACKNOWLEDGEMENT

To have conceived, nurtured and actualised this idea would not have been made possible without the unmerited favour from God almighty. My sincere thanks to Dr. Martin Nyaaba Adokiya for having accepted to mentor me in the course of my studies. His tireless efforts, time, patience and guidance aimed at ensuring that, the best comes out of me despite the inconveniences I caused him through odd hour calls cannot be quantified in words. My heartfelt gratitude to the Head of Department for Nutritional Sciences, Dr. Abdul-Razak Abizari for creating an enabling environment for me to gain this knowledge worthy more than gold. My sincere thanks also go to the District Director of Health Services for the Tatale -Sanguli district, Mr Mohammed Abdulai Malle for his generosity towards the pursuit of this programme

I wish also to express my sincere gratitude to the District Director of Health Services for Zabzugu district, Chief Ewuntomah E. Mahama and his staff for the massive support they gave me during the data collection exercise. I equally wish to thank the pregnant women who voluntarily participated in this study at the study setting despite their physiological status. My deepest appreciation goes to my data collection team that included the Nutrition Officers and Midwives from both Tatale and Zabzugu districts for their sacrificial work.

Importantly, my wife, Apegwine Elizabeth for the peace at home, my daughters, Apalawa-Enya Audris and Awingura Karis whose ‘sisterly fights’ will always keep me awake to continuously work on this project. Finally, my extended family who supported me in diverse ways and all my friends and colleagues who encouraged me during the course of this work.

May God richly bless you.

DEDICATION

To my Daughters: Abodoon Apalawa-Enya Audris and Abodoon Awingura Karis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND THEIR MEANINGS

ANC	Antenatal care
BMI	Body Mass Index
CAPI	Computer Aided Personal Interviewing
CDC	Centre for Disease Control and Prevention
CHPS	Community-based Health and Planning Services
DDS	Dietary Diversity score
DDS-W	Dietary Diversity Score-Women
G6PD	Glucose-6-Phosphate-dehydrogenase Deficiency
GDHS	Ghana Demographic and Health Survey
GDP	Gross Domestic Products
GHS	Ghana Health Service
GSS	Ghana StatisticaL Service
Hb	Hemoglobin
HIV	Human Immunodeficiency Virus
ICF	ICF International
IFA	Iron and folic acid
IPT	Intermittent Preventive Treatment
LBW	Low Birth Weight
LLINs	Long Lasting Insecticide Treated Nets
LMIC	Low- and Middle-Income Countries
MoH	Ministry of Health
MUAC	Mid-upper arm Circumference
RCH	Reproductive and Child Health
RR	Relative Risk
SGA	Small for Gestational Age
SPSS	Statistical Package for Social Sciences
USAID	United State Agency for International Development
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.0 Background of the Study

The World Health Organization (WHO) defined anaemia in pregnancy as the haemoglobin (Hb) level below 11.0g/dl at sea level (WHO 2012). The global prevalence of anaemia has declined significantly in women who are pregnant (Stevens et al. 2012). This decline according to Stevens et al., (2012) moved from 43% to 38% between 1995 and 2011. In Ghana, there, a higher anaemia prevalence than the global average of 45% in women who are pregnant (GDHS,2014). Antenatal care (ANC) is a vital platform that enables pregnant women with anaemia to be diagnosed, counselled and managed to ensure lower rates and adverse birth outcomes (Baruah and Boruah 2016). Many studies undertaken by different researchers have found the varying impact of anaemia in pregnant women. For example, maternal anaemia is found to be a predictor for mortality and morbidity (WHO 2014, Sapre, Raithatha and Bhattacharjee, 2018).

Similarly, another study in Iran found that anaemia from the conception of pregnancy to the first twelve weeks (first trimester) through to the third trimester showed a statistically significant relationship with low birth weight and intrauterine growth retardation (Moghaddam Tabrizi, 2015, Figueiredo *et al.*, 2018). Maternal anaemia, particularly within the first trimester, is a key contributor to adverse pregnancy outcomes (Rahmati et al. 2017). In furtherance, anaemia in pregnancy is linked to higher rates of postpartum haemorrhage (PPH) and small for gestational age (SGA) (Nair et al. 2016). Also, another study found that anaemia aggravates the chance of giving birth to abnormal babies or

babies with deformities that include low birth weight and Apgar scores (Alizadeh et al. 2014). Similarly, anaemia in pregnancy is found as contributing to an increased risk of fetal distress, preterm deliveries, and bigger birth weight (Smithers et al. 2014).

The WHO recommends enhancing dietary diversity; fortifying food with elemental iron, intake of elemental iron combined with folic acid every day from conception to delivery. This is aimed at eliminating the chance of giving birth to babies with deformities (WHO,2014, WHO, 2012). The control of infections and malaria" also reduces poor birth outcomes (WHO,2014, WHO, 2012). When the pregnant women are given iron and folic acid (IFA) tablets and/or syrup, it is documented by many studies to improve Hb levels (Balasubramanian, Aravazhi, and Sampath 2016). Similarly, an intervention study which involves giving IFA to adolescent girls was conducted in an anaemia endemic community and reported an increased in mean Hb with reduced prevalence of anaemia (Kuril et al. 2016). Evidence exists that iron supplementation pattern during pregnancy period enhances the neonate's neurodevelopment (Aranda et al. 2017).

1.1 Problem Statement

Being anaemic whilst pregnant remains a serious public health issue with significant economic implications globally (WHO, 2014). This comes along with its impact on maternal and child morbidity and mortalities (WHO, 2014). Though some studies have established the effect of anaemia in pregnancy on delivery outcomes, most of the studies focused on the impact of anaemia in early pregnancies (<33 weeks of gestation) on birth outcomes. The evidence available on the effects of anaemia in pregnancy on stunting at birth is also limited.

Further, the factors that influence adverse birth outcomes are multifaceted. There is, however, limited data on the impact of anaemia in the third trimester of pregnancy in both Zabzugu and Tatale districts. It is against the above information that this study seeks to contribute to bridging this knowledge gap in the literature.

1.2 Study objectives

1.2.1 Main objective

The main objective was to determine the effect of anaemia during third trimester of pregnancy on birth outcomes in Tatale and Zabzugu districts, Ghana.

1.2.2 Specific study objectives

1. To determine the prevalence of anaemia among pregnant women in Tatale and Zabzugu districts
2. To identify the factors influencing anaemia among pregnant women
3. To assess the incidence of birth outcomes (low birth weight, preterm birth and stunting)
4. To determine the association between anaemia in pregnancy and birth outcomes.

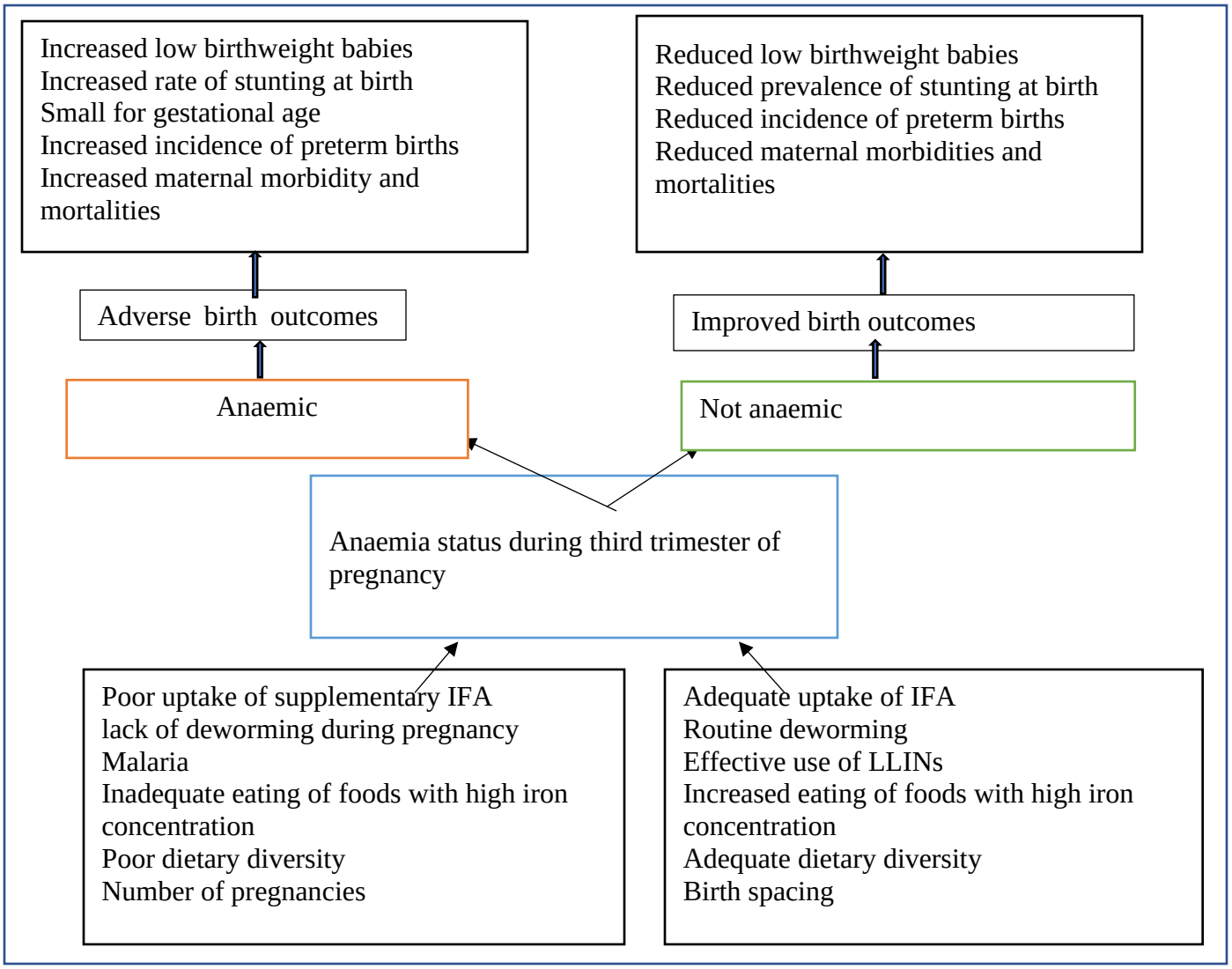

Figure 1 Conceptual framework for impact of anaemia in pregnancy ≥ 33 weeks

Anaemia status of the pregnant woman depends on the following risk factors: low uptake of iron-folic acid supplementation; worm infestation and malaria infections (Getachew et al. 2012). These risk factors could lead to poor iron stores in the pregnant women which will manifest as anaemia in pregnancy. Once the pregnant woman becomes anaemic, the impact could be low birth weight, stunted at birth, preterm delivery and small for gestational age.

There is however an opportunity to intervene at addressing these risk factors by encouraging adequate supplementation of IFA and increasing the intake of foods with high iron concentration. And also educating pregnant women about the importance of dietary diversity. When the risk factors are addressed, iron stores would improve leading to reduced anaemia with an added advantage to further reduced the rate of low birth weight deliveries, stunting, preterm deliveries and small for gestational age (SGA).

This conceptual framework is dependent on the evidence available that anaemia could be higher in the third trimester than any of the other trimesters. For example, the Ethiopian study reported a 28.3% of pregnant women suffered anaemia during the third trimester compared to 11.5% and 23.8% in first and second trimesters respectively (Lebso, Anato, and Loha 2017). Also Melku et al. ((2014), in their study in Gondar, Northwest Ethiopia also reported a higher prevalence of anaemia in the third trimester at 18.9%. Furthermore, a study in the University hospital of Kumasi, Ghana reported that ‘anaemia prevalence was high (69.0%) among women who were in their third trimester than those who were in their second trimester (60.8%) and first trimester (64.0%) (Tay et al. 2013). Finally, another study linked severe anaemia in late pregnancy to 44% prematurity, 24.8% low birthweight, 4.4% stillbirth and 11.5% neonatal birth in a hospital in Gujarat, India (Sapre et al., 2018).

1.4 Significance of this study

The study added knowledge on the prevalence of anaemia at ≥33 weeks of gestation in the Tatale and Zabzugu districts. It has also provided knowledge on the incidence of low birth weight, preterm deliveries and stunting at birth in the two districts. This study demonstrates that decision making autonomy on food purchase by the pregnant woman, husband involvement in ANC, kinds of food pregnant women were counselled to eat and four or more ANC visits are the factors that contribute to anaemia prevalence in the two districts. Additionally, the study provided information on which public health interest groups can use to advocate for local-level policy change to help improve the anaemia situation in the study area.

Importantly, the results of this study will serve as a baseline information for a much larger study on the same or similar subject matter that will generate the needed data to inform policy makers in planning policies of reduction of maternal mortality levels particularly the overall anaemia levels in third trimester.

1.5 Organization of the chapters

This thesis is organized into six chapters. Chapter one is the introduction of the study. It includes the background to the study, the problem statement, objectives, conceptual framework, the significance of the study and organization of the thesis. Chapter two reviews various literature on the topic of study. It begins with an introduction which highlights the themes to be discussed in the review. Comprehensively discussed under this chapter are the following: prevalence of anaemia at ≥33 weeks of gestation; factors accounting for anaemia at ≥33 weeks of gestation; the incidence of birth outcomes (preterm

deliveries; low birth weight and stunting at birth) and the association between anaemia and birth outcomes. In Chapter three, the research methodology of the study is explained. The study methodology described the study setting; design; the pregnant women to take part in this study; the conditions that will qualify a pregnant woman to partake and those conditions which will not qualify them to take part in the study; variables for this research, definition of variables; sample and sample size determination; sampling frame; sampling method; data collection methods; analysis, and interpretation; quality controls and finally, ethical clearance to commence the study. Chapter four deals with the presentation of the results. Chapter five discusses the findings in relation to prevailing conditions and related literature and Chapter six which is the last chapter contains the conclusion and suggestions which when implemented will improve the anaemia situation of the pregnant women.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter contains a summary of existing knowledge related to this topic of study. It contains related findings from around the globe on the global and regional prevalence of negative delivery outcomes and also, the impact of anaemia at ≥33weeks of gestation on these outcomes. The birth outcomes were preterm delivery; low birth weight and stunting. The chapter examined the socio-demographic, pregnant women decision-making autonomy, health care-related and dietary factors influencing anaemia at ≥33 weeks of gestation. It also reviewed materials that have documented information on anaemia among pregnant women at the global, regional, national and local levels. The factors contributing to anaemia in the third trimester of pregnancy considered in this chapter included education at the antenatal care, antenatal care attendance; iron and folic acid supplementation, minimum dietary diversity score for women; malaria prevention and deworming among others. The review of literature helped to identify the research design appropriate for such research, the tools for data collection and the appropriate methods for the data analysis. Finally, it helped to discuss the findings in line with existing knowledge.

2.1 Anaemia among pregnant women at ≥33 weeks of gestation

Public health problems are mostly informed by the rate of occurrence or prevalence of that condition. Knowing the percentage of pregnant women at ≥33 weeks of gestation who are anaemic will inform public health interest groups within the study setting to take pragmatic

measures to curtail it. Information on anaemia prevalence will also increase the level of public awareness and hence encourage effective monitoring of affected groups.

International bodies mainly the WHO declare anaemia to be of public health importance using certain standard indicators. Anaemia prevalence is considered to be of no public health concern when the rate is <5%; it is of mild public health importance if the rate is from 5–19.9%, 'if the rate is from 20-39,9% then it is considered a moderate public health concern and a prevalence of ≥40% is classified as a severe public health issue' (WHO, 2011).

Globally "it was estimated that 43% of children, 38% of pregnant women, 29% of non-pregnant women and 29% of all women of reproductive age have anaemia". "This translates to 273 million children, 496 million non-pregnant women and 32 million pregnant women' (WHO 2015)". The less-developed continents especially Africa and Asia reported the majority of anaemia cases in women who were pregnant at 44.6% and 39.3% respectively as compared to 24.3%, 24.9 and 25.8 in Western Pacific, Americas and Europe. However, comparing WHO (2008) and WHO (2015) estimates, Africa and Asia also reported the highest decreases of 12.5% and 8.9% respectively. All West African countries recorded over 40% prevalence of anaemia at a time when China recorded the lowest rate of anaemia in pregnant women at 22% (WHO, 2015). Prevalence in West Africa ranges from 63 in Benin to 45 in Sierra Leon. Prevalence in Ghana is estimated to be 62% (WHO, 2015). According to the WHO report (2011), Africa and South-East Asia consistently contributed to the global majority cases of severe anaemia among the

vulnerable groups. For example, the global under-five severe anaemia was 1.5% and out of this, Africa contributed 3.6% and South East Asia contributed 1.5%. Furthermore, Africa contributed 1.5% and South East Asia 1.1% of the 0.9% global rate of severe anaemia among pregnant women aged 15-49 years. Furthermore, a systematic review considering pregnant women with anaemia and its consequences on delivery and health parameters in poor and developing countries also found 42.9% anaemia prevalence in the study participants (Rahman et al. 2016).

These high estimates seem to be backed by both national and isolated studies that reported varying but the high prevalence in West Africa. In a study conducted by Stevens et al. (2012) studies, Central and West Africa lead all others in terms of anaemia by reporting 61% in the year1995. This, however, declines to 56% in the year 2011. A report of a systematic review on the anaemia situation in West and Central Africa found 50% anaemia prevalence in women who were pregnant at the time of the study (Ayoya et al. 2012b). Similarly, a study in Enugu state, Nigeria revealed that pregnant women had 53.7% anaemia (Engwa et al. 2017). A study in the Benin Republic, reported trimester-specific anaemia prevalence at 64.7% and 64.1% in the second and third trimesters respectively (Bodeau-livinec et al. 2011). Importantly, the prevalence reported in these types of studies is comparatively lower in different regions of the world than that of Central and West Africa. In Asia, Wei et al (2018) reported a total anaemia prevalence at 23.5%. First-trimester prevalence was the least at 2.7% followed by the second trimester at 14.7% and the third trimester been the highest at 16.6% in their retrospective study in China. Additionally, Moghaddan & Tabrizi (2015) reported anaemia prevalence at 20.1%. in their

prospective study involving 1405 third trimester pregnant women in Iran. In East Africa also, anaemia prevalence of 22.1% was reported in a comparative study in two regional hospitals in Uganda (Obai, Odongo, and Wanyama 2016).

Furthermore, a community-based study in Southern Ethiopia reported an overall anaemia prevalence among pregnant women at 23.2% with first, second and third trimesters prevalence respectively as 11.5%; 23.8% and 28.3% (Lebso, Anato, and Loha 2017). In addition, Melku et al., (2014) reported from their study in Gondar, Northwest Ethiopia a 16.6% anaemia in pregnant women. This study equally reported a much higher anaemia prevalence in the third trimester at 18.9%. Similarly, another study in some public health facilities in Ethiopia reported 19.7% of anaemia among pregnant women in Mekele town (Abriha, Yesuf, and Wassie 2014). Furthermore, 57% second and third trimesters anaemia prevalence was reported in Kenya (Pumwani Maternity Hospital) in East Africa (Mirie et al. 2016) However, there are isolated studies in the other regions far higher than in West Africa. A typical example is the one in Maharashtra State, India which reported a 90% anaemia prevalence among pregnant women (Patel et al. 2018).

Within the East Africa region also, a study in Dar Bashir in Ethiopia reported a 43% anaemia prevalence among both pregnant and lactating mothers. However, anaemia prevalence was highest in pregnant women compared to lactating mothers (Dar 2018). From a report in Assam India, Asia which is less developed, a 53.4% rates of anaemia in pregnant women were reported (Tandu-Umba and Mbangama 2015). This tends to suggest,

anaemia among pregnant women has assumed a higher proportion best described as a severe public health issue in West Africa. This is evident because of the higher anaemia prevalence in pregnant and non-pregnant women which respectively stood at 50% and 40% (Ayoya et al., 2012). The level of economic growth according to the World Bank (2013) also accounts for these differences in anaemia burden within Africa.

In Ghana, Northern Region recorded the second highest prevalence of 47.5% after Volta region (48.7%) among women of reproductive age (15-19) while the Upper Regions recorded the lowest prevalence (GSS, GHS, and ICF International 2015). Comparatively, the national anaemia prevalence for pregnant women was the least at 44.6% (GSS, GHS, and ICF International 2015). The reports from other smaller studies in some regions and facilities in Ghana also showed varying anaemia prevalence. For example, a study in the regional capital of Ghana, which lies along the coastal belt reported a 51% pregnancy anaemia in 2018 (Acheampong et al. 2018). Similarly, one other study in the University hospital of Kumasi which is within the middle belt, Ghana found anaemia in pregnancy at 62.6% and that among those not pregnant to be at 53.2% (Tay et al. 2013). This study further indicated that "women in the third trimester had the highest anaemia prevalence (69.0%) compared to 60.8% in the second trimester and 64.0% during the first trimester" (Tay et al. 2013). Also, a study in the Dangme East, Ghana found 66.6% anaemia prevalence among pregnant women (Crowther et al. 2017). Furthermore, Anlaakuu & Anto (2017) reported a prevalence of anaemia at 40.8% in pregnant women at the regional Hospital at Sunyani, Ghana. Studies that were undertaken in the Northern sector of Ghana

seems to corroborate the 2014 GDHS prevalence. Jaween (2013) reported a prevalence of 47% of anaemia among pregnant women.

Comparing the number of studies that were conducted to determine anaemia prevalence in general pregnancy to those that considered trimester-specific prevalence especially the third trimester, it has become clear that very few studies actually considered trimester-specific prevalence. These few findings might not be representative enough to trigger a national policy dialogue on reducing the anaemia prevalence in third-trimester pregnant women. Besides, few of the studies that looked at trimester-specific did not comprehensively establish the impact of anaemia in the third trimester on the birth outcomes.

2.2 Factors associated with Anaemia in pregnancy during third trimester

Existing literature has linked several factors to anaemia in pregnancy. The literature review takes an evaluative view base on levels of causation using both social and biomedical context. Biomedically, all factors identified are said to lead into three main causes -blood loss, hemolysis and impaired haemoglobin synthesis which are in turn influenced by several other factors that include genetic, nutritional, infections, physical and chronic conditions (Maakaro, 2018, Greenburg, 1996). In a similar way, the factors responsible for anaemia in the whole world were mainly of three (3) forms namely iron deficiency comprising iron deficiency anaemia, hookworm, and schistosomiasis, haemoglobinopathy

comprising sickle cell disorders and thalassemia; and finally, malaria. (The American Society of Hematology 2014).

Nutritional deficiency including iron is noted as a single most known causal agent for anaemia in the whole world (Stevens et al. 2012). This should not be the difficult majority of the other factors both hidden and apparent that often lead to some level of deficiency and so become secondary causes. Considering nutrition as a whole, lower dietary diversity scores have been linked to increased risk of anaemia even though there seems to be inconsistency.To be more specific, the adjusted risk of 2.29 among pregnant women with inadequate Dietary Diversity scores (DDS) was reported in Ethiopia (Zerfu, Umeta, and Baye 2016). On the other hand, higher DDS was found to be a protective factor against maternal anaemia in Ghana (Saaka and Abdul 2015). A similar study in the Northern region of Ghana found no significant association between DDS and anaemia (Saaka et al. 2017).

In another way of measuring food inadequacy, a systematic review revealed an overall increased odds of 1.45 of anaemia among food secured participants (Moradi et al. 2018). With regards to nutrition status measured via macronutrient indicators, MUAC less than 23 cm is said to be a statistically significant independent risk factor (Mirie et al. 2016). Being underweight within the first trimester of pregnancy is also considered to be a risk factor for anaemia at antenatal care registration among Indonesian and Ghanaian pregnant women (Mocking et al., 2018). Among the dietary factors observed to be associated with anaemia are Iron, vitamin A, Folate, riboflavin, among others (WHO 2015). Lack of iron

is said to contribute about 50% of the anaemia cases (WHO 2015) even though this may vary in some parts of the world. With the African continent, iron deficiency and consumption of iron absorption inhibitors have been reported to link anaemia in pregnancy in Uganda and Ethiopia (Baingana, Enyaru, Tjalsma, Swinkels, & Davidsson, 2015 and Dar, 2018). In West Africa, a study in Nigeria also suggests iron deficiency anaemia (Ojukwu et al, 2018).

In Ghana, a limited number of studies have been able to link nutritional deficiencies and anaemia in pregnancy. A study in Bolgatanga suggested lack of iron as a contributory factor for anaemia in pregnant women (Ahenkorah et al., 2016) and the only accessed study that estimated the percentage of anaemia caused by iron deficiency estimated it at 13%. If this result should reflect the entire country, then iron deficiency causes far less than a quarter of anaemia in Ghana. Surely, nutritional deficiencies are brought about by some upstream factors. These could include diseases and sociodemographic factors.

Another key factor that is widely accepted to cause anaemia is a disease condition. Several diseases are linked to an increase in the risk of anaemia in pregnant women. Common infections and inflammations qualified as determining factors for anaemia in the first trimester in Uganda (Baingana et al. 2015). Furthermore, malaria and hookworm infection are found to contribute to an elevated severe anaemia among women who are pregnant (Lebso et al., 2017, Anlaakuu & Anto, 2017 & (Umeh et al. 2018). Umeh et al. (2018) further concluded that the prevalence of malaria and hookworm infection increases with gestational age. Another study in Bahir Dar, Ethiopia also identified malaria and

hookworm infection to cause anaemia in pregnant women (Dar, 2018). Going further upstream, socioeconomic factors have been identified to contribute to anaemia in pregnancy (Ayoya et al. 2012a; Ojukwu et al. 2018). Lower socioeconomic status of women is linked with increased episodes of anaemia (Lebso et al., 2017, Anlaakuu & Anto, 2017). However, there is another school of thought suggesting that lower socioeconomic is quite broad and may pose difficulty in ensuring precision in measuring.

Several studies reported specific socioeconomic variables influencing the risk of anaemia. One of the socioeconomic factors is education. WHO (2017) argued that education as a predictor of health makes it a major determinant in the risk of getting anaemia. Indeed, recent studies produced a relationship that was statistically significant between formal education and anaemia status in pregnancy.

In Ghana, Saaka et al., (2017) concluded that education predicts anaemia in pregnancy. Unemployment or a housewife have also been linked to anaemia in pregnancy (Mirie et al., 2016 &Obai et al., 2016). A study in Bolgatanga suggests a strong association of unemployment and maternal anaemia with a statistically significant adjusted odds ratio of 4.76 (Ahenkorah, Nsiah, and Baffoe 2016). Individual maternal factors are also reported to influence the risk of anaemia. Parity, gravidity, gestational age, antenatal care attendance and the age of the pregnant woman have all been identified as risk factors. Maternal anaemia prevalence is said to vary with a woman's age within the same countries (Ayoya et al. 2012a). Geographically, rural women are documented to have a higher risk than urban

counterparts. A study in Bolgatanga reported over three (3) fold increased risk among rural pregnant women compared to urban (Ahenkorah, Nsiah, and Baffoe 2016). In India, urbanization was identified as statistically significantly associated with anaemia reduction (Chakrabarti et al. 2018). Furthermore, parity was considered the cause of anaemia in pregnant women according to a study that was carried out in the Greater Accra region of Ghana (Acheampong et al. 2018). Additionally, a woman without a husband and /or partner was found having a statistically significant relationship with anaemia in pregnancy (Masukume et al. 2015). Also, poor nutritional status in early pregnancy is a determinant of anaemia. For instance, underweight within the early part of pregnancy increased the risk of anaemia at registration for ANC among Indonesian and Ghanaian pregnant women (Mocking et al. 2018).

Another study in Bahir Dar, Ethiopia identified malaria infection; hookworm infection; abortion; tea consumption; pregnancy and mid-upper arm circumference as having a positive association with anaemia (Dar 2018). Furthermore, a community-based study in Southern Ethiopia identified low dietary diversity; lack of iron supplementation; trimester of pregnancy; low socioeconomic status; gravidity three to five; six and above and hookworm infection as the determinants of anaemia in pregnancy (Lebso et al., 2017, Anlaakuu & Anto, 2017). Being unemployed, inadequate consumption of the combined iron with folic acid tablets and /or syrups, and smaller (<23cm) mid-upper arm circumference (MUAC) have been identified as independent determinants for anaemia among pregnant women (Mirie et al. 2016). Engwa et al., (2017) in their study also identified G6PD deficiency as a major contributor to anaemia in pregnant women. In

furtherance, parity, eating less than two times in a day, low dietary diversity score and inadequate meat intake determine anaemia in pregnant women (Abriha, Yesuf, and Wassie 2014). Saaka et al., (2017) in their study indicated that pregnant women who had higher education were less anaemic when compared with those without educational training.

Also, Saaka et al., (2017) found in their study that gestational age, number of times a pregnant woman attended antenatal care (ANC), number of children less than five years in a household, level of wasting, and maternal height independently predicted anaemia in pregnancy.

Conversely, Tay et al., (2013) were able to demonstrate that anaemia prevalence increases with gravida and found that, multigravida has higher anaemia prevalence (67.1%) compared to primigravida (50.0%). The green leafy vegetable powder intervention was found to increase the mean haemoglobin levels among some study participants in an intervention group and resulted in a minimal anaemia prevalence compared to the control group (Egbi et al. 2018, Rao et al. 2014). Crowther et al., (2017) were able to show that the age of the pregnant woman, gravidity, parity and parasitic infections determine anaemia among “pregnant women in the Dangme East District of Ghana”. According to Obai et al., (2016) being a housewife in Uganda showed a statistically significant relationship with a high rate of anaemia.

Importantly, pregnant women who have absolute and independent way of making decisions about their health and food purchase is found to contribute to increasing the utilization of health care services including antennal care that have direct or indirect effects on anaemia

status (Ghose et al. 2017, Tiruneh, Chuang, and Chuang 2017, Fawole and Adeoye 2015). The ability of the woman to make her own decisions improves the use of modern contraception (Ewerling et al. 1999) Women who can single handily make decisions on household food purchase had a higher dietary diversity when compared with women who do not have a say according to a study in Ghana (Amugsi et al. 2016). The trimester within which a pregnant woman visits the health facility for the first antenatal care also determines anaemia. This is supported by study findings by Adanikin and Awoleke (2016), A.K Monjurul et al. (2006), Nwizu et al. (2011) and Amna (2012) who identified late (second or third trimester) initiation of antenatal care as a determinant of anaemia.

It is obvious from the evidence gathered thus far; a complex web of factors may be contributing to anaemia in pregnant women. Furthermore, it's unclear why anaemia exists in the third trimester after one or two interventions are being given to pregnant women from the point of registration at ANC.

2.3 Incidence of birth outcomes

The birth outcomes that are discussed in this chapter include preterm births; low birth weight and stunting.

2.3.1 Preterm births

The "World Health Organisation (WHO) defines preterm birth as babies born alive before 37 weeks of pregnancy are completed". "Preterm birth is subcategorised into extremely preterm (<28 weeks), very preterm (28 to <32 weeks) and moderate to late preterm (32 to <37 weeks)" (Howson, Kinney, and Lawn 2012). Over 60% of preterm births occur in Africa and South Asia (Howson et al., 2012, Blencowe et al., 2012). Preterm is a global problem since the 10 countries with the highest numbers include both rich and poor countries such as Brazil, the United States, India and Nigeria (Howson, Kinney, and Lawn 2012). The world recorded about fourteen million and nine hundred thousand (14·9 million) newborn in the year 2010 delivered before thirty-seven (37) weeks of gestation, with some European countries accounting for 5% and the highest (18%) been recorded in some African countries (Blencowe et al. 2012). The estimated rate of preterm birth for the whole world for 2014 stood at 10·6% whilst the projected regional preterm birth rates for 2014 within North Africa was 13·4% and the European community expected to record 8.7%. According to Chawanpaiboon et al. (2018), the African continent especially the sub-saharan countries, as well as Asian, contributed about 81·1% of preterm births the world over in 2014. More than three quarters (85%) of babies that were born before the 37th. Week occurred within the late preterm period (Chawanpaiboon et al. 2018).

In Brazil, the prevalence of preterm for the period 2011-2012 was 11.5%. Late preterm was the largest category, at 74 % of preterm, or 8.5 % of all births. Spontaneous preterm births made up 60.7 % of all preterm births and extremely premature births at 5%. Provider-initiated preterm births were 39.3 % of the total, due to almost entirely (90 %) to the

prelabour caesarean section (Leal et al. 2016). Similarly in the Africa region, 18.3% incidence of preterm birth was reported a national hospital in Kenya (Wagura et al. 2018). There are well-documented effects of preterm births that include the death of the infant, incapacitation of the child leading to unproductive human capital in the future at the global level (Blencowe et al. 2013). The complications of preterm birth as the single direct cause of deaths among neonates across the world at 35% (Blencowe et al. 2013). This translates to about 3 in 4 deaths among neonates globally as a result of complications emanating from preterm births (35%), much higher when compared with complications involving labour and delivery at 24%, and sepsis contributing 15% (Report 2014). Half of the total births in the world come from South Asia and sub-Saharan Africa that, particularly recorded more than 80% of the deaths out of one million and one hundred thousand (1.1million) among infants who were born preterm (Howson, Kinney, and Lawn 2012). Also, out of the 7·6 million deaths in infants below the age of five in 2010, preterm is deemed the main cause of 14.1 % of the neonatal deaths (Liu et al. 2010). Preterm birth complications are reported to have contributed 41% neonatal mortality from birth to the sixth day; 21% from the seventh day to the twenty-seventh day and 34% within the overall neonatal period (0–27 days) of neonatal deaths worldwide in 2012 (Lawn et al. 2015).

Preterm birth has multiple causes including biological, clinical, and social-behavioural risk factors (Howson, Kinney, and Lawn 2012). Pulat Demir, (2018) was able to demonstrate from their study results that preterm births are influenced by the “mother’s body mass index” during the pre-pregnancy period, maternal weight gain, and nutrition during pregnancy. Therefore, the rate of preterm births with high mortality and morbidity can be

reduced by maintaining ideal body weight combine with giving mothers healthy nutrition education. “A Peruvian study in the National Hospital Sergio E. Bernales reported that not receiving prenatal care, receiving inadequate prenatal care, preeclampsia and history of premature birth as some of the risk factors for prematurity” (Ahumada-Barrios & Alvarado, 2016, Access, 2018, Chung et al., 2017). Ferrero et al., (2016) identified previous preterm birth and preeclampsia as the strongest individual risk factors of preterm birth in their cross-country study. “They further concluded that nulliparity and male sex were the two risk factors with the highest impact on preterm birth rates” (Ferrero et al. 2016). Wagura et al., (2018), indicated that preterm birth is determined by many factors that include: age of the mother, parity, twin gestation, infection of the urinary tract of the mother, hypertension during pregnancy, antepartum haemorrhage and prolonged prelabour rupture of membranes. Other evidence available showed that older age of 40 years and above is also identified to contribute more to premature birth than the age of the mother between 30–34 years (Fuchs et al. 2018). In contrast, “advanced maternal age is not independently associated with the risk of low birth weight or preterm delivery among mothers who have had at least 2 live births” in Finland (Goisis et al. 2017).

A systematic review report published in 2017 that looked at different types of scientific studies on the risk of vitamin D deficiency on preterm birth concluded that maternal vitamin D deficiency could aggravate the chance of premature birth (Zhou et al. 2017). And that supplementation during pregnancy can reduce the rate of preterm birth (Zhou et al. 2017). Furthermore, premature births are determined largely by severe complications of infections (Cappelletti et al. 2016) just as autoimmune hepatitis significantly contribute to preterm delivery (Bottai 2016). Also, shorter pregnant women have a greater chance of

giving birth preterm compared to taller women as well as those living in rural areas (Access 2018). Supporting this evidence further, a population-based study revealed that shorter pregnant women in Sweden were more likely to give birth to premature babies (Derraik et al. 2016).

In a large cohort study to assess the impact of foetal gender on the risk of preterm birth, male foetal gender was reported a significant risk factor for spontaneous preterm birth in white European women (Peelen et al. 2016). Leal et al., (2016) in the "Birth in Brazil study" for the period 2011–2012 identified provider-initiated preterm delivery as a major risk factor for preterm births in Brazil. Socioeconomic factors of the pregnant woman including educational training, whether the woman is married or not married, ethnicity have a statistically significant relationship with the rate of preterm birth in Norway (Oftedal et al. 2016). Effects of maternal stress exposure during pregnancy are of public health importance because it impacts positively on the rate of preterm birth at about 20% (Lilliecreutz et al. 2016). Similarly, a systematic review report indicated that prenatal maternal anxiety could increase the rate of preterm birth (Rose, Pana, and Premji 2016). It is also worthy to note that preterm birth could have similar risk factors with the early term (37 and 38 weeks of gestation) and they include: a previous preterm delivery, short stature, underweight, obesity, low formal educational training and those mostly coming from the Sub-Saharan African origin (Delnord et al. 2018). A study was conducted to investigate the relationship between sleep disorder diagnosis during pregnancy and risk of preterm birth. It was revealed that a preterm birth prevalence of 10.9% occurred in the reference pregnant women and 14.6% in pregnant women with the condition of sleep disorder (Felder

et al. 2017). This study identified insomnia and sleep apnea as the major threats significantly associated with the increased risk of preterm birth (Felder et al. 2017). According to a study in Sweden, the rate at which pregnant women either gain or loss weight could be a determining factor for premature birth. Also, when the woman gives birth and gained too much weight before the next pregnancy, it can result in premature delivery (Villamor and Cnattingius 2016). Furthermore, poor oral health including diseases of the teeth can also contribute to premature birth and low birth weight infants according to a systematic review report (Teshome and Yitayeh 2016). Depression was also found as a risk factor for premature birth (Jarde et al. 2016).

2.3.2 Low birthweight

Low birth weight defines a heterogeneous group of infants: some are born early, some are born growth restricted, and others are born both early and growth-restricted (Wardlaw 2004). Globally, low birthweight indicates the complex nature of the public health issues confronting society today. It magnifies the malnutrition situation among prospective mothers and further showcase the futuristic negative impact on the human capital base of a society and inadequate care of the pregnant woman being the basis (Wardlaw 2004). The weight of the newborn is determined by the health status of the mother. The child's weight at birth is categorized into normal weight (≥2.5) low birth weight (<2.5kg), very Low birthweight (<1.5kg) and extremely low birth weight (<1.0kg) (Wardlaw 2004). Wardlaw (2004) further observed that more than 20 million babies were born with low birthweight globally. These according to the report are mainly found in Asia (72%) and Africa (22%).

India alone accounts for 40% of low birthweight births in the developing world and more than half of those in Asia. There are more than 1 million infants born with low birth weight in China and nearly 8 million in India. Latin America and the Caribbean, and Oceania have the lowest number of low birth weight infants, with 1.2 million and 27,000, respectively.

Recent evidence is that low birth weight is still on the increase. According to a comparative analysis that succeeded in comparing a decade long prevalence of low birth weight in India, the study revealed that the average birth weight in 2011 was 2.6 kg, a decrease from 2.75kg in 2001 (Sachdeva, Nanda, and Sachdeva 2013). According to this same study, the percentage of low birth weight was 36.1% in 2011 an increase from 30.5% in 2001 (Sachdeva, Nanda, and Sachdeva 2013). Similarly, a study with a sample of 455 babies from rural India reported a 24.4% prevalence of low birthweight (Gosavi, Koparkar, Sv, Contemp, & May 2014). In Thailand, 10.4% among all documented newborn babies in 2014 had birth weight below 2.5kg accounting for 180,853 healthy lives lost in that country (Aung, Makka, and Bundhamchareon 2018), This study further reported that the "number of deaths resulting from LBW was 2.4 per 1000 live births and that LBW was the leading cause of death in children under five years of age" (Aung, Makka, and Bundhamchareon 2018). Also, low birth weight was reported by some other studies as the main cause for obesity at a later age, insulin resistance diabetes and type 2 diabetes (Jornayvaz et al. 2016). "A cross-sectional study to determine the prevalence of low birthweight and its association with maternal body weight status in some selected African countries, reported the prevalence of LBW in Burkina Faso, Ghana, Malawi, Senegal and Uganda respectively" as, 13.4%, 10.2%, 12.1%, 15.7% and 10% (He et al. 2018).

Low birth weight was reported to be positively associated with the period of gestation; maternal anaemia, and maternal age according to a study in the university hospital of Cape Coast, Ghana (Prah et al. 2016). This very study also reported a low birthweight prevalence of 7.7% among anaemic pregnant women where inadequate antenatal care attendance was identified as a determinant of the low birthweight (Prah et al. 2016). Additionally, diet quality determines the rate of low birthweight. For example, a study in Australia concluded that a high-quality diet can lower the rate of low birth weight deliveries (Gresham et al. 2016). The age of the pregnant woman including sex of the baby was significantly associated with low birth weight (Gosavi et al. 2014). Another systematic review and meta-analysis to compare "neonatal outcomes in women with untreated depression with women without depression" concluded that untreated depression is a risk factor for low birth weight (Jarde et al. 2016). A study in Nigeria aimed at identifying the reasons behind the high prevalence of low birth weight reported a 7.3% prevalence of babies born with birth weight less than 2.5kg (Dahlui et al. 2016). Factors that were associated with this prevalence are employment status of the father, geopolitical zone, parity, number of pregnancies, and pregnant woman's weight (Dahlui et al. 2016). Similarly, another study concluded, "that low birth weight (LBW) is associated with low socioeconomic status, anaemia, primiparity, short maternal height and underweight" (Access 2016). Others also identified autoimmune hepatitis as the determining factors for low birthweight (Bottai 2016).

Finally, the effects of low birthweight could be high disease occurrences and deaths. For instance, low birth weight is identified as the number one cause of premature death in

children who were less than five years old and it is a typical point of reference in Thailand where the children who died as a result of low birth weight is reported at 2.4 per 1000 live births for both males and females (Aung, Makka, and Bundhamchareon 2018).

2.3.3 Stunting at birth

"Stunting is the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation". "Children are defined as stunted if their height-for-age is more than two standard deviations below the WHO Child Growth Standards medians" (WHO | Stunting in a nutshell 2015). The global nutrition report (2018) observed the following: that "stunting in children under five years of age is declining at a global level but numbers in Africa are increasing, and there are significant disparities in progress at the subnational level". For instance, "stunting has declined from 32.6% of all the world's children under 5 years of age in 2000 to 22.2% in 2017; that stunting among children in Asia has declined from 38.1% to 23.2% since 2000 and in Latin America and the Caribbean from 16.9% to 9.6%; and finally, stunting among children in Africa has decreased in percentage terms from 38.3% to 30.3% over the same period, yet due to population growth, the actual number of stunted children has risen". In Sri Lanka, a stunting prevalence of 16.8% among children aged 6-36 months was reported (Sujendran, Senarath, and Joseph 2015).

In Ghana, nearly 1 in 5 (19%) of children under five are stunted (GSS, GHS, and ICF International 2015). Importantly, the Northern region, in particular, experienced the

highest-burden of stunting with one-third (33.1%) of children under five been stunted (GSS, GHS, and ICF International 2015). Many other studies recently reported stunting occurring more in utero and at birth. For example, childhood undernutrition has its origins in the foetal period (Christian et al. 2018). Supporting this finding further, a study in Guatemala found that stunting was carried over from in utero growth retardation in short-stature Guatemalan mothers (Solomons et al. 2014). Also, Stunting at birth was reported at 3.8% in a study that took place in Brazil, China, India, Italy, Kenya, Oman, England, and the United States (Victora et al. 2015). The Lungwena Child Survival Study, Malawi, also found that stunting actually starts from birth through to the ages of fifteen years (Teivaanm 2015). Furthermore, another study reported a stunting prevalence among Bhutanese children from zero (0) to twenty-three (23) months old at 27.5% (Aguayo, Badgaiyan, and Paintal 2015). However, the study further reported that the stunting prevalence was much pronounced (36.7%) in children from twelve (12) months to twenty-three (23) months old compared to children from zero to eleven months old (17.7%) (Aguayo, Badgaiyan, and Paintal 2015).

The weight gained by the mother from the time she became pregnant to about thirteen to twenty-seven weeks (second trimester) of gestation has a negative impact on the foetal length (Neufeld, Haas, and Martorell 2018). In contrast, others also found stunting among children occurring after birth particularly in India where a 50% undernutrition among children 2-5 years was reported (Nitish 2016). The WHO indicated “that linear growth in early childhood is a strong marker of healthy growth given its association with morbidity and mortality risk, non-communicable diseases in later life, and learning capacity and

productivity" (WHO | Stunting in a nutshell 2015). Further, small head size at birth is associated with lower grades and lower occupational prestige among individuals born into both advantaged and disadvantaged social classes (Dekhtyar et al. 2015). The nutritional status of the pregnant woman is recognised as a critical factor that significantly increases poor fetal development in poor countries (WHO 1995). Stunting remains one most single important nutrition indicator of recent time and denotes a failed effort to attain full mental and physical development due to lack of favourable nutritional conditions (WHO 1995). There is more than one factor that contributes to stunting among children as observed in the Indian cohort study that found that the height of the mother, formal educational training and the season at which the woman becomes pregnant as the main factors responsible for stunting from birth through to pre-adolescence (Svefors et al. 2016).

Low birth weight (LBW) was found as the major determinant of stunting (Aryastami et al., 2017; Rachmi, Agho, Li, & Baur, 2016). Apart from the low birth weight, gender (boys), history of neonatal illness and poverty are other factors related to stunting among children aged 12–23 months in Indonesia (Aryastami et al. 2017). Quite a number of studies are reporting that water, sanitation and hygiene (WASH) determines the rate of stunting in childhood. These studies further indicated that "WASH" strategies impact stunting in diverse ways including biological, social and economic pathways (Cumming & Cairncross, 2016; Aguayo et al., 2015). Preterm and small for gestational babies born to HIV-negative women in Tanzania had a greater risk of becoming stunted (Sania et al. 2015). Yet the most leading worldwide risk factor in terms of ranking several factors and their contributions to "stunting is being born term, and small for gestational age" (Danaei

et al. 2016). Born term and small for gestational age are contributing 10.8 million cases of stunting among two-year-olds out of 44.1 million in the world followed by poor sanitation (7.2 million cases) and 5.8million cases of diarrhoea (Danaei et al. 2016).

On a regional basis, foetal growth restriction and premature birth topped all other factors in all the regions under consideration (Danaei et al. 2016). “Environmental risks had the second-largest estimated impact on stunting globally and in South Asia, sub-Saharan Africa, and East Asia and Pacific regions, whereas child nutrition and infection was the second leading cluster of risk factors in other regions” (Danaei et al. 2016). Stunting apart from its relationship with shorter adult height, also impede economic progress as the consequences of stunting include poor mental development and unproductive individuals who might not contribute effectively to the progress of society (Dewey and Begum 2011). Children et al., (2018) also concluded in their study that the impact of stunting is intergenerational. They observed that those children who were born to parents of short stature had: impaired developmental quotients; low intelligent quotients; and lower height-for-age (Children et al. 2018).

2.4 Association between anaemia in pregnancy and birth outcomes

A number of studies have demonstrated that premature delivery and low birth weight were statistically significant associated with those pregnant women with anaemia than those without. For instance, a study in China (Wei et al. 2018) reports a statistically significant association between anaemia and birth outcomes. Also, an observational study involving 3965 babies found a positive association between severe anaemia in pregnancy with

adverse maternal and birth outcomes (Sapre, Raithatha, and Bhattacharjee 2018). In furtherance, Anaemia at birth is significantly associated with caesarean section (Drukker et al. 2015). Apart from anaemia in pregnancy, adolescent pregnancy is established to have a significant relationship with increased poor pregnancy outcomes (Ganchimeg et al. 2014). Significantly, an appreciable level of evidence from several studies have also reported a statistically significant relationship between being anaemic and giving birth prematurely, for example, a study to investigate the independent contribution of maternal anaemia to adverse birth outcomes concluded that prematurity and the poor neonatal outcome are positively associated with anaemia (Rani et al. 2014).

Tandu-Umba and Mbangama also observed in their study that anaemia in pregnancy contributes significantly to giving birth prematurely, small for gestational age (SGA) and stillbirths (Tandu-Umba and Mbangama 2015). A systematic review by Figueiredo et al (2018) has linked anaemia in pregnancy to the possibility of giving birth to a low birthweight child (Figueiredo et al., 2018, Nair et al., 2016). Also, a study to find the relationship between anaemia in pregnant women and low birth weight reported a significant association particularly in the first trimester of pregnancy and decreases within the second and third trimesters (Rahmati et al. 2017). Low birth weight is reported to have a relationship with maternal anaemia, according to a study in the university hospital of Cape Coast, Ghana (Prah et al. 2016). There is evidence that severe anaemia is associated with a higher risk of low birth weight especially in the third trimester (Bodeau-livinec et al. 2011). A study to assess the haemoglobin level of pregnant women and how that relates with their babies birthweights found that anaemia throughout the three trimesters of

resulted in low birth weight in Iran (Moghaddam Tabrizi 2015). The presence of both anaemia and underweight in pregnant women exposes them to delivering low birthweight babies (Patel et al. 2018). Also, anaemia among other factors such as failure to attend antenatal care, history of preterm birth, first pregnancy, and rural residence were risk factors for a higher proportion of children born with low birthweight in a government hospital, Rohtak (Sachdeva, Nanda, and Sachdeva 2013).

Assessing the Peruvian economy using the impact of anaemia, it was revealed that the resultant effect of anaemia costs the Peruvian society approximately 0.62% of its gross domestic products (GDP) (Alcázar 2013). The main cost factor was the effect of cognitive impairment in adults due to anaemia in childhood, representing 0.33% of GDP and the costs faced by the state stood at S/. 632 million, of which the greatest was the cost of providing care for preterm births caused by anaemia representing 0.08% of GDP (Alcázar 2013). There are significant other studies that showed that anaemia in pregnancy does not have an association with birth outcomes. For example, a study among pregnant women revealed that there was no effect between anaemia and birth outcomes though, an increased risk of poor pregnancy outcomes in anaemic women in early pregnancy was observed (Masukume et al. 2015). Also, another study on Indonesian and Ghanaian pregnant women residing in urban areas found that anaemia has no association with adverse birth outcomes (Mocking et al. 2018). Additionally, a depleted iron status within the “first trimester of pregnancy” has no association with low birth weight (Alwan et al. 2015). Furthermore, it was observed in a study that changes in haemoglobin level from the first trimester to the third trimester of pregnancy were inversely associated with birth weight, placental weight,

and placental ratio according to a study (Jwa et al. 2015). Similarly, a study that investigated the effect of involving pregnant women who attended antenatal care in testing, knowing their malaria and haemoglobin status and asking questions concerning their care concluded that there were no beneficial effects on birth outcomes (Ampofo, Tagbor, and Bates 2018).

Despite the available evidence on the impact of anaemia in pregnancy on birth outcomes, there is limited information on the third-trimester specific impact and none is known about the Zabzugu and Tatale Districts where this study was carried out. By reviewing several articles and research findings as in above, it is clear anaemia is specifically a major determining factor for low birth weight births. Research evidence on the impact of anaemia on low birth weight will be important in informing local policy-making and health promotion programmes. However, fewer studies actually indicate how anaemia among pregnant women in their third trimester could impact so much on low birthweight. Furthermore, information on the impact of anaemia in the third trimester on stunting is scanty. Besides, most surveys focus on the prevalence of stunting in children from 6-59 months. This could create a situation where more emphasis by nutrition actors could be more geared towards reducing stunting between 6-59 months and less on preconception, conception and during pregnancy, a more vulnerable period stunting could occur. These and many other reasons informed this study in the Tatale and Zabzugu districts.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the research methods. The presentations centred on the study settings, study design, study population, sample size and sampling procedure, research instruments, data collection procedure, data analysis and ethical considerations.

3.1 Study setting

The study was conducted in Ghana. The country is located on the south coast of West Africa and it is bordered by Cote d'Ivoire to the west, Burkina Faso to the north, Togo to the east and the Gulf of Guinea to the south. It covers an area of 238,539 km2, of which about 5% is comprised of permanent water bodies. Administratively, Ghana is divided into 16 regions. The northern region is one of the administrative regions of Ghana. The Northern Region shares boundaries with the North East and the Savanna Regions to the North, the Bono and the Volta Regions to the south, and two neighbouring countries, the Republic of Togo to the east, and La Cote d'Ivoire to the west. The land is mostly low lying except in the north-eastern corner where we have the Gamabaga escarpment and also along the western corridor. The region is drained by the Black and White Volta and their tributaries, Rivers Nasia and Dakar. It is divided into sixteen (16) administrative districts, of which Tatale and Zabzugu are part.

3.1.1 Tatale-Sanguli district

The Tatale-Sanguli district was carved out of the then Zabzugu/Tatale district. It shares boundaries with Togo to the east, Zabzugu district to the west, Saboba district to the

North and Nanumba North district to the South. It is one of the least developed in terms of infrastructure in the region. It is mainly rural and has a sparse and scattered population that makes infrastructure development difficult. It has an estimated population of about 73,485 people, projected from 2010 population census. The population growth rate is approximately 1.03% per annum. The population density is about 20 persons per square kilometre, living in 159 settlements (Tatale Sanguli district profile). The major occupation is farming. Farming and farm-related business made up of about 85% of the workers while trading/service and manufacturing made up of 14% and 1% of the workers respectively (Tatale Sanguli district profile). The road network is poor and the main means of transport include minibuses, tricycles, motorbikes, and farm tractors. Most communities still depend on non-conventional means of transport such as bicycles and head loading to transport their goods to major market centres. According to the district profile of Tatale, there is poor distribution of electricity in the district and only eleven (11) out of 159 communities have been connected to the national electricity grid. The people in the district have access to the airwaves through Radio Ghana Savana FM, Saboba FM and other Togo radio stations. There is no post office in the district and accessibility to newspapers and other publications is still a problem. About 67% of the people in the district lack clean and safe drinking water. Water is an essential commodity especially during the dry season when 90% of all available wells and boreholes dry up and inhabitants have no option than to use water from dams and rivers that serve their livelihood. The district is divided into six sub-districts comprising of fourteen health facilities which include eight Community-based Health Planning and Services (CHPS) Compounds, four health centres, one clinic and a District hospital that serve the health needs of the entire district population.

3.1.2 Zabzugu District

Zabzugu district is located in the eastern part of the Northern region and covers an area of 1,100SqKm^2. It shares boundaries with Tatale/Sanguli district to the east, Yendi municipal and Mion district to the west, Nanumba North and Nanumba South to the south and Saboba district to the north. The district has a total population of 78,766. The ethnic groups are Dagombas, Konkombas, Bassares, Ewes and Fulanis. The Ewes are mainly settler fishermen who have settled along the major oti river to engage in fishing activities. The Fulanis are herdsmen for the indigenous people. The most common food products cultivated in the district include yam, maize, millet, rice, cassava and groundnuts. The main cash crop produced is the Shea nut, which is grown in the wild. Goats and sheep are the small ruminants reared in the district (Zabzugu District profile). Zabzugu district has one district hospital, two health centres, one RCH centre and ten functional CHPS zones. Of the ten functional CHPS zones, eight have compounds but only four have staff residing in them. However, staff have been identified and posted to the rest of the four compounds and they provide outreach services in the compounds. The district has one hundred and fifty communities and these are served by the health facilities. Malaria is number one on the top ten causes of admission in the Zabzugu district (36.0%) for the year 2017 and the second highest cause of admission is anaemia (11.2%) according to the district health services annual report 2017. Anaemia and malaria are isolated as the main cause of deaths in the district at 36% and 24% respectively (DHMT 2017 annual report 2017).

3.2 Study design

A prospective cohort design was used for the study based on their anaemia status. The study was conducted between the month of November 2018 to September 2019 in the study area.

3.3 Study populations

The research population was only pregnant women in their third trimester (≥33 weeks of gestation) living within the study settings. The total number of pregnant women at ≥33 weeks of gestation was obtained from the antenatal register from each health facility.

3.3.1 Inclusion criteria

- Any woman aged 18 years or more and who were either 33 weeks of gestation or more.
- Pregnant women registered for antenatal care
- Those pregnant women who will voluntarily agree to take part.

3.3.2 Exclusion criteria

- If you have multiple gestations
- Pregnant women with a history of chronic illness including diabetes mellitus, hypertension, heart disease or thyroid disease
- Pregnant women tested positive for sickle cell
- Pregnant women with Glucose-6-phosphate-dehydrogenase deficiency (G6PD)

- Pregnant women who planned to leave the study area before their delivery time.

3.4 Sample size determination

A sample size of 359 respondents was selected from the study population for the study. This sample size was calculated using Yamane Taro formula (1967) for sample size determination, as cited in (Polonia 2013)

n=N/[1+N(e)2]

where n = the total sample size for this study

N = the total population of pregnant women in the two districts

e=error tolerance (0.05)

The population of pregnant women (≥33 weeks of gestation) in the two Districts obtained by reviewing the antenatal care registers from each health facility at the time of the study was 2045

$n = N/[1 + N(e)2]$

where n = the total sample size for this study

N = 2045

e=error tolerance (0.05)

n=2045/[1+2045(0.05)2]

n=335.

5% of the sample was added to control for loss to follow up, given a total sample of n=352.

The minimum sample size for this study was 352. However, 369 pregnant women were interviewed and followed up until they deliver. A total of 359 respondents had complete data for birth outcomes and were used for the analysis.

3.5 Sampling method

Simple random sampling without replacement was used to select study participants in facilities. A complete list on the antenatal care register containing pregnant women ≥33 weeks of gestation was obtained from each of the health facilities providing antenatal care services in the study area. Those who attended antenatal care on the data collection day had their names written on a piece of paper and kept in a basket. The papers were thoroughly mixed before and after each time a name was selected without replacement. All health facilities with midwives conducting both antenatal care and deliveries were included in the study making up a total of seven (7) health facilities from Tatale-Sanguli district and five (5) health facilities from Zabzugu district. A proportion to population size was used to select the number of respondents based on the population of the facility. In facilities where the participants were less than or equal to the total per facility, all were interviewed and then followed up until they delivered during which the birth outcome data were taken and recorded by the midwives.

3.6 Data collection techniques

Data collection was done in two stages. First, all eligible pregnant women consenting to partake in the study were interviewed at the antennal clinics. The pregnant women were interviewed face-to-face by administering a structured questionnaire using Nutrition officers with a minimum qualification of diploma in nutrition and information obtained on socioeconomic, adherence to iron and folic acid (IFA) supplementation, sources of drinking water, food preparation, food intake using the 24-hour dietary recall method. Data on Hemoglobin (Hb), gestational age of the pregnancy, medical history, deworming status, IFA supplementation information was obtained from the mother's antenatal care (ANC) booklet.

The selected study participants were given colour-coded identification stickers on their ANC booklets and followed prospectively until they delivered. Midwives conducting deliveries in the selected facilities were officially informed and supplied with data collection template, onto which they extracted and recorded birth data on length; head circumference; weight; Apgar score; mode of delivery, and delivery outcome from their delivery registers.

3.7 Data collection procedure

All pregnant women in their third trimester partaking in the study were interviewed using the standardized questionnaire in the English language but was translated into Dagbani, Baasare and Likpaka languages for those participating in the study who did not speak English. Haemoglobin (Hb) was measured by trained midwives during the routine antenatal clinics. The researcher provided HemoCue301 micro cuvettes to the midwives to measure the Hb of pregnant women being studied. These health facilities already have HemoCue devices, electronic infant weighing scales and infantometers of the same specifications given to them by the Department of the United State Agency for International Development (USAID) and is used according to manufacturer's instructions. The researcher only provided a known weight of 2.0kg to all facilities involved in the study for daily standardization of the weighing scales. The pregnant women that were interviewed were prospectively followed until delivery. The data on the birth outcomes were taken by the midwives that conducted the delivery the same day after delivery.

3.7.1 Blood sample measurement

"Finger prick blood samples were" taken from the middle and ring fingers by trained midwives in the participating health facilities following the (WHO 2010) standard procedure as follows:

1. Applied alcoholic swap to the entry site and allowed to air dry
2. Punctured the skin with one quick stroke, to achieve a good flow of blood and to prevent the need to repeat the puncture.
3. Wiped away from the first drop of blood because it may be contaminated with tissue fluid or debris.
4. Avoid squeezing the finger too tightly to prevent diluting the blood sample with tissue fluid.
5. Applied firm pressure on the site to stop the bleeding when the blood collection procedure was completed (WHO 2010).

3.7.2 Length measurement

The length at birth was measured with the aid of an infantometer with an accuracy of 0.1cm and measurable length 45-90cm as follows:

- baby being measured "head was held vertical against the head plate by" one midwife;
- back straight on the infantometer;
- knees "straightened, and foot positioned by another midwife vertically against the footplate".
- the baby's head was adjusted against the head plate so that the lower orbital margin and tragus lie on the same plane
- read the measurement on the tape**.**

- the length was measured three times and the average of the three measurements taken to the nearest 0.1 cm.

Caution: the baby's dorsum of the foot was usually pressed on to the footplate so that there was no gap between the foot and the footplate (WHO 2008).

3.7.3 Weight measurement

The birth weight was measured with an electronic infant scale with an accuracy of 0.1kg. Weighing scale was tarred to the zero reading before the newly born baby was placed on it naked, and the reading in kilograms noted and recorded.

3.7.4 Head circumference measurement

The head circumference was measured at each point following the steps as follows:

- Used a measuring tape that cannot be stretched;
- The measuring tape was securely wrap around the widest possible circumference of the head,
- With the broadest part of the forehead above the eyebrow, and above the ears,
- Identifying the most prominent part of the back of the head and
- The measurement were taken three (3) times and selected the largest measurement to the nearest 0.1 cm' (CDC 2016)

Using the WHO child growth standards recommended age (birth to 13 weeks z-scores) and sex-specific (blue colour for boys and pink colour chart for girls) length and head circumference cut off points, a birth length of below 46.1 cm for boys is stunted; birth length below 45.4 cm for girls is stunted and a head circumference below 31.9cm is stunted for boys and head circumference below 31.5cm for girls will be classified as stunted.

3.8 Variables for the study

Independent variables	Dependent variables	Explanatory variables
Haemoglobin level Iron and folate acid supplementation	Low birth weight Stunting at birth Small for gestational age, Preterm delivery, Mode of delivery, Low APGAR score Delivery outcome	Antenatal care attendance Adherence to IFA supplementation during pregnancy Maternal weight gain HIV infections Perceived traditional supplements for anaemia prevention Gestational age Occupation Gravidity Mid-upper arm circumference (MUAC) Age Residence History of malaria infection Deworming status Parity History of abortion Use of insecticide-treated net, use of mosquito coils Tea consumption Use of the animal product Family size Meal frequency Dietary diversity score Husband involvement at ANC Early presentation at ANC Level of education

3.9 Data quality controls

All data collectors were trained on how to use the Computer Aided Personal Interviewing (CAPI) software with android phones. The data collectors were properly trained before pretesting of questionnaire to correct any discrepancies that would have arisen. After the pretesting, data collectors were retrained on areas of the questionnaire that needed improvement. The design of the CAPI incorporated checks that did not allow for double data entry, ensure accurate transmission of data to a centralized system once the device is connected to internet service. All midwives conducting deliveries in

the selected health facilities were given a refresher training by the researcher on how to measure the length, head circumference and weight at birth using the World Health Organization standard protocol to ensure accuracy of data. The accuracy of the infantometer was tested by using a measuring rod provided by the researcher to check the accuracy of the infantometer in five locations on the infantometer. If this gives a consistent reading, then the infantometer is accurate and suitable for the measurements. Each length was measured three (3) times and the average length is taken to reduce measurement errors. A known weight of 2.0kg was used to test the accuracy of the weighing scale. At the beginning of each measurement day, a known standardized weight of 2.0kg was placed on each scale. The acceptable margin was always ±0.5kg (BMI Task Force 2010).

The questionnaire was pretested in the Gnani Health Center that serves about 48 communities. These communities share similar characteristics with communities within the Tatale and Zabzugu districts, and data collected were analyzed to test for validity and reliability. Contact numbers of pregnant women interviewed were compiled to enable follow up. Each pregnant woman interviewed was assigned to a community health volunteer living in that community who constantly reminded and encouraged the woman to visit the health facility for delivery when she is due. This helped to reduce the dropout rates. Finally, the researcher was monitoring the labour cases that were sent to the health facilities within the two districts including referrals in the two districts on the labour "WhatsApp platform", and constant reminders were given to midwives to complete the data collection template provided.

3.10 Data analysis and interpretation

The data collected were analyzed using SPSS version 25. Descriptive statistics were used to determine the prevalence of anaemia among pregnant women in their third trimester and incidence of birth outcomes in the two districts. Bivariate logistics regression was used to identify the determinants of anaemia in the study setting and also determine the impact of anaemia on low birth weight, preterm delivery and stunting at birth. Multivariate logistics regression was used to identify the independent predictors of anaemia among pregnant women in the study setting. Relative risk (RR) was calculated to determine the strength of association between the outcome variable and the exposure variables. RR>1 indicates a positive association, RR< 1 indicates a protective effect and RR=1 indicates no association.

3.11 Ethical Consideration

Ethical clearance for this study was obtained from the ethics committee of the Navrongo Health Research Center, Navrongo with ethics approval ID: NHRCIRB356. A consent form was given to the pregnant women which explicitly explained the rationale of the study. The pregnant women were informed of their exclusive rights to withdraw from the study at any stage before the data could be collected. In the case where the pregnant woman could neither read nor write, an impartial witness was present during the consent process and confirmed that the information in the consent form was accurately explained, and that consent was freely given. Informed consent was documented with a signature or a thumbprint. Pregnant women (≥33 weeks of gestation) identified as anaemic during the interview period were given nutritional counselling. The questionnaire was translated into Dagbani, Basaare and Likpakpa for study participants who could understand English depending on their ethnic group. The data collected was

stored in a secure laptop computer with secrete password to prevent unauthorized persons from getting access. This data will be locked for the next two years before it will be discarded.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter presents the results of the study. The main items presented include the prevalence of anaemia at ≥33 weeks of gestation at the study area, socio-demographic factors, socio-economic factors, health care interventions affecting anaemia, diet and diet-related factors, the incidence of birth outcomes, a test of associations using the multinomial logistics regression

4.2 Factors associated with anaemia at ≥33 weeks

The results on factors influencing anaemia presented under this include the socio-demographic, decision-making process, health care interventions and diet and diet-related.

4.2.1 Socio-demographic characteristics of respondents

Table 1 presents the socio-demographic characteristics of respondents in Tatale-Sanguli and Zabzugu districts. The modal age of the respondents (27.9%) was between the ages of 26 and 30 years in both districts. However, Tatale-Sanguli district had the majority (29.8%) of the respondent within this age bracket than Zabzugu district that had 26.9% within the same age bracket. The least age group (12.5%) of the respondents were ≥36 years. There were similar (14.9% and 13.9%) of the respondents who were less than 20 years of age for Tatale-Sanguli and Zabzugu respectively. Also, about two-thirds (66.7%) of the respondents had no formal education from the Tatale district compared to 63.3% from the Zabzugu district. Cumulatively, more than half (64.3%) had no formal education from the two districts. About half of the respondents (20.2%)

who had basic education had senior high school education in Tatale-Sanguli district compared to the Zabzugu district where 15.1% and 16.3% of respondents who had basic education and senior high school education respectively. The least of the respondents (4.5%) interviewed had Tertiary education from the two districts.

In addition, almost all the respondents (98.6%) reported married. The least of the single respondents of 0.8% were from Zabzugu district. Also, half of the respondents reported within the second trimester for their first antenatal care in the Tatale-Sanguli district and more than two-thirds (80.4%) reported within the second trimester for their first antenatal care in the Zabzugu district. Cumulatively, a little below two-thirds of the respondents from the two districts presented themselves in the second trimester for their first antenatal care. Significantly, there were more respondents below 36 weeks of gestation (39.4%) interviewed in Tatale-Sanguli district compared to 16.7% from the Zabzugu district. Also, the majority (43.7%) of the respondents in Zabzugu district were ≥38 weeks of gestation compared with 19.3% from Tatale-Sanguli district. Furthermore, 35.9% of the respondents were ≥38 weeks of gestation in the two districts.

In addition, the Zabzugu district recorded the majority (34.3%) of nulliparous respondents than the Tatale-Sanguli district which recorded 19.5%. More than half (53.8) of the respondents had a parity of 1-3 in the two districts. The Zabzugu district further recorded the highest primigravida of 31.8% compared with 14.0% from the Tatale-Sanguli district. Half of the pregnant women from Tatale-Sanguli district had gravida of 4+ compared with 18.8% from the Zabzugu district. On the whole, a little below half (45.1%) had gravida 2-3 from the two districts. On employment status of

respondents, the majority of the respondents (41.8%) were unemployed. And more unemployed respondents (54.7%) were from Zabzugu district compared to Tatale-Sanguli district (14.0%). The majority (56.6%) of the employed respondents from Tatale-Sanguli district were farmers whilst the least (3.5%) were salary workers.

Table 1 Socio demographic characteristics of respondent

Exposure variable	Tatale(n=114)	Zabzugu(n=245)	Total (n=359)
	N (%)	N (%)	N (%)
Age of pregnant woman (years)			
≤20	17(14.9)	34(13.9)	51(14.2)
21-25	24(21.1)	50(20.4)	74(20.6)
26-30	34(29.8)	66(26.9)	100(27.9)
31-35	23(20.2)	66(26.9)	89(24.8)
36+	16(14.0)	29(11.8)	45(12.5)
Level of education			
No education	76(66.7)	155(63.3)	231(64.3)
Basic education	23(20.2)	37(15.1)	60(16.7)
Senior High School	12(10.5)	40(16.3)	52(14.5)
Tertiary education	3(2.6)	13(5.3)	16(4.5)
Marital status			
Single	3(2.6)	2(0.8)	5(1.4)
Married	111(97.4)	243(99.2)	354(98.6)
Gestational age at reg in weeks			
1st trimester (1-12)	46(40.4)	18(7.3)	64(17.8)
2nd trimester (13-27)	57(50.0)	197(80.4)	254(70.8)
3rd trimester (28-37)	11(9.6)	30(12.2)	41(11.4)
The current age in weeks			
33	21(18.4)	16(6.5)	37(10.3)
34	11(9.6)	18(7.3)	29(8.1)
35	13(11.4)	7(2.9)	20(5.6)
36	30(26.3)	30(12.2)	60(16.7)
37	17(14.9)	67(27.3)	84(23.4)
38+	22(19.3)	107(43.7)	129(35.9)
Parity			
Nulliparous	22(19.3)	84(34.3)	106(29.5)
1-3	57(50.0)	136(55.5)	193(53.8)
4-7	35(30.7)	25(10.2)	60(16.7)
Gravidity			
Primigravida	16(14.0)	78(31.8)	94(26.2)
2-3	41(36.0)	121(49.4)	162(45.1)
4+	57(50.0)	46(18.8)	103(28.7)
Occupation			
Salary worker	4(3.5)	9(3.7)	13(3.6)
Trader	11(9.6)	57(23.3)	68(18.9)
Farming	64(56.1)	41(16.7)	105(29.2)
Unemployed	16(14.0)	134(54.7)	150(41.8)
Other	19(16.7)	4(1.6)	23(6.4)

Source: field survey 2019

4.2.2 Decision-making of respondents

Table 2 presents the results on participants having a say in decision making that influence anaemia among pregnant women at ≥ 33 weeks of gestation in the Tatale-Sanguli and Zabzugu districts of Northern Ghana. Having a say in the decision making regarding what food to purchase for the household among the respondents is low at 8.9% for the two districts. From the table, it is common to see both husband and wife (57.0%) jointly making a decision regarding what food to purchase for the household in Tatale-Sanguli district compared to the Zabzugu district which had 14.3% of respondents reporting joint decision makings. Close to two-thirds (72.7%) of husbands actually made decisions for their wives on food purchase in Zabzugu district compared to about a quarter in the Tatale-Sanguli district. Cumulatively, the majority of the pregnant women representing 57.7% indicated that their husbands are the ones who decide what food should be purchased for the household in the two districts.

Furthermore, more than half (57.0%) of the respondents from Tatale-Sanguli district were involved in decision making with their husbands particularly regarding visiting the health facility for antenatal care and other medicals conditions compared to the Zabzugu district. The majority (22.8%) of the respondents who made their individual decisions regarding when to visit the health facility for health care were from Tatale-Sanguli with the least (16.3%) of the respondents who made their own decisions on accessing health care coming from the Zabzugu district.

Table 2 Decision making of respondents

Exposure variable	Tatale(n=114)	Zabzugu(n=245)	Total (n=359)
	N (%)	N (%)	N (%)
Food purchase decision			
Self	8(7.0)	24(9.8)	32(8.9)
Husband/partner	29(25.4)	178(72.7)	207(57.7)
Both partners	68(59.6)	35(14.3)	103(28.7)
Someone else	9(7.9)	8(3.3)	17(4.7)
Health care decision			
Self	26(22.8)	40(16.3)	66(18.4)
Husband/partner	22(19.3)	174(71.0)	196(54.6)
Both partners	65(57.0)	28(11.4)	93(25.9)
Someone else	1(0.9)	3(1.2)	4(1.1)

Source: field survey 2019

4.2.3 Health care provision for pregnant women

Table 3 presents the results on health care interventions that affect anaemia among the pregnant women at ≥33 weeks of gestation in the Tatale-Sanguli and Zabzugu districts in the Northern region. The findings from this study indicate that 52.4% of pregnant women indicated that their husbands did accompany them for antenatal care visits. The majority (61.6%) of the pregnant women who reported that their husbands accompanied them for antenatal care were from the Zabzugu district compared to 32.5% from the Tatale-Sanguli district. The results make it clear that the majority (78.6%) of the pregnant women were able to make four (4) or more antenatal care visits from the two districts. Zabzugu district contributed 77.9% whilst Tatale-Sanguli district contributed 79.9%.

Importantly, of the respondents who were asked whether they were educated about the signs and symptoms of anaemia during their ANC visits, more than three-quarters (77.4%) of them indicated they were not given that education from the two districts. The majority of the respondents who had no formal educational training representing

84.2% were from Tatale-Sanguli district whilst 74.3% of those without formal educational training were from the Zabzugu district.

Furthermore, 96.1% of the respondents reported supplied with iron and folic acid tablets for the prevention of anaemia. Majority of them (97.1%) from Zabzugu and 93.9% from Tatale-Sanguli district reported receiving iron and folic acid supplementation. Significantly, three-quarters (75.1%) of the respondents were ever given a prescription to buy the IFA because of shortage at the health facilities in Zabzugu as compared to 31.6% in the Tatale-Sanguli district. Also, it was common for the respondents from Tatale-Sanguli district to be given only folic acid and multivitamins (89.5%) compared to Zabzugu districts where the respondents (81.2%) were given all three combination of iron, folic acid and multivitamins.

In addition, about two-thirds (66.0%) of the respondents from the two districts reported that they were given counselling on the benefits of consuming the IFA during pregnancy. Also, 93.9% of the respondents from the two districts interviewed disclosed that they never heard about anaemia been discussed at the community level as a topical public health issue like tuberculosis, HIV/AIDS and viral hepatitis. A few representing 6.1% however, reported they ever heard about it from either the radio, television and/or newspaper. On IPT supplementation, 87.5% were reported being given IPT for the two districts. About 63.7% of the respondents reported taking IPT for 1-2 number of times whilst 36.3% reported taken IPT for 3-4 number of times. In conclusion, almost all the respondents from the Tatale-Sanguli district reported that they were not given

deworming tablets, and the records from the maternal record booklets confirmed that they were not dewormed.

Table 3 Health care provision for pregnant women

Exposure variable	Tatale(n=114)	Zabzugu(n=245)	Total(n=359)
	N (%)	N (%)	N (%)
Husband involvement in ANC			
Yes	37(32.5)	151(61.6)	188(52.4)
No	77(67.5)	94(38.4)	171(47.6)
Number of ANC visits			
1-3	23(20,2)	54(22.0)	77(21.4)
4-6	67(58.8)	177(72.2)	244(68.0)
7-9	24(21.1)	14(5.7)	38(10.6)
Education on anaemia symptoms			
Yes	18(15.8)	63(25.7)	81(22.6)
No	96(84.2)	182(74.3)	278(77.4)
IFA supplementation during pregnancy			
Yes	107(93.9)	238(97.1)	345(96.1)
No	7(6.1)	7(2.9)	14(3.9)
Ever asked to purchase IFA			
Yes	36(31.6)	184(75.1)	220(61.3)
No	78(68.4)	61(24.9)	139(38.7)
IFA supplementation			
Only multivitamins	0(0.0)	8(3.3)	8(2.2)
IFA with multivitamins	4(3.5)	199(81.2)	203(56.6)
Only IFA and multivitamins	102(89.5)	23(9.4)	125(34.8)
Only ferrous sulphate	1(0.9)	2(0.8)	3(0.8)
Not applicable	7(6.1)	13(5.3)	20(5.6)
Counselling on benefits of IFA			
Received	56(49.1)	181(73.9)	237(66.0)
Not received	58(50.9)	64(26.1)	122(34.0)
Source of health information on anaemia			
Radio/tv/newspaper	13(11.4)	9(3.7)	22(6.1)
Never heard about it discussed	101(88.6)	236(96.3)	337(93.9)
Counselling on malaria prevention			
Yes	55(48.2)	149(60.8)	204(56.8)
No	59(51.8)	96(39.2)	155(43.2)
IPT during this pregnancy			
Yes	94(82.5)	220(89.8)	314(87.5)
No	20(17.5)	25(10.2)	45(12.5)
Number of times anti-malarial taken			
1-2	58(61.7)	142(64.5)	200(63.7)
3-4	36(38.3)	78(35.5)	114(36.3)
IPT supply			
Given recommended	93(81.6)	223(91.0)	316(88.0)
Not given	21(18.4)	22(9.0)	43(12.0)
Deworming during pregnancy			
Yes	1(0.9)	31(12.7)	32(8.9)
No	113(99.1)	143(58.4)	256(71.3)
Do not remember	0(0.0)	71(29.0)	71(19.8)

Source: field survey 2019

4.2.4 Diet and diet-related factors affecting anaemia

Table 4 presents the results on diet and diet-related factors that affect anaemia status in pregnant women in the study setting. The results from this study indicate that 56.1% of the pregnant women in the Tatale-Sanguli district were given counselling by health workers on what kinds of food to eat during pregnancy. It further shows that close to two-thirds (64.5%) of the respondents from the Zabzugu district reported been given counselling on diet. Cumulatively, 61.8% of the respondents reported ever receiving counselling on diet from the two districts. Furthermore, this study reveals that more than three-quarters (88.2%) of the respondents from the Zabzugu district did eat 3-4 times with/out a snack compared to 58.8% of the pregnant women who indicated having eaten 3-4 times with/out in a day in the Tatale-Sanguli district. In total, 78.8% of respondents from both districts did eat 3-4 times with/out a snack in a day.

The results further indicate that almost all the respondents ate food mainly from grains, roots and tubers; more than three quarters of the respondents took dark green leafy vegetables mainly ayooyo; nearly all respondents from Tatale-Sanguli district reported taking meat (flesh foods) even though dried fish commonly called ‘Amani’ was reported been eaten compared to 64.1% of the respondents from Zabzugu; at least half (52.6%) of the respondents from the two districts took food from the legumes and nuts sources; more than three quarters (82.2%) did not eat vitamin A rich source of food. Also, more than three quarters (81.9%) did not eat food from the dairy products from the two districts. Significantly, half (11.4%) of the respondents reported to have eaten an egg from the Zabzugu district compared to 22.8% from Tatale-Sanguli district.

The proportion of respondents who indicated eating five (5) or more food groups out of 10 food groups from the Tatale-Sanguli district was 27.2% and that from the Zabzugu district is 15.9%. Cumulatively, 19.5% of the respondents met the minimum dietary diversity score for women (MDDS-W) in both districts. Generally, there were 4.2% cases of food taboo reported by the respondents.

Table 4 Diet-related factors affecting anaemia in Tatale and Zabzugu (n=359)

Exposure variable	Tatale(n=114)	Zabzugu(n=245)	Total(n=359)
	N (%)	N (%)	N (%)
Counselling on diet			
Yes	64(56.1)	158(64.5)	222(61.8)
No	50(43.9)	87(35.5)	137(38.2)
Number of times eaten in a day			
1-2 with/out snack	47(41.2)	29(11.8)	76(21.2)
3-4 with/out snack	67(58.8)	216(88.2)	283(78.8)
Grains, roots, tubers			
No	2(1.8)	2(0.8)	4(1.1)
Yes	112(98.2)	243(99.2)	355(98.9)
Vitamin A-rich foods			
No	98(86.0)	197(80.4)	295(82.2)
yes	16(14.0)	48(19.6)	64(17.8)
Other fruits and vegetables			
No	20(17.5)	18(7.3)	38(10.6)
Yes	94(82.5)	227(92.7)	321(89.4)
Legumes and nuts			
No	35(30.7)	135(55.1)	170(47.4)
Yes	79(69.3)	110(44.9)	189(52.6)
Flesh foods			
No	6(5.3)	88(35.9)	94(26.2)
Yes	108(94.7)	157(64.1)	265(73.8)
Eggs			
No	88(77.2)	217(88.6)	305(85.0)
Yes	26(22.8)	28(11.4)	54(15.0)
Dairy product			
No	96(84.2)	198(80.8)	294(81.9)
Yes	18(15.8)	47(19.2)	65(18.1)
MDDS-W			
Adequate MDDS	31(27.2)	39(15.9)	70(19.5)
Inadequate MDDS	83(72.8)	206(84.1)	289(80.5)
Food taboo			
Yes	11(9.6)	4(1.6)	15(4.2)
No	103(90.4)	241(98.4)	344(95.8)

Source: field survey 2019

4.3 Prevalence of anaemia at ≥33 weeks

Table 5 presents results on the prevalence of anaemia among pregnant women at ≥33 weeks of gestation for Tatale-Sanguli and Zabzugu districts in the Northern region. From the table, pregnant women with Hb less than seven (Hb<7g/dl) was at 1.4% in both districts. The pregnant women with Hb between 7.9g/dl to 9.9 g/dl was at 30%. The prevalence of mild anaemia in the two districts was 41%. The Zabzugu district contributed less of the severe cases of anaemia at 1.2% and more of moderate anaemia among the respondents at 31.4% . Cumulatively, the prevalence of anaemia defined as the haemoglobin level less than 11.0g/dl was 72.1% at the study setting.

Table 5 Prevalence of anaemia among respondents

Exposure variable	Tatale(n=114)	Zabzugu(n=245)	Total (n=359)
	N (%)	N (%)	N (%)
Hb classification			
Severe (<7)	2(1.8)	3(1.2)	5(1.4)
Moderate (7-9.9g/dl)	30(26.3)	77(31.4)	107(29.8)
Mild (10-10.9g/dl)	40(35.1)	107(43.7)	147(40.9)
All forms(<11.0g/dl)	72(63.2)	187(76.3)	259(72.1)
Normal (≥11g/dl)	42(36.8)	58(23.7)	100(27.9)

Source field survey 2019

4.4 Incidence of birth outcomes

Table 6 presents results on the incidence and prevalence of birth outcomes in the Tatale-Sanguli and Zabzugu districts of Northern Ghana. From the table, more than three quarters (83.6%) of the respondents had normal vaginal deliveries. Cumulatively, less than one-fifth (16.4%) of the deliveries were conducted through caesarean section. The majority (19.6%) of the deliveries through caesarean section were conducted in the Zabzugu district.

Furthermore, the incidence of stillbirths in Tatale-Sanguli district was 0.9% whilst that of Zabzugu was 1.6% of the total deliveries. In total, the proportion of stillbirths in the two districts was 1.4%. Also, there were more males (50.9%) than females (49.1%) delivered in the Tatale Tatale-Sanguli district compared to the Zabzugu district where there were more females (54.3%) than males (45.7%) delivered. The incidence of low birth weight in the Tatale district is 6.3% whilst that of Zabzugu was 1.6% and the total proportion of low birth weight deliveries in the two districts was 3.1%.

In addition, stunting prevalence at birth was found to be at 28.9% in the Tatale-Sanguli district and 23.3% in the Zabzugu district. Cumulatively, the prevalence of stunting at birth was 25.1%. On the other hand, 36.0% and 22.0% of children delivered had smaller head circumference in the Tatale-Sanguli and Zabzugu districts respectively with the cumulative prevalence at 26.5%. In conclusion, the incidence of preterm births was 5.3% in the Tatale-Sanguli district and 0.8% in the Zabzugu district. Cumulatively, the incidence of preterm deliveries was 2.2% in the two districts.

Table 6 Incidence of birth outcomes in Tatale and Zabzugu (n=359)

Birth outcome	Tatale(n=114)	Zabzugu(n=245)	Total(n=359)
	N (%)	N (%)	N (%)
Mode of delivery			
Caesarean section	11(9.6)	48(19.6)	59(16.4)
SVD	103(90.4)	197(80.4)	300(83.6)
Delivery outcome			
Live birth	113(99.1)	241(98.4)	354(98.6)
Still birth	1(0.9)	4(1.6)	5(1.4)
Sex of baby			
Male	56(49.1)	133(54.3)	189(52.6)
Female	58(50.9)	112(45.7)	170(47.4)
Birth weight			
Low birth weight	7(6.1)	4(1.6)	11(3.1)
Normal	107(93.9)	241(98.4)	348(96.9)
Birth length			
Stunted	33(28.9)	57(23.3)	90(25.1)
Normal	81(71.1)	188(76.7)	269(74.9)
Head circumference			
Small	41(36.0)	54(22.0)	95(26.5)
Normal	73(64.0)	191(78.0)	264(73.5)
Term of delivery			
Full term (≥ 37 weeks)	108(94.7)	243(99.2)	351(97.8)
Preterm (<37 weeks)	6(5.3)	2(0.8)	8(2.2)

Source: field survey 2019

4.5 Test of associations

Binary logistic regression analysis was performed on all the exposure variables to identify the risk factors of anaemia at ≥33 weeks of gestation in the study area. Those exposure variables that showed statistically significant association with anaemia at ≥33 weeks of gestation were kept in a single model controlling for confounding variables and multivariate logistic regression performed to identify the independent predictors of anaemia at ≥33 weeks of gestation in the study setting. Included in this test are socio-demographic characteristics of the respondent, household-level decision-making autonomy of the respondents, health care provision interventions, diet and diet-related factors and anaemia at ≥33 weeks of gestation.

4.5.1 Socio-demographic determinants of anaemia

Table 7 shows the results of the association between the socio-demographic characteristics of respondents and their anaemia status at ≥33 weeks using binary logistics regression. The respondents who were between 21-30 years of age were protective from becoming anaemic [RR=0.8 (95% CI: 0.4-1.5); p=0.150] compared to pregnant women who were <20 years of age. This result was not statistically significant. Also, considering the gestational age at registration in weeks among the respondents, it was revealed that, respondents who initiated antenatal care in the third trimester of their pregnancy were 4.0 times more likely to be anaemic [RR= 4.0 (95% CI: 1.6-10.4); p=0.004] as compared to pregnant women who initiated antenatal care in the first trimester and this result was statistically significant. The results further showed that respondents who were unemployed were 5.5 times more likely to be anaemic [RR=5.5 (95% CI: 1.7-18.0); p= 0.004] as compared to those who were salaried workers and this this relationship was statistically significant. Furthermore, pregnant women who were

anaemic during their first antenatal visit were 2.4 times at risk of becoming anaemic at ≥33 weeks compared to those who were not anaemic [RR=2.4 (95% CI: 1.4-3.9); p= 0.001]. This relationship was statistically significant.

Table 7 Socio-demographic risk factors of anaemia in Tatale and Zabzugu (n=359).

Exposure variable	Total (%)	Normal (%)	Anaemic (%)	Risk Ratio (95% CI)	p-value
Age (years)					
<20	51(14.2)	13(25.5)	38(74.5)	1.0	
21-30	174(48.5)	54(31.0)	120(69.0)	0.8(0.4-1.5)	
31+	134(37.3)	33(24.6)	101(75.4)	1.0 (0.5-2.2)	0.150
Level of education					
No formal education	231(64.3)	59(25.5)	172(74.5)	1.0	
Basic education	60(16.7)	20(33.3)	40(66.7)	0.7(0.4-1.3)	0.228
Senior High School	52(14.5)	17(32.7)	35(67.3)	0.7(0.4-1.4)	0.295
Tertiary education	16(4.5)	4(25.0)	12(75.0)	1.0(0.3-3.3)	0.962
Marital status					
Single	5(1.4)	2(40.0)	3(60.0)	1.0	
Married	354(98.6)	98(27.7)	256(72.3)	1.7(0.3-10.6)	0.547
Gestational age at registration in weeks					
1st trimester (1-12)	64(17.8)	29(45.3)	35(54.7)	1.0	
2nd trimester (13-27)	254(70.8)	64(25.2)	190(74.8)	2.5(1.4-4.3)	**0.002***
3rd trimester (28-37)	41(11.4)	7(17.1)	34(82.9)	4.0(1.6-10.4)	**0.004***
Gestational age at survey					
>36	213(59.3)	56(26.3)	157(73.7)	1.0	
33-36	146(40.7)	44(30.1)	102(69.9)	0.8(0.5-1.3)	0.425
Parity					
Nulliparous	106(29.5)	26(24.5)	80(75.5)	1.0	
1-3	193(53.8)	57(29.5)	136(70.5)	0.8(0.5-1.3)	0.356
4-7	60(16.7)	17(28.3)	43(71.7)	0.8(0.4-1.7)	0.591
Gravidity					
Primigravida	94(26.2)	24(25.5)	70(74.5)	1.0	
2-3	162(45.1)	45(27.8)	117(72.2)	0.9(0.5-1.6)	0.696
4+	103(28.7)	31(30.1)	72(69.9)	0.8(0.4-1.5)	0.476
Occupation					
Salary worker	13(3.6)	8(61.5)	5(38.5)	1.0	
Trader	89(24.8)	28(31.5)	61(68.5)	3.5(1.04-11.6)	**0.042***
Farming	105(29.2)	30(28.6)	75(71.4)	4.0(1.2-13.2)	**0.023***
Unemployed	152(42.3)	34(22.4)	118(77.6)	5.5(1.7-18.0)	**0.004***
Anaemia status at registration					
Normal	86(24.0)	36(41.9)	50(58.1)	1.0	
Anaemic	273(76.0)	64(23.4)	209(76.6)	2.4(1.4-3.9)	**0.001***

***P value<0.05, shows statistical significance.**

***Normal defines Hb>11.0g/dl**

***Anaemic defines Hb<11.0g/dl**

4.5.2 Household-level determinants of anaemia

Table 8 shows the results of the association between household-level decision making of the respondents and their anaemia status at the time of the study (current Hb). Respondents whose husbands took a decision regarding what food should be purchased for the household had 1.4 times more likely to be anaemic [RR = 1.4 (95% CI: 1.9-3.5); p = 0.021]. as compared to the pregnant women who made their own decisions on what food to purchase. This result was found to be statistically significant. Respondents who had their partners solely decide when they should visit the health care facility for health care during pregnancy were 1.5 times at risk of anaemia [RR = 1.5 (95% CI: 0.8-2.7); p = 0.218] compared to the respondents themselves deciding when to seek health care even though the relationship was not statistically significant.

Table 8 Household level risk factors of anaemia in Tatale and Zabzugu (n=359)

Variable	Total (%)	Normal (%)	Anaemic (%)	Risk Ratio (95% CI)	p-value
Food purchase decision making					
Self	32(8.9)	9(28.1)	23(71.9)	1.0	
Husband/partner	207(57.7)	46(22.2)	161(77.8)	1.4 (1.9-3.5)	**0.021***
Both partners	103(28.7)	38(36.9)	65(63.1)	0.7 (0.3-1.6)	0.365
Health care decision making					
Self	66(18.4)	22(33.3)	44(66.7)	1.0	
Husband/partner	200(55.7)	51(25.5)	149(74.5)	1.5(0.8-2.7)	0.218
Both partners	93(25.9)	27(29.0)	66(71.0)	1.2(0.6-2.4)	0.563

***P value<0.05, shows statistical significance.**

***Normal defines Hb>11.0g/dl**

***Anaemic defines Hb<11.0g/dl**

4.5.3 Health care determinants of anaemia

Table 9 presents the results on the association between the health care interventions and anaemia status of pregnant women at the time of conducting the study using bivariate logistic regression. The results showed that pregnant women whose husbands were involved in antenatal care were protective from developing anaemia [RR= 0.6 (95% CI: 0.4—0.9); p=0.015] as compared to those whose husbands were not involved in antenatal care. This result was statistically significant. The results also showed that respondents who attended antenatal care up to seven or more times were protective from developing anaemia [RR= 0.2 (95% CI: 0.1-0.6); p=0.001] as compared to those who attended antenatal care 1-3 times. The results also showed that respondents who were ever asked by health workers to purchase iron and folic acid during pregnancy were 1.6 times more likely to be anaemic [RR= 1.6 (95% CI: 1.01-2.6); p=0.046] as compared to those who were not asked to purchase iron and folic acid during pregnancy. The results further showed that respondents who never heard about anaemia being discussed at the community level as a public health issue were 3.4 times more likely to be anaemic [RR= 3.4 (95% CI: 1.4-8.1); p=0.006] as compared to those who heard of anaemia from the media. The results further showed that respondents who took anti-malarial drugs during pregnancy for 3-4 times were protective from becoming anaemic [RR= 0.8 (95% CI: 0.5-1.3); p=0.275] as compared to those who took the drugs for 1-2 times. This relationship was however, not statistically significant.

Table 9 Health care risk factors of anaemia in Tatale and Zabzugu (n=359)

Variable	Total (%)	Normal (%)	Anaemic (%)	Risk Ratio (95% CI)	p-value
Husband involvement in ANC					
No	188(52.4)	42(22.3)	146(77.7)	1.0	
Yes	171(47.6)	58(33.9)	113(66.1)	0.6 (0.4-0.9)	**0.015***
Number of ANC visits					
1-3	77(21.4)	15(19.5)	62(80.5)	1.0	
4-6	244(68.0)	66(27.0)	178(73.0)	0.7(0.3-1.2)	0.185
7+	38(10.6)	19(50.0)	19(50.0)	0.2(0.1-0.6)	**0.001***
Anaemia symptoms taught					
Yes	81(22.6)	24(29.6)	57(70.4)	1.0	
No	278(77.4)	76(27.3)	202(72.7)	1.1 (0.6-1.9)	0.686
IFA during pregnancy					
Yes	345(96.1)	99(28.7)	246(71.3)	1.0	
No	14(3.9)	1(7.1)	13(92.9)	5.2(0.7-40.5)	0.113
Ever purchased IFA					
No	139(38.7)	47(33.8)	92(66.2)	1.0	
Yes	220(61.3)	53(24.1)	167(75.9)	1.6(1.01-2.6)	**0.046***
Counselling on benefits of IFA					
No	122(34.0)	40(32.8)	82(67.2)	1.0	
Yes	237(66.0)	60(25.3)	177(74.7)	1.4(0.9-2.3)	0.136
Information on anaemia					
Radio/tv/newspaper	22(6.1)	12(54.5)	10(45.5)	1.0	
Never heard about it discussed	337(93.9)	88(26.1)	249(73.9)	3.4(1.4-8.1)	**0.006***
Counselling on malaria					
Yes	204(56.8)	57(27.9)	147(72.1)	1.0	
No	155(43.2)	43(27.7)	112(72.3)	1.0(0.6-1.6)	0.967
Taken anti-malaria drugs					
Yes	314(87.5)	85(27.1)	229(72.9)	1.0	
No	45(12.5)	15(33.3)	30(66.7)	0.7(0.4-1.4)	0.382

IPT taken					
1-2	200(55.7)	50(25.0)	150(75.0)	1.0	
3-4	114(31.8)	35(30.7)	79(69.3)	0.8(0.5-1.3)	0.275
Deworming during pregnancy					
Yes	32(8.9)	10(31.3)	22(68.8)	1.0	
No	256(71.3)	79(30.9)	177(69.1)	2.6 (0.9-3.5)	0.066

***P value<0.05, shows statistical significance.**

***Normal defines Hb>11.0g/dl**

***Anaemic defines Hb<11.0g/dl**

4.5.4 Diet and diet-related determinants of anaemia

Table 10 shows the results on the association between dietary indicators including minimum dietary diversity score-women and the anaemia status at the time of conducting the study (current Hb) on pregnant women. The respondents who reported they did not receive counselling on diet were 2.2 times more likely to be anaemic [RR=2.2 (95% CI: 1.2-3.5); p=0.002] as compared to those who did receive counselling on diet and the results were statistically significant. Pregnant women who reported eating food 3-4 number of times a day were protective from becoming anaemic [RR= 0.9 (95% CI: 0.5-1.9); p=0.811] compared to those who ate 1-2 times in a day. This result was not statistically significant.

Table 10 Dietary risk factors of anaemia in Tatale and Zabzugu (n=359)

Exposure variable	Total (%)	Normal (%)	Anaemic (%)	Risk Ratio (95% CI)	p-value
Counselling on diet					
Yes	222(61.8)	58(26.1)	164(73.9)	1.0	
No	137(38.2)	42(30.7)	95(69.3)	2.2 (1.2-3.5)	**0.002***
Number of times eaten in a day					
1-2 with/out snack	283(78.8)	78(27.6)	205(72.4)	1.0	
3-4 with/out snack	76(21.2)	22(28.9)	54(71.1)	0.9(0.5-1.6)	0.811
MDDS-W					
Adequate MDDS	70(19.5)	20(28.6)	50(71.4)	1.0	
Inadequate MDDS	289(80.5)	80(27.7)	209(72.3)	1.0 (0.5-1.9)	0.890

***P value<0.05, shows statistical significance.**

***Normal defines Hb>11.0g/dl**

***Anaemic defines Hb<11.0g/dl**

4.5.5 Multivariate logistic regression

After controlling for all confounding variables, gestation at first antenatal care booking predicted anaemia in the two districts. For instance, pregnant women who presented for antenatal care in the third trimester had 2.7 times risk of developing anaemia [RR= 2.7 (95% CI: 01.9-4.3); p=0.041] compared to pregnant women who presented in the first trimester for antenatal care. Also, pregnant women who reported that their husbands accompanied them during antenatal care visit were protected from developing anaemia [RR= 0.5 (95% CI: 0.3-0.9); p=0.030] compared to pregnant women whose husbands did not accompany them during antenatal care visits.

Table 11 Independent predictors of anaemia in Tatale/Sanguli and Zabzugu districts (n=359)

Exposure variable	Total (%)	Normal (%)	Anaemic (%)	Relative risk (95% CI)	P-Value
Gestation at first ANC booking					
1st trimester (1-12)	64(17.8)	29(45.3)	35(54.7)	1.0	
2nd trimester (13-27)	254(70.8)	64(25.2)	190(74.8)	1.7 (0.8-3.3)	0.100
3rd trimester (28-37)	41(11.4)	7(17.1)	34(82.9)	2.7(1.9-4.3)	**0.041***
Occupation					
Salary worker	13(3.6)	8(61.5)	5(38.5)	1.0	
Trader	89(24.8)	28(31.5)	61(68.5)	2.4(0.5-11.0)	0.270
Farming	105(29.2)	30(28.6)	75(71.4)	3.7(0.8-18.1)	0.102
Unemployed	152(42.3)	34(22.4)	118(77.6)	2.9(0.6-13.6)	0.181
Anaemia status at first antenatal booking					
Normal	86(24.0)	36(41.9)	50(58.1)	1.0	
Anaemic	273(76.0)	64(23.4)	209(76.6)	1.6(0.9-2.9)	0.106
Food purchase decision making					
Pregnant woman	32(8.9)	9(28.1)	23(71.9)	1.0	
Husband/partner	207(57.7)	46(22.2)	161(77.8)	0.9(0.3-2.4)	0.833
Both partners	103(28.7)	38(36.9)	65(63.1)	0.5(0.2-1.4)	0.197
Husband involvement in ANC					
No	188(52.4)	42(22.3)	146(77.7)	1.0	**0.030***
Yes	171(47.6)	58(33.9)	113(66.1)	0.5(0.3-0.9)	
Number of ANC visits					
1-3	77(21.4)	15(19.5)	62(80.5)	1.0	
4-6	244(68.0)	66(27.0)	178(73.0)	0.7(0.3-1.5)	0.368
7+	38(10.6)	19(50.0)	19(50.0)	0.4(0.1-1.1)	0.079
Ever purchased IFA					
No	139(38.7)	47(33.8)	92(66.2)	1.0	
Yes	220(61.3)	53(24.1)	167(75.9)	1.4(0.8-2.4)	0.285
Health information on anaemia					
Radio/TV/newspaper	22(6.1)	12(54.5)	10(45.5)	1.0	
Never heard about it discussed	337(93.9)	88(26.1)	249(73.9)	2.8(0.9-8.6)	0.068

***P value<0.05, shows statistical significance.**

***Normal defines Hb>11.0g/dl**

***Anaemic defines Hb<11.0g/dl**

4.5.6 Impact of anaemia on birth outcomes

Table 11 shows the association between birth outcomes and anaemia status at the time of conducting the study (current Hb) on pregnant women. Of all the under listed birth

outcomes, it was observed that none of them showed any statistically significant relationships with the current anaemia status of pregnant women at ≥33 weeks of gestation in both Tatale-Sanguli and Zabzugu districts.

Table 12 Effect of anaemia on birth outcomes in Tatale and Zabzugu (n=359)

Anaemia status	**Total (%)**	**Birth outcomes**		**Risk Ratio (95% CI)**	**p-value**
		Mode of delivery			
	Total (%)	SVD	CS		
No anaemia	100(27.9)	84(28.0)	16(27.1)	1	
anaemic	259(72.1)	216(72.0)	43(72.9)	1.0 (0.5-1.9)	0.890
		Delivery outcome			
	Total (%)	Live birth	Still birth		
No anaemia	100(27.9)	98(27.7)	2(40.0)	1	
anaemic	259(72.1)	256(72.3)	3(60.0)	0.6(0.1-3.4)	0.547
		Birth weight			
	Total (%)	Normal	Low birth weight		
No anaemia	100(27.9)	96(27.8)	4(36.4)	1	
anaemic	259(72.1)	249(72.2)	7(63.6)	0.7(0.2-2.3)	0.538
		Birth length			
	Total (%)	Normal	Stunted		
No anaemia	100(27.9)	29(32.2)	71(26.4)	1	
anaemic	259(72.1)	61(67.8)	198(73.6)	0.8(0.4-1.2)	0.287
		Head Circumferences			
	Total (%)	Normal	Small		
No anaemia	100(27.9)	25(26.3)	75(28.4)	1	
anaemic	259(72.1)	70(73.7)	189(71.6)	1.1(0.7-1.8)	0.696
		Term of delivery			
	Total (%)	Full term	Preterm		
No anaemia	100(27.9)	97(27.6)	3(37.5)	1	
anaemic	259(72.1)	254(72.4)	5(62.5)	0.6(0.1-2.7)	0.541

***P value<0.05, shows statistical significance.**

***No anaemia defines Hb>11.0g/dl**

***Anaemic defines Hb<11.0g/dl**

CHAPTER FIVE

DISCUSSIONS

5.0 Introduction

This chapter discusses the key results emanating from this research and related the finding to the existing literature in chapter two of this study. It further discusses the reasons why the results of this study are similar or different from the existing literature.

5.1 Anaemia among pregnant women ≥33 weeks of gestation

The prevalence of anaemia among pregnant women at ≥33 weeks were assessed. From the results, it came out that the rate of anaemia was 72% among the respondents in the study settings. This result is similar to a study done by Bodeau-livinec et al. (2011) in Benin, where anaemia prevalence among pregnant women during the third trimester was 64.1%. It is also comparable to Tay et al., (2013) who in their study reported a 69.0% in the third trimester of pregnancy in Kumasi. The similarity in terms of the three different studies under different geographical locations, economic and social conditions and at different time periods could be due to their inability to attend antenatal care services timely and regularly since poor antenatal attendance was a key determinant of anaemia reported by these studies. Additionally, low iron intake, especially during the developmental process of the foetus and the nutritional requirement for the foetus and the mother may lead to anaemia. On the other hand, this results is higher than the 57% reported in Kenya by Mirie et al., (2016), the 23.6% prevalence reported by Wei et al (2018) in China, 19.7% prevalence in Ethiopia by Abriha, Yesuf, & Wassie, (2014). It is equally higher than the 20.1% prevalence reported in Iran by Moghaddan & Tabrizi

(2015). Also, it is high compared to the 23.2% of anaemia reported by Lebso et al., (2017).

Several reasons could have accounted for these disparities. One of such reasons could be the level of education attained by their respondents was higher. For instance, 1.9% of the respondents had no formal educational training reported in the study in Kenya by Mirie et al., (2016) compared to 64.3% of the respondents in this study who did not have any formal education. Also, 36% of respondents had no formal education in Mekelle town in a study by Abriha, Yesuf, & Wassie, (2014) compared to 64.3% of the respondents in this study. Furthermore, 24.6% of the respondents had no formal education reported in a study by Lebso et al., (2017) compared to the 64.3% in this study. Since level of education empower women and influence how they are able to make decisions regarding household food purchase, when to initiate antenatal care attendance and also enable them get access to fleshy foods such as meat and eggs cumulatively influence their anaemia status.

Another reason could be the work the respondents do that provide them with their daily living. For example, it was observed from this study that 42% of the respondents had no job. This is higher when compared to the 32.6% of respondents in Mirie et al., (2016) study. The primary results of the 42% respondents of the current study been unemployed could have accounted for low finances resulting in the lower percentage of pregnant women meeting the minimum dietary diversity score from both districts. What was also observed from this study was that most of the respondents did not eat varieties of diets rather they ate from one food group mainly the grains several number

of times a day. Furthermore, 77.4% of the respondents were not educated on the symptoms of anaemia and could not have taken adequate measures to prevent its occurrence which might have resulted into the higher prevalence of anaemia in this current study. The other important reason that could have led to this 72% prevalence of anaemia in this current study is that 94% of the respondents reported they never heard about anaemia being discussed at the community level as a public health concern. A problem that is not recognised at the community level might not get the needed support from decision makers at the community level.

Also, the composition of IFA supplementation as observed by this study suggests that pregnant women might not have gotten the recommended 60mg of elemental iron 0.4mg of folic acid (WHO 2012) and multiple micronutrients. This manifested because 3.3% of the respondents received only multivitamins, 5.6% did not received any form of supplementation, 0.8% received only ferrous sulphate and 34.8% received folic acid and vitamins without iron. Quite apart from the poor composition that could contribute to the high rates of anaemia, non-adherence to the supplementation due to inadequate information on the significance of iron and folic acid by the respondents could be a possible reason why pregnant women at ≥33 weeks of gestation were still anaemic despite been given supplementation. This supports the assertion that some pregnant women could receive and take IFA tablets but the supplementation may be inadequate(Sununtnasuk, Agostino, and Fiedler 2015).

Additionally, almost all of the respondents who reported receiving only multivitamins were anaemic compared to one out of ten of those with normal haemoglobin level who

received multivitamins in addition to folic acid and iron. This indicates a lack of required iron needed by the respondents. Interestingly, all the respondents who received only ferrous sulphate were anaemic, an indication of the lack of other micronutrients that would have aided in the absorption of the iron. Furthermore, the habit of fruit consumption by pregnant women is lacking in the setting as over 95% of pregnant women interviewed never reported ever eating fruit in the past 24-hours. There exists an anecdotal evidence that, some of the pregnant women within the study area consumed one or more traditional supplements with the aim of preventing and treating anaemia. The efficacy of these traditional supplements for anaemia prevention has not been scientifically established. This has the potential to lead to malabsorption and unavailability of iron which has resulted in the higher anaemia prevalence among the respondents. Significantly also, the majority (71.3%) of the respondents were not given deworming tablets to prevent worm infestation in the study area. The explanation is due to out of stock of the supplement for the whole period of their pregnancy. We found there were no records in the maternal health record booklets indicating that the respondents ever received a deworming tablet in the course of their pregnancy

One other reason that could have led to the high prevalence of anaemia among the respondents in this current study is that decision-making autonomy among the respondents on what food to purchase for the household was low (8.9%) in the setting of the study. Over fifty per cent (57.7%) of the pregnant women had their husbands decide what food should be purchased for the household. And since the husbands are not the ones who receive dietary counselling during ANC, choice of iron rich food for the household might be limited. The evidence from this study also indicates that only 32.5% of the men accompanied their wives for ANC in Tatale district. Accompanying one's wife for ANC usually involves the man transporting the pregnant wife to the

health care facility, listen to nutrition education and also keeping abreast with danger signs during pregnancy. During the ANC education, these men are encouraged to support their pregnant women at home to take their routine drugs and also with household chores. Thus, they may not have adequate knowledge of the recommended food a pregnant woman will eat in order to stay healthy as well as support the pregnant women to take their routine drugs thereby increasing the pregnant women susceptibility to anaemia.

Another important reason that could have contributed to the high prevalence of anaemia in the study setting is that, the husbands mostly decide the time the pregnant woman should visit a health facility for health care. This is likely a potential reason for delayed ANC at registration. For example, 70.8% of the respondents initiated their first ANC visit in the second trimester and 11.4% of them initiated their first ANC visit in the third trimester in both districts. Importantly, pregnant women are given iron and folic acid supplementation beginning at ANC registration and this could have been affected in the current setting. Comparatively, delayed ANC registration were more pronounced in the Zabzugu district (80.4% second trimester and 12.2% third trimester) than in the Tatale district (50% second trimester and 9.6% third trimester). As a result, the pregnant women who started ANC visits in the second or third trimesters, could not have been able to take adequate number of iron and folic acid tables as well as antimalarial drugs. We found that those who were able to take 1-2 number of IPT tablets had more than two times risk of anaemia compared to pregnant women who were able to take 3-4 number of times during the pregnancy.

Also, there is anecdotal evidence at the study setting that the indigenes are predominantly farmers and the men usually will leave home early and return late in the night. They might not support their pregnant wives to take the routine medications provided during the ANC visits, a key factor in determining that the pregnant women actually followed the right recommendation of iron and folic acid intake during the pregnancy. It could also explain why some pregnant women even though were given the recommended iron-folic acid combination; they still became anaemic at ≥33 weeks of gestation in the study area.

5.2 Incidence of birth outcomes

This section of the discussion focuses on the incidence of birth outcomes (preterm birth, low birth weight and stunting) in the study setting.

5.2.1 Preterm deliveries

The results revealed that preterm deliveries were 2.2%. This is lower than the 16% incidence of preterm reported in Southern Nigeria (Zini and Omo-Aghoja 2019). It is also lower than the 33.3% reported in Ridge Hospital in the Greater Accra region (Aseidu et al. 2019). This finding from the study is further lower than the incidence which was reported by Wagura et al. (2018) wherein a systematic review of preterm deliveries, an 18.3% incidence was reported at the Kenyatta National Hospital. The difference in terms of these studies could be due to the geographic settings coupled with the nature and scope of the studies. The sampled participants in those studies could also account for the variation in the results. In the current study, two districts with the larger parts being rural were used for the study from which respondents were sampled to form the study population unlike in Wagura et al. (2018) study, where pregnant women who

attended a single referral hospital were sampled. Apart from the settings being different, 76% of the respondents were at ≥36 weeks of gestation at the time of conducting the current study. The possibility of delivering preterm among the respondents with the current gestational age was limited. The majority (78.6%) of the pregnant women from this setting were able to make four (4) or more ANC visits, which might have accounted for the lower incidence of preterm deliveries in the Tatale and Zabzugu districts.

5.2.2 Low birth weight

The results of this study show that the incidence of low birth weight is 3.1%. This result is similar to the 4.7% reported by Safari et al. (2016) in Garmsar, Iran. It is about half the result (6.3%) reported by Oladeinde et al. (2015). However, the current results is lower than the 7.7% reported from a study in the University hospital of Cape Coast (Prah et al. 2016), and the 7.3% prevalence in Nigeria (Dahlui et al. 2016). Also, the results are lower than that reported at country level in Burkina Faso (13.4%), Ghana (10.2%), Malawi (12.1%), Senegal (15.7%) and Uganda (10.0) by He et al., (2018); and 10.4% of low birth weight reported in Thailand (Aung, Makka, and Bundhamchareon 2018); the 12.5% reported by Muchemi, Echoka, and Makokha (2015); the 24.4% prevalence of low birth weight reported by Gosavi,.. et al (2014) in rural India; and the 30% prevalence reported by Lateef, Gupta, and Srivastava (2015) in their study in Lucknow hospital in Era.

Several reasons could have accounted for the differences in prevalence in these study reports. The category of respondents could be a reason for the variations compared to other studies. This is because the majority (59.3%) of the study participants in this study

were ≥37 weeks of gestation at the time of the study which reduces the possibility of delivering babies with low birthweight. A typical example is the results from Prah et al. (2016) study in which they documented that preterm delivery contributed 48.39% of the low birth weight babies recorded. Another reason that differentiate the prevalence of low birth weight in Prah et al. (2016) study from this study is that whilst their study included sickle cell positve mothers., this study did not include sickle cell positve pregnant women and that could explain the higher prevalence in their study than this study. The low birth weight prevalence from this study could also be as a result of the health care interventions the respondents received during ANC. For instance, the patronage of the study participants on antenatal care services was found to be very high with about 78.6% making ≥4 ANC visits and this could explain the low prevalence of low birth weight recorded in the study setting. From this study, most of the study participants (61.8%) reported to have received dietary counselling and some had adequate intake of IFA during pregnancy as well as IPT supplementation in the study setting. These health interventions could have played an important role that led to a low rate of low birth weight deliveries in the study area. Furthermore, the location of the various studies could have been the reason for the lower incidence of LBW in Tatale and Zabzugu districts compared to Cape Coast in the Central region and any other location.

5.2.3 Stunting at birth

The prevalence of stunting among the children delivered during the study was 25.1% using birth length measurement and 26.5% using the head circumference measurement. This result is higher than the 3.8% reported in a study that took place “in Brazil, China, India, Italy, Kenya, Oman, England, and the United States” (Victora et al. 2015). The

difference in the prevalence from these two studies could be due to the settings. while the study of Victora et al (2015) study was limited to regional capitals and /or urban centres of the participating countries, the current study took place in deprived districts with setting that is more rural. The reason for the higher prevalence of stunting at birth in the current study could also be as a result of the 82.2% of the respondents reported not eating vitamin A rich food, 26.2% reported not eating meat and 21.2% reported a meal frequency less than 3, which are factors that influence anaemia and stunting according to Mohammed, Larijani, and Esmaillzadeh (2019). This result is comparable to the 27.5% contained in a report by Aguayo et al., (2015). The similarities in the prevalence of stunting from the two studies could be due to the similarity in the educational training of the respondents. For example, 62.3% of the respondents in Aguayo et al 2015 study did not attain formal education, quite similar to the 64.3% of respondents in the current study who had no formal education. Another important reason for the similarities is that more male children were recorded than female children from both studies. The rate of stunting among males is similar. The finding from this study is lower when compared with the 38% reported at a rural setting in Guatemala (Solomons et al. 2015). The implication of this results is that the high stunting prevalence of 33.1% in Northern Ghana among children under the age of five years according to the GDHS 2014 report might have been carried forward from in uteru. The impact of this high prevalence of stunting in the Tatale and Zabzugu districts could be impaired growth and development and high morbidity and mortality in the near future. Howver, stunting at birth can be reversed through optimal nutrition. For example, encouraging the mothers of the stunted children to practice exclusive breastfeeding for the first six months and introduction of timely and appropriate complementary feeding at 6months with continued breastfeeding for up to two years.

5.3 Determinants of anaemia in Tatale and Zabzugu districts

The possible determinants of anaemia in pregnancy were assessed. These include socio-demographic, household decision-making autonomy, health care and nutritional determinants.

5.3.1 Socio-demographic determinants of anaemia

On anaemia and education level of pregnant women, the results showed that the pregnant women who had senior high school educational training were protective from becoming anaemic [RR=0.7 (95% CI: 0.4-1.4); p=0.295] compared to those who had no formal educational training even though not statistically significant. This result is consistent with the Stephen et al. (2018) assertion that education predicts health and makes it play a key role in the risk of anaemia. It is also consistent with Saaka et al., (2017) who found that pregnant women who had higher educational training were less at risk of anaemia compared to those with no formal education. This study further corroborated a study finding by Cheema et al. (2016) who documented that increasing levels of education decreases the prevalence of anaemia in pregnant women. There exist similarities in these study reports because education tend to empower women and educated women appear more conscious with their health and feeding. The higher your educational level, the more likelihood that you could gain a decent and better paying job or ran a business to generate income for the household and from their earnings, they could afford more diversified food. The impact of attaining higher education on anaemia will be improved birth outcomes.

On anaemia and parity. the results showed that pregnant women who had parity ≥4 were protective from becoming anaemic [RR=0.8 (95% CI: 0.4-1.7); p=0.591] compared to pregnant women who were pregnant for the first time. This result was not statistically significant. This study finding is different from a study by Çelik Kavak and Kavak (2017) who documented that the prevalence of anaemia is higher (22%) in pregnant women with multiple pregnancies than in nulliparous (19%). Cheema et al. (2016) also observed from their study that pregnant women with parity >3 had higher (90.8%) prevalence of anaemia than those with parity <3. This difference observed could have come from the study participants. This study considered only pregnant women at ≥33 weeks of gestation and also did not include pregnant women below 18 years of age whilst their study included pregnant women from the first trimester through to late third trimester that has the potential to increase the age and parity differences.

Also, the trimester within which the pregnant woman initiated antenatal care were statistically significant and had an association with anaemia among pregnant women at ≤ 33 weeks of gestation in the study setting. For example, pregnant women who initiated antenatal care within the third trimester were four times (4) times at risk of becoming anaemic [RR= 4.0 (95% CI: 1.6-10.4); p=0.004] as compared to those who initiated antenatal care in the first trimester This result is consistent with Adanikin and Awoleke (2016), A.K Monjurul et al. (2006), Nwizu et al. (2011) and Amna (2012) who identified late (second or third trimester) initiation of antenatal care as a determinant of anaemia. The similarities among these studies indicates that pregnant women who initiated antenatal care in the second or third trimester missed the opportunity to get optimal interventions to correct anaemia. Some of these interventions are iron and folic acid supplementation and antimalaria drugs (IPT) given to pregnant

women starting from first antenatal care booking to reduce the risk of anaemia. Therefore, presenting for first ANC booking in the third trimester limits the number of IFA and IPT tablets they were required to take before delivery. They might have lost the opportunity to also receive adequate dietary counselling at the health facilities. The impact of delayed initiation of ANC visit in the Tatale-Sanguli and Zabzugu districts will be persistent high prevalence of anaemia among pregnant women and this could increase the cost of care for them. Their immune system might be compromised that could lead to maternal deaths in the study setting.

The work pregnant women do to earn a living was statistically significant with the anaemia prevalence in the study setting. Pregnant women who reported been unemployed at the time of the study were 5.5 times at risk of becoming anaemic [RR=5.5 (95% CI: 1.7=18.0); p=0.004] compared to pregnant women who earned salary. This could be as a result of those earning salary ability to access antenatal care services easily and timely. Their ability to make decisions on the type of food to purchase for the family consumption is higher than those unemployed.

5.3.2 Household-level decision-making autonomy

The results from this study shows that pregnant women whose husbands took decision on what food should be purchased for the household were 1.4 times at risk of becoming anaemic [RR = 1.4 (95% CI: 1.9-3.5); p = 0.021] compared to those pregnant women who had full control over household decision making on the type of food that should be purchased for the household. Furthermore, this study found that pregnant women who could not make their own decisions on when to visit the health facility for care had 1.5 times risk of anaemia [RR = 1.5 (95% CI: 0.8-2.2); p = 0.218] compared to those

pregnant women who could make their own decision even though the result was not statistically significant. The findings from the study is similar to the studies done by Ghose et al. (2017), Tiruneh, Chuang, and Chuang (2017), and Fawole and Adeoye (2015) in which they were able to demonstrate that women independent decision making increased the utilization of health care services including antenatal care that have improved health outcomes. The results are also comparable to a study that documented that women who make decisions on household food purchase recorded higher dietary diversity compared to those who do not (Amugsi et al. 2016). These findings are similar because decision making is a form of women empowerment. Once the pregnant women receive dietary education from the health facilities during ANC, they are more likely to implement optimal nutrition recommendations provided they have the means to do so. The impact of giving women the opportunity to make independent decisions on when to visit the health facility for ANC and on what food should be purchased for the household in the Tatale-Sanguli and Zabzugu district will result in a reduced prevalence of anaemia among pregnant women.

5.3.3 Health care risk factors of anaemia

The results showed that the husband's involvement in antenatal care determines anaemia in the Tatale-Sanguli and Zabzuzu districts. It implies that pregnant women who had their husbands accompanying them for antennal care were protective from developing anaemia compared to those whose husbands never followed them for ANC visits [RR= 0.6 (95% CI: 0.4-0.9); p=0.015]. This finding is similar to Ade et al. (2016) who in their study found that husband involvement increased IFA adherence among pregnant women. This result is also consistent with a study that found that women educated with their husbands at antenatal care had improved maternal health outcomes

than women who were educated alone (Mullany, Becker, and Hindin 2007). There is evidence that husband involvement in health care has beneficial effects on health outcomes especially reducing the prevalence of low birth weight (Mbah, Marty, and Salihu 2010). These study finding are similar and may be due to the fact that men who accompany their partners to the health facility for ANC are more likely to support their spouses to take the routine drugs given to them by the health workers. The men after also receiving the health education will more likely provide the necessary dietary needs and other conditions that will contribute to improved health status of the pregnant wife than those who might not have the time to visit the health facility with their partners.

The number of times the pregnant woman visited the health facility for antenatal care [RR= 0.2 (95% CI: 0.1-0.6); p=0.001] protected pregnant women from anaemia at ≥33weeks of gestation. The findings from this study are consistent with the study done by Ayoya et al., (2012a) where it was shown that antenatal care attendance is associated with anaemia in pregnancy. It further agrees with Saaka et al., (2017) who also concluded that the number of ANC attendance predicts anaemia in pregnant women. The consistency of these findings could be due to the fact that those who attended ANC more than four (4) times were able to receive the needed interventions such as iron and folic acid supplementation, IPT in sufficient quantities. They possibly might have benefited from routine nutritional counselling which enhanced their food choice leading to improved nutritional status. The implication of these results is that the pregnant women who attended antenatal care for four or more times had less risk of anaemia.

Pregnant women who reported not receiving Iron and folic acid supplementation was found to increase the risk of anaemia among pregnant women [RR= 5.2 (95% CI: 0.7-40.5); p=0.113] though not statistically significant. Also, pregnant women who were ever asked to purchase iron and folic acid tablets had increased risk of anaemia compared to those who were never asked to purchase [RR= 1.6 (95% CI: 1.01-2.6); p=0.046]. This may be due to the fact that those pregnant women may not have gone to buy or totally lacked the financial capacity to buy and hence might not have bought at all. This finding is consistent with a study done in Southern Ethiopia where it was reported that lack of iron supplementation determines anaemia (Lebso et al., 2017, Anlaakuu & Anto, 2017). It is also similar to a study done by Mirie et al. (2016) who identified inadequate intake of iron and folic acid as risk factors for anaemia in pregnancy. These results support the findings from Paulino et al. (2005) in which they demonstrated that iron and folic acid supplementation improved the iron status of Filipino women. The finding is also supported by WHO (2012), guidelines for IFA supplementation that indicates that iron and folic acid supplementation reduces the risk of anaemia in pregnancy. The similarities from these studies demonstrate that pregnancy comes with a high demand for iron for both the mother and the unborn baby that cannot be met alone through dietary intake. And therefore, the IFA supplementation is able to increase the haemoglobin levels of the pregnant women thereby reducing the prevalence of anaemia.

Discussing anaemia as a public health issue at the community level was also found as a risk factor in the study setting. The results indicate that pregnant women who reported that they did not hear health information about anaemia from listening to the radio or watching television had increased risk of anaemia [RR= 3.4 (95% CI: 1.4-8.1);

p=0.006] compared to those who did say they heard anaemia been discussed as a public health issue at the community level. This is because the media play a critical role in information dissemination in modern times. Health workers are usually the main actors in terms of health education. If pregnant women were educated on the effects of anaemia at the health facility and it being discussed at the community level through the media, then their perception about its severity might increase. This may lead to lifestyle changes that could enhance their nutritional status.

5.3.4 Diet and diet-related determinants of anaemia.

The results show that pregnant women who received nutritional counselling had less risk of being anaemic compared to those who reported that they did not receive [RR= 2.2 (95% CI: 0.9-3.5); p=0.002]. This result is similar to the study finding by Gitau, Kimiywe, and Waudo (2016) in Kenya where they demonstrated that nutrition education has improved the haemoglobin levels of school students. It is also consistent with the findings of Kaur and Sangha (2016) in which reduction of anaemia prevalence was reported after a nutrition counselling was offered. Girard and Olude (2012) also reported a similar finding in their systematic review report in which a 30% reduction of anaemia in pregnancy was recorded as a result of nutrition education. The health workers from both Zabzugu and Tatale-Sanguli districts as observed by the data collection team gave routine nutrition education to pregnant women during antenatal care services. This was done in groups aimed at enhancing their knowledge on the best food to eat. They were also taught danger signs of pregnancy and how to maintain personal hygiene at all time.

Furthermore, pregnant women who reported eating 3-4 times a day were protective from developing anaemia [RR= 0.9 (95% CI: 0.5-1.6); p=0.811] compared to those whose ate 1-2 times a day though not statistically significant. Similarly, pregnant women who met the minimum dietary diversity score-women were not different from those who did not meet the minimum dietary diversity score-women [RR= 1.0 (95% CI: 0.5-1.9); p=0.890] though not statistically significant. This finding from the study is different from the study done by Abriha et al. (2014) where it was revealed that the number of times eaten in a day, food diversity were considered factors influencing anaemia in pregnant women.

5.4 Impact of anaemia at ≥33 weeks on birth outcomes

The results of pregnant women who were anaemic and delivered were examined among the sampled respondents to assess the impact. Statistical inference was made taking into consideration the outcome of this study. It revealed that no statistically significant association exists between anaemia and preterm delivery; low birth weight, stillbirths and stunted growth among the sampled respondents. This finding from the study agrees with a study by Masukume et al., (2015) that revealed "no statistically significant effect of anaemia on birth outcomes" among pregnant women. It further agrees with the findings of a study in Indonesian and Ghanaian pregnant women residing in urban areas that reported that anaemia has no association with adverse birth outcomes (Mocking et al. 2018). However, the finding from this study is not in conformity with Sapre et al. (2018); Wei et al., (2018); Figueiredo et al (2018); Rahmati et al., (2017); Nair et al., (2016); Drukker et al., (2015); Tandu-Umba & Mbangama, (2015); Moghaddam Tabrizi, (2015) Ganchimeg et al., (2014); Rani, Gupta, Gupta, &

Aggarwal, (2014); and Bodeau-livinec et al., (2011); who found from their individual studies that anaemia during pregnancy was associated with adverse birth outcomes.

The variance in these studies could be due to the sample size for the study which is far smaller compared to other studies and also the category of respondents that were studied. While most of the studies reporting statistically significant associations between anaemia and birth outcomes were largely due to severe anaemia, this study did not find severe anaemia to be a major public health concern in the study area. The difference could also be due to the geographical settings of the studies as well. There is also evidence that ANC attendance is very instrumental in averting the impact of anaemia among pregnant women. In the current study, the respondents were attending ANC regularly. The role of good nutrition in helping pregnant women achieve good birth outcomes has been advocated strongly in the study area.

5.5 Strengths and limitations of the study

This study was facility-based covering twelve (12) health facilities in the two districts. The respondents were from diverse backgrounds. The facilities provided a conducive environment for the interviews to be conducted and also the birth outcome data to be collected. All the data enumerators had nutrition background and experience in conducting interviews and taking anthropometric measurements. Blood samples were taken by qualified and practicing midwives. However, some pregnant women might have doubted that their responses will be strictly kept confidential despite the assurance given to them by the data collection team. This could have led to some of them giving bias responses just to please the health staff at the selected health facilities.

Furthermore, some of the pregnant women had experienced one form of nutrition intervention or the other (ie food aid) in the past and would have thought that a similar one is about to come. Therefore, they might have not given a true reflection of their situation despite the information given to them by the data collection team at the time of conducting the study that it was purely for academic purpose. Though the midwives were trained on how to accurately measure the birth outcome data especially the length and head circumference, consistency might have been affected.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.0 Conclusion

The study found the rate of anaemia among the pregnant women at ≥ 33 weeks of gestation in the Tatale-Sanguli and Zabzugu districts as 72%. The Zabzugu district contributed less percentage of both severe and moderate anaemia among the respondents. However, it contributed close to two-thirds of the mild anaemia prevalence when compared with Tatale-Sanguli district that contributed a little above half. This study demonstrated from the bivariate regression analysis that antenatal care visit, decision making autonomy on food purchase, husband involvement in ANC, counselling on diet and four or more antenatal care visits were the possible determinants of anaemia in pregnancy at ≥33 weeks of gestation in Tatale-Sanguli and Zabzugu districts. It further demonstrated from the multivariate logistics regression that first antenatal care visit in the third trimester and husband involvement in antenatal care were the independent predictors of anaemia among pregnant women at ≥33 weeks of gestation in the study setting.

The proportion of stillbirths in the two districts was 1.4%, the proportion of babies born with low birth weight in the two districts was 3.1%. Furthermore, this study found the prevalence of stunting at birth to be at 25.1% using the birth length measurement and 26.1% prevalence of small heard circumference in the two districts. Finally, the incidence of preterm births deliveries was 2.2% in the two districts.

This study finds no statistically significant association between anaemia at ≥33 weeks of gestation and birth outcomes (preterm delivery; low birth weight, stillbirths and stunted growth) in the Tatale and Zabzugu districts of the Northern Region.

6.1 Recommendations

Considering the findings from this study, the following interventions are recommended to be instituted in the two districts to help drastically mitigate the rate of anaemia in pregnancy:

1. Community sensitization should specifically target traditional beliefs aimed at encouraging early initiation for the ANC services after a pregnancy is confirmed and continuous attendance until delivery.
2. Emphasis should be placed on home visitation to identify pregnant women early enough for first antenatal care booking
3. Health care providers and community leaders should create more awareness that will eliminate the traditional practices where household-level decision making is dominated by men on food purchase for the household, rather empower women to always lead decision making on what food should be purchased for the household.
4. Rigorous nutrition education and sensitization of the people to encourage husbands to always accompany their wives for antenatal care.
5. Religious leaders should be targeted as change agents in promoting husband participation in antenatal care services
6. Backyard gardening should be encouraged in the study setting to increase the availability of iron-rich foods the whole year-round.

REFERENCES

A.K Monjurul Hoque, Suriya B kader, Ehsanul Hoque and Charles Mugero. 2006. "14554-27177-1-PB.Pdf."

Abriha, A., Yesuf, M. E., & Wassie, M. M. (2014). Prevalence and associated factors of anemia among pregnant women of Mekelle town: a cross sectional study, 1–6.

Access, O. (2016). Frequency and risk factors of low birth weight in term pregnancy, 32(1), 138–142.

Access, O. (2018). births in Mulago Hospital, Kampala, Uganda: a case control study, 8688, 1–8. https://doi.org/10.11604/pamj.2018.30.272.13531. Accessed on 10th. June, 2018

Acheampong, K., Appiah, S., Baffour-awuah, D., & Arhin, Y. S. (2018). International Journal of Health Sciences and Research, 8(January), 186–193.

Adanikin, A. I., and J. O. Awoleke. 2016. "Sociodemographic Factors Associated with Anaemia in Pregnancy at Booking for Antenatal Care." *Journal of Obstetrics and Gynaecology* 36(1): 44–47. http://dx.doi.org/10.3109/01443615.2015.1025727.

Ade, Luh et al. 2016. "Role of Family Support and Women ' s Knowledge on Pregnancy-Related Risks in Adherence to Maternal Iron – Folic Acid Supplementation in Indonesia." 19(15): 2818–28.

Aguayo, V. M., Badgaiyan, N., & Paintal, K. (2015). Original Article Determinants of child stunting in the Royal Kingdom of Bhutan: an in-depth analysis of nationally representative data, (Unicef 2014), 333–345. https://doi.org/10.1111/mcn.12168. Accessed on 4th. August, 2019

Ahenkorah, B., Nsiah, K., & Baffoe, P. (2016). Sociodemographic and Obstetric Characteristics of Anaemic Pregnant Women Attending Antenatal Clinic in Bolgatanga Regional Hospital. Scientifica, 2016, 1–8. https://doi.org/10.1155/2016/4687342. Accessed on 20th. September, 2019.

Ahumada-Barrios, M. E., & Alvarado, G. F. (2016). Risk Factors for premature birth in a hospital. Revista Latino-Americana de Enfermagem, 24(0). https://doi.org/10.1590/1518-8345.0775.2750. Accessed on 3rd. February,2019.

Alcázar, L. (2013). The economic impact of anaemia in Peru. Lima: Group for the Analysis of Development and Action Against Hunge.

Alizadeh, L., Raoofi, A., Salehi, L., & Ramzi, M. (2014). Impact of Maternal Hemoglobin Concentration on Fetal Outcomes in Adolescent Pregnant Women. Iranian Red Crescent Medical Journal, 16(8), 1–5. https://doi.org/10.5812/ircmj.19670. Accessed on 10th. November, 2018.

Alwan, N. A., Cade, J. E., McArdle, H. J., Greenwood, D. C., Hayes, H. E., & Simpson, N. A. B. (2015). Maternal iron status in early pregnancy and birth outcomes: Insights from the Baby's Vascular health and Iron in Pregnancy study. British Journal of Nutrition, 113(12), 1985–1992. https://doi.org/10.1017/S0007114515001166. Accessed on 10th. November, 2018.

Amna, Ambreen. 2012. "Late Antenatal Booking, Its Barrier and Maternal Complications." *sra Medical JournalI* 7(1): 38–41.

Ampofo, G. D., Tagbor, H., & Bates, I. (2018). Effectiveness of pregnant women's active participation in their antenatal care for the control of malaria and anaemia in pregnancy in Ghana: A cluster randomized controlled trial ISRTCTN88917252 ISRTCTN. Malaria Journal, 17(1), 1–15. https://doi.org/10.1186/s12936-018-2387-1. Accessed on 10th. November,2018.

Amugsi, Dickson A, Anna Lartey, Elizabeth Kimani-murage, and Blessing U Mberu. 2016. "Women' s Participation in Household Decision-Making and Higher Dietary Diversity: Findings from Nationally Representative Data from Ghana." Journal of Health, Population and Nutrition: 1–8. http://dx.doi.org/10.1186/s41043-016-0053-1.

Anlaakuu, P., & Anto, F. (2017). Anaemia in pregnancy and associated factors: a cross sectional study of antenatal attendants at the Sunyani Municipal Hospital, Ghana. BMC Research Notes, 10(1), 402. https://doi.org/10.1186/s13104-017-2742-2

Aranda, N., Hernández-Martínez, C., Arija, V., Ribot, B., & Canals, J. (2017). Haemoconcentration risk at the end of pregnancy: Effects on neonatal behaviour. Public Health Nutrition, 20(8), 1405–1413. https://doi.org/10.1017/S136898001600358X

Aryastami, N. K., Shankar, A., Kusumawardani, N., Besral, B., & Jahari, A. B. (2017). Low birth weight was the most dominant predictor associated with stunting among children aged 12 – 23 months in Indonesia, 1–6. https://doi.org/10.1186/s40795-017-0130-x

Aseidu, Ernest Konadu et al. 2019. "Obstetric Determinants of Preterm Delivery in a Regional Hospital, Accra, Ghana 2016." BMC Pregnancy and Childbirth 19(1): 1–8.

Aung, E., Makka, N., & Bundhamchareon, K. (2018). Estimated Burden of Premature Death and Morbidity from Low Birth Weight Infants in Thailand. International Journal of TROPICAL DISEASE & Health, 31(2), 1–10. https://doi.org/10.9734/IJTDH/2018/41821

Ayoya, M. A., Bendech, M. A., Zagré, N. M., & Tchibindat, F. (2012a). Maternal anaemia in West and Central Africa: time for urgent action. Public Health Nutrition, 15(5), 916–927. https://doi.org/DOI: 10.1017/S1368980011002424

Ayoya, M. A., Bendech, M. A., Zagré, N. M., & Tchibindat, F. (2012b). Maternal anaemia in West and Central Africa: Time for urgent action. Public Health Nutrition, 15(5), 916–927. https://doi.org/10.1017/S1368980011002424

Baingana, R. K., Enyaru, J. K., Tjalsma, H., Swinkels, D. W., & Davidsson, L. (2015). The aetiology of anaemia during pregnancy: A study to evaluate the contribution of iron deficiency and common infections in pregnant Ugandan women. Public Health Nutrition, 18(8), 1423–1435. https://doi.org/10.1017/S1368980014001888

Balasubramanian, T., Aravazhi, M., & Sampath, S. D. (2016). Awareness of Anemia among Pregnant Women and Impact of Demographic Factors on their Hemoglobin Status, 3(12), 303–305. https://doi.org/10.17354/ijss/2016/170

Baruah, A., & Boruah, B. (2016). Burden of Anaemia among Pregnant Women Attending a Tertiary Care Hospital in Assam, 6(July), 18–23.

Blencowe, H., Cousens, S., Chou, D., Oestergaard, M., Say, L., Moller, A., & Kinney, M. (2013). Blencowe H, et al.: Born Too Soon: The global epidemiology of 15 million preterm births. Reproductive Health, 10(Suppl 1), 1–14. https://doi.org/10.1186/1742-4755-10-S1-S2

Blencowe, H., Cousens, S., Oestergaard, M. Z., Chou, D., Moller, A. B., Narwal, R., … Lawn, J. E. (2012). National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: A systematic analysis and implications. The Lancet, 379(9832), 2162–2172. https://doi.org/10.1016/S0140-6736(12)60820-4

BMI Task Force. (2010). A Training Manual for Height and Weight Assessment. Arkansas Center for Health Improvement, 1–22. Retrieved from http://www.achi.net/BMIContent/Documents/101007_Height_and_Weight_Measurement_Training_Manual1with_revisions.pdf. Accessed on 1st. January,2019.

Bodeau-livinec, F., Briand, V., Berger, J., Xiong, X., Massougbodji, A., Day, K. P., & Cot, M. (2011). Maternal Anemia in Benin: Prevalence, Risk Factors, and Association with Low Birth Weight, 85(3), 414–420. https://doi.org/10.4269/ajtmh.2011.10-0599

Bottai, M. (2016). Increased risk of preterm birth in women with autoimmune hepatitis – a nationwide cohort study, (February 2015), 76–83. https://doi.org/10.1111/liv.12901

Cappelletti, M., Bella, S. Della, Ferrazzi, E., Mavilio, D., & Divanovic, S. (2016). Inflammation and preterm birth, 99(January). https://doi.org/10.1189/jlb.3MR0615-272RR

CDC. (2016). Measuring Head Circumferen Ce, 1.www.cdc.gov/zika. Accessed on 24th. February,2019.

Çelik Kavak, Ebru, and Salih Burçin Kavak. 2017. "The Association between Anemia Prevalence, Maternal Age and Parity in Term Pregnancies in Our City." *Perinatal Journal* 25(1): 6–10.

Chakrabarti, S., George, N., Majumder, M., Raykar, N., & Scott, S. (2018). Identifying sociodemographic, programmatic and dietary drivers of anaemia reduction in pregnant Indian women over 10 years. Public Health Nutrition, 21(13), 2424–2433. https://doi.org/DOI: 10.1017/S1368980018000903

Chawanpaiboon, S., Vogel, J. P., Moller, A. B., Lumbiganon, P., Petzold, M., Hogan, D., … Gülmezoglu, A. M. (2018). Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. The Lancet Global Health, 37–46. https://doi.org/10.1016/S2214-109X(18)30451-0

Cheema, H K, Baljit Singh Bajwa, Kulbir Kaur, and Harshdeep Joshi. 2016. "Prevalence and Possible Risk Factors of Anaemia in Different Trimesters of Pregnancy." *International Journal of Contemporary Medical Research* 343(4Online): 2393–2915. www.ijcmr.com.

Children, G., Walker, S. P., Chang, S. M., Wright, A., Osmond, C., & Grantham-mcgregor, S. M. (2018). Early Childhood Stunting Is Associated with Lower Developmental Levels in the Subsequent, (June), 823–828. https://doi.org/10.3945/jn.114.200261.Downloaded

Christian, P., Lee, S. E., Angel, M. D., Adair, L. S., Arifeen, S. E., Ashorn, P., … Hu, G. (2018). Risk of childhood undernutrition related to small-for-gestational age

and preterm birth in low- and middle-income countries, (August 2013), 1340–1355. https://doi.org/10.1093/ije/dyt109

Chung, P., Coker, T., Currier, R. J., Druzin, M. L., Kuppermann, M., Muglia, L. J., … Jelliffe-, L. L. (2017). HHS Public Access, 128(2), 364–372. https://doi.org/10.1097/AOG.0000000000001506.Recurrence

Crowther, S., Tay, K., Nani, E. A., & Walana, W. (2017). Parasitic infections and maternal anaemia among expectant mothers in the Dangme East District of Ghana. BMC Research Notes, 1–9. https://doi.org/10.1186/s13104-016-2327-5. Accessed on 5th. August,2018.

Cumming, O., & Cairncross, S. (2016). Review Article Can water, sanitation and hygiene help eliminate stunting? Current evidence and policy implications, 12, 91–105. https://doi.org/10.1111/mcn.12258

Dahlui, M., Azahar, N., Oche, O. M., Aziz, N. A., Dahlui, M., Azahar, N., & Oche, O. M. (2016). Risk factors for low birth weight in Nigeria: evidence from the 2013 Nigeria Demographic and Health Survey Risk factors for low birth weight in Nigeria: evidence from the 2013 Nigeria Demographic and Health Survey, 9716. https://doi.org/10.3402/gha.v9.28822. Accessed on 5th. August,2018.

Danaei, G., Andrews, K. G., Sudfeld, C. R., Fink, G., McCoy, D. C., Peet, E., … Fawzi, W. W. (2016). Risk Factors for Childhood Stunting in 137 Developing Countries: A Comparative Risk Assessment Analysis at Global, Regional, and Country Levels. PLoS Medicine, 13(11), 1–18. https://doi.org/10.1371/journal.pmed.1002164

Dar, B. (2018). Pregnant mothers are more anemic than lactating mothers, a comparative, 1–7. https://doi.org/10.1186/s12878-018-0096-1. Accessed on 5th. August,2018.

Dekhtyar, S., Neuroscience, C., Psychology, S., Institutet, K., Wang, H., Goodman, A., & Herlitz, A. (2015). Associations of head circumference at birth with early - life school performance and later - life occupational prestige, 6(1), 26–42.

Delnord, M., Blondel, B., Prunet, C., & Zeitlin, J. (2018). Are risk factors for preterm and early- term live singleton birth the same? A population-based study in France, 1–9. https://doi.org/10.1136/bmjopen-2017-018745

Derraik, J. G. B., Lundgren, M., Cutfield, W. S., & Ahlsson, F. (2016). Maternal Height and Preterm Birth: A Study on 192, 432 Swedish Women, 1–7. https://doi.org/10.1371/journal.pone.0154304

Development Initiatives, 2018. 2018 Global Nutrition Report: Shining a light to spur action on nutrition. Bristol, U. D. I. (2018). Global Nutrition Report.

Dewey, K. G., & Begum, K. (2011). Original Article Long-term consequences of stunting in early life, 7, 5–18. https://doi.org/10.1111/j.1740-8709.2011.00349.x

Drukker, L., Hants, Y., Farkash, R., Ruchlemer, R., Samueloff, A., & Grisaru-Granovsky, S. (2015). Iron deficiency anemia at admission for labor and delivery is associated with an increased risk for Cesarean section and adverse maternal and neonatal outcomes. Transfusion, 55(12), 2799–2806. https://doi.org/10.1111/trf.13252

Egbi, G., Gbogbo, S., Mensah, G. E., Glover-amengor, M., & Steiner-asiedu, M. (2018). Effect of green leafy vegetables powder on anaemia and vitamin-A status of Ghanaian school children, 1–10.

Engwa, G. A., Unaegbu, M., Unachukwu, M. N., Njoku, M. G. C., Agbafor, K. N., Mbacham, W. F., & Okoh, A. (2017). Low serum ferritin and G6PD deficiency as potential predictors of anaemia in pregnant women visiting Prime Care Hospital Enugu Nigeria. BMC Research Notes, 10(1), 1–5. https://doi.org/10.1186/s13104-017-3051-5

Ewerling, Fernanda et al. 1999. "Articles The SWPER Index for Women' s Empowerment in Africa: Development and Validation of an Index Based on Survey Data." The Lancet Global Health 5(9): e916–23. http://dx.doi.org/10.1016/S2214-109X(17)30292-9.

Fawole, Olufunmilayo I, and Ikeola A. Adeoye. 2015. "Women' s Status within the Household as a Determinant of Maternal Health Care Use in Nigeria." 15(1).

Felder, J. N., Baer, R. J., Prather, A. A., Rand, L., & Jelliffe-pawlowski, L. L. (2017). and Risk of Preterm Birth, 130(3), 573–581. https://doi.org/10.1097/AOG.0000000000002132

Ferrero, D. M., Larson, J., Jacobsson, B., Carlo, G., Renzo, D., Norman, E., … Simpson, J. L. (2016). Cross-Country Individual Participant Analysis of 4 . 1 Million Singleton Births in 5 Countries with Very High Human Development Index Confirms Known Associations but Provides No Biologic Explanation for 2 / 3 of All Preterm Births, 1–19. https://doi.org/10.1371/journal.pone.0162506

Figueiredo, A., Gomes-Filho, I., Silva, R., Pereira, P., Mata, F., Lyrio, A., … Pereira, M. (2018). Maternal Anemia and Low Birth Weight: A Systematic Review and Meta-Analysis. Nutrients, 10(5), 601. https://doi.org/10.3390/nu10050601

Fuchs, F., Monet, B., Ducruet, T., Chaillet, N., & Audibert, F. (2018). Effect of maternal age on the risk of preterm birth: A large cohort study, 08, 1–10.

Ganchimeg, T., Ota, E., Morisaki, N., Laopaiboon, M., Lumbiganon, P., Zhang, J., … WHO Multicountry Survey on Maternal Newborn Health Research Network. (2014). Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicountry study. BJOG: An International Journal of Obstetrics and Gynaecology, 121 Suppl, 40–48. https://doi.org/10.1111/1471-0528.12630

Getachew, M., Yewhalaw, D., Tafess, K., Getachew, Y., & Zeynudin, A. (2012). Anaemia and associated risk factors among pregnant women in Gilgel Gibe dam area, Southwest Ethiopia, 1–8.

Ghana Demographic Health Survey, H. (2014). Ghana.

Ghose, Bishwajit et al. 2017. “Women’ s Decision-Making Autonomy and Utilisation of Maternal Healthcare Services: Results from the Bangladesh Demographic and Health Survey.” : 1–8.

Girard, Amy Webb, and Oluwafunke Olude. 2012. “Nutrition Education and Counselling Provided during Pregnancy : Effects on Maternal , Neonatal and Child Health Outcomes.” 26: 191–204.

Gitau, Gladys Njura, Judith O Kimiywe, and Judith N Waudo. 2016. “Quality Nutrition Education and Its Impact on Haemoglobin Levels of School Pupils of

Muranga County , Kenya.” 4(1): 155–73.

Goisis, A., Remes, H., Barclay, K., Martikainen, P., & Myrskylä, M. (2017). Original Contribution Advanced Maternal Age and the Risk of Low Birth Weight and Preterm Delivery: a Within-Family Analysis Using Finnish Population Registers, 186(11), 1219–1226. https://doi.org/10.1093/aje/kwx177

Gosavi, S. V, Koparkar, A. R., Sv, G., Contemp, I. J., & May, P. (2014). Predictors of low birth weight: a retrospective study from rural India, 1(1), 7–9. https://doi.org/10.5455/2349-3291.ijcp20140503

Greenburg, A. G. (1996). Pathophysiology of anemia. The American Journal of Medicine, 101(2, Supplement 1), 7S-11S. https://doi.org/https://doi.org/10.1016/S0002-9343(96)00161-1

Gresham, E., Collins, C. E., Mishra, G. D., Byles, J. E., & Hure, A. J. (2016). Diet quality before or during pregnancy and the relationship with pregnancy and birth outcomes: The Australian Longitudinal Study on Women’s Health. Public Health Nutrition, 19(16), 2975–2983. https://doi.org/10.1017/S1368980016001245

GSS, GHS, & ICF International. (2015). Ghana 2014 Demographic and Health Survey Key Findings, 1–29. https://doi.org/10.5261/2013.GEN1.04

He, Z., Bishwajit, G., Yaya, S., Cheng, Z., Zou, D., & Zhou, Y. (2018). Prevalence of low birth weight and its association with maternal body weight status in selected countries in Africa: A cross-sectional study. BMJ Open, 8(8), 1–8. https://doi.org/10.1136/bmjopen-2017-020410

Howson, E. C., Kinney, M., & Lawn, J. (2012). Born too soon. The Global Action Report on Preterm Birth. Born Too Soon, The Global Action Report on Preterm

Birth. Eds CP Howson, MV Kinney, JE Lawn. World Health Organization. Geneva, 13(5), 1, 2, 9. https://doi.org/http://whqlibdoc.who.int/publications/2012/9789241503433_eng.pdf

Jarde, A., Morais, M., Kingston, D., Giallo, R., Macqueen, G. M., Giglia, L., … Mcdonald, S. D. (2016). Neonatal Outcomes in Women With Untreated Antenatal Depression Compared With Women Without Depression A Systematic Review and Meta-analysis, 73(8), 826–837. https://doi.org/10.1001/jamapsychiatry.2016.0934

Jaween, C.B (2013). Determination of Possible Causes of Nutritional Anaemia Among Pregnant Women in Tamale Metropolis, Ghana. University of Ghana, Legon. Available from [http://ugspace.ug.edu.gh/handle/123456789/5533]. (accessed on 08 May 2019)

Jornayvaz, F. R., Vollenweider, P., Bochud, M., Mooser, V., Waeber, G., & Vidal, P. M. (2016). Low birth weight leads to obesity, diabetes and increased leptin levels in adults: the CoLaus study. Cardiovascular Diabetology, 1–10. https://doi.org/10.1186/s12933-016-0389-2

Jwa, S. C., Fujiwara, T., Yamanobe, Y., Kozuka, K., & Sago, H. (2015). Changes in maternal hemoglobin during pregnancy and birth outcomes. BMC Pregnancy and Childbirth, 15(1), 1–10. https://doi.org/10.1186/s12884-015-0516-1

Kaur, Sukhdeep, and Jasvinder Kaur Sangha. 2016. “Effect of Iron Supplementation Along with Vitamin C and Nutrition Counseling on the Anaemic Status of Adolescent Girls.” 6(May): 279–87

Kuril, B. M., Janbade, C., Lone, D. K., Hirani, S., Ankushe, R. T., & Doibale, M. K. (2016). Study of adherence and effect of iron and folic acid supplement on haemoglobin level among adolescent girls in rural area, 3(4), 906–911.

Lateef, Esbah, Pratibha Gupta, and Jyoti Srivastava. 2015. "The Prevalence of Low Birth Weight Infants amongst Hospital Deliveries in Lucknow." International Journal of Community Medicine and Public Health 2(4): 510–12.

Lawn, J. E., Blencowe, H., Oza, S., You, D., Lee, A. C. C., Waiswa, P., … Barros, A. J. D. (2015). Every Newborn 2 Progress, priorities, and potential beyond survival, 6736(14). https://doi.org/10.1016/S0140-6736(14)60496-7

Leal, C., Esteves-pereira, A. P., Nakamura-pereira, M., Torres, J. A., Theme-filha, M., Maria, R., … Gama, S. G. (2016). Prevalence and risk factors related to preterm birth in Brazil. Reproductive Health, 13(Suppl 3). https://doi.org/10.1186/s12978-016-0230-0

Lebso, M., Anato, A., & Loha, E. (2017). Prevalence of anemia and associated factors among pregnant women in Southern Ethiopia: A community based cross-sectional study, 1–11. https://doi.org/10.6084/m9.figshare.5616433.Funding

Lilliecreutz, C., Larén, J., Sydsjö, G., & Josefsson, A. (2016). Effect of maternal stress during pregnancy on the risk for preterm birth. BMC Pregnancy and Childbirth, 1–8. https://doi.org/10.1186/s12884-015-0775-x

Liu, L., Johnson, H. L., Cousens, S., Perin, J., Scott, S., Lawn, J. E., … Li, M. (2010). Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. The Lancet, 379(9832), 2151–2161. https://doi.org/10.1016/S0140-6736(12)60560-1

Maakaron, J.E (2018). Anaemia. Retrieved from https://emedicine.medscape.com/article/198475-overview#a

Masukume, G., Khashan, A. S., Kenny, L. C., Baker, P. N., & Nelson, G. (2015). Risk factors and birth outcomes of anaemia in early pregnancy in a nulliparous cohort. PLoS ONE, 10(4), 1–15. https://doi.org/10.1371/journal.pone.0122729

Mbah, Alfred K, Æ Phillip J Marty, and Hamisu M Salihu. 2010. "The Impact of Paternal Involvement on Feto-Infant Morbidity Among Whites , Blacks and Hispanics." : 735–41.

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

Mirie, W., Odhiambo, E., Habtu, M., Okube, O. T., & Sabina, W. (2016). Prevalence and Factors Associated with Anaemia among Pregnant Women Attending Antenatal Clinic in the Second and Third Trimesters at Pumwani Maternity Hospital, Kenya. Open Journal of Obstetrics and Gynecology, 06(01), 16–27. https://doi.org/10.4236/ojog.2016.61003

Mocking, M., Savitri, A. I., Uiterwaal, C. S. P. M., Amelia, D., Antwi, E., Baharuddin, M., … Browne, J. L. (2018). Does body mass index early in pregnancy influence the risk of maternal anaemia? An observational study in Indonesian and Ghanaian women, 1–9.

Moghaddam Tabrizi, et al. (2015). Maternal Hemoglobin Levels during Pregnancy and their Association with Birth Weight of Neonates. Iranian Journal of Pediatric Hematology and Oncology, 5(4), 211–217.

Mohammed, Shimels Hussien, Bagher Larijani, and Ahmad Esmaillzadeh. 2019. "Concurrent Anemia and Stunting in Young Children: Prevalence, Dietary and Non-Dietary Associated Factors." *Nutrition Journal* 18(1): 1–10.

Moradi, S., Arghavani, H., Issah, A., Mohammadi, H., & Mirzaei, K. (2018). Food insecurity and anaemia risk: a systematic review and meta-analysis. Public Health Nutrition, 21(16), 3067–3079. https://doi.org/DOI: 10.1017/S1368980018001775

Muchemi, Onesmus Maina, Elizabeth Echoka, and Anselimo Makokha. 2015. "Factors Associated with Low Birth Weight among Neonates Born at Olkalou District Hospital, Central Region, Kenya." Pan African Medical Journal 20: 1–11.

Mullany, Britta C, S Becker, and M J Hindin. 2007. "The Impact of Including Husbands in Antenatal Health Education Services on Maternal Health Practices in Urban Nepal : Results from a Randomized Controlled Trial." 22(2): 166–76.

Nair, M., Choudhury, M. K., Choudhury, S. S., Kakoty, S. D., Sarma, U. C., Webster, P., & Knight, M. (2016a). Association between maternal anaemia and pregnancy outcomes: a cohort study in Assam, India, 1–9. https://doi.org/10.1136/bmjgh-2015-000026

Nair, M., Choudhury, M. K., Choudhury, S. S., Kakoty, S. D., Sarma, U. C., Webster, P., & Knight, M. (2016b). Association between maternal anaemia and pregnancy outcomes: a cohort study in Assam, India. BMJ Global Health, 1(1), e000026. https://doi.org/10.1136/bmjgh-2015-000026

Neufeld LM, Haas JD, Grajéda R, Martorell R. Changes in maternal weight from the first to second trimester of pregnancy are associated with fetal growth and infant length at birth. Am J Clin Nutr. 2004;79(4):646-652. doi:10.1093/ajcn/79.4.646

Tigga PL, Mondal N and Sen J. 2016. Head circumference as an indicator of undernutrition among tribal preschool children aged 2-5 years of North Bengal, India. Human Biology Review, 5 (1), 17-33.

Nwizu, E. N., Z. Iliyasu, S. A. Ibrahim, and H. S. Galadanci. 2011. "Socio-Demographic and Maternal Factors in Anaemia in Pregnancy at Booking in Kano, Northern Nigeria." *African journal of reproductive health* 15(4): 33–41.

Obai, G., Odongo, P., & Wanyama, R. (2016). Prevalence of anaemia and associated risk factors among pregnant women attending antenatal care in Gulu and Hoima Regional Hospitals in Uganda: A cross sectional study. BMC Pregnancy and Childbirth, 16(1), 1–7. https://doi.org/10.1186/s12884-016-0865-4

Oftedal, A. M., Busterud, K., Irgens, L. M., Haug, K., & Rasmussen, S. (2016). Socio-economic risk factors for preterm birth in Norway 1999-2009. Scandinavian Journal of Public Health, 44(6), 587–592. https://doi.org/10.1177/1403494816653288

Ojukwu, O. M., Ezem, B. U., Nzeribe, E. A., Okorochukwu, B. C., Onyegbule, O. A., & Bamayi, N. U. (2018). Determinants and Pattern of Anaemia in Pregnancy at Booking in Federal Medical Centre Owerri, 33(2), 1–13. https://doi.org/10.9734/IJTDH/2018/44496

Oladeinde, Henry Bankole, Oladapo Babatunde Oladeinde, Richard Omoregie, and Adekunle Abdufattai Onifade. 2015. "Prevalence and Determinants of Low Birth Weight: The Situation in a Traditional Birth Home in Benin City, Nigeria." African Health Sciences 15(4): 1123–29.

Patel, A., Prakash, A. A., Das, P. K., Gupta, S., Pusdekar, Y. V., & Hibberd, P. L. (2018). Maternal anemia and underweight as determinants of pregnancy outcomes:

cohort study in eastern rural Maharashtra, India. BMJ Open, 8(8), e021623. https://doi.org/10.1136/bmjopen-2018-021623

Paulino, Lourdes S, Imelda Angeles-agdeppa, Unita Mari M Etorma, and Adelisa C Ramos. 2005. "Weekly Iron-Folic Acid Supplementation to Improve Iron Status and Prevent Pregnancy Anemia in Filipino Women of Reproductive Age : The Philippine Experience through Government and Private Partnership." (December): 109–15.

Peelen, M. J. C. S., Kazemier, B. M., Ravelli, A. C. J., De Groot, C. J. M., Van Der Post, J. A. M., Mol, B. W. J., … Kok, M. (2016). Impact of fetal gender on the risk of preterm birth, a national cohort study. Acta Obstetricia et Gynecologica Scandinavica, 95(9), 1034–1041. https://doi.org/10.1111/aogs.12929

Prah, J., Ameyaw, E. O., Afoakwah, R., & Kudom, A. (2016). Factors affecting birth weight in Cape Coast, Ghana, 5(5), 1536–1539.

Pulat Demir, H. (2018). Term and preterm birth effects of the nutritional status and habits in pregnancy. Eurasian Journal of Medicine and Oncology, 2(2), 84–90. https://doi.org/10.14744/ejmo.2018.61687

Rachmi, C. N., Agho, K. E., Li, M., & Baur, L. A. (2016). Stunting, Underweight and Overweight in Children Aged 2. 0 – 4. 9 Years in Indonesia: Prevalence Trends and Associated Risk Factors, 1–17. https://doi.org/10.1371/journal.pone.0154756

Rahman, M., Abe, S. K., Rahman, S., Kanda, M., Narita, S., Bilano, V., … Shibuya, K. (2016). Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: systematic review and, 495–504. https://doi.org/10.3945/ajcn.115.107896.Am

Rahmati, S., Delpishe, A., Azami, M., Hafezi Ahmadi, M. R., & Sayehmiri, K. (2017). Maternal Anemia during pregnancy and infant low birth weight: A systematic review and Meta-analysis. International Journal of Reproductive Biomedicine (Yazd, Iran), 15(3), 125–134. https://doi.org/10.29252/ijrm.15.3.125

Rani, K., Gupta, J., Gupta, R., & Aggarwal, K. (2014). Maternal anaemia and its severity: an independent risk factor for preterm delivery and adverse neonatal outcome. International Journal of Reproduction, Contraception, Obstetrics and Gynecology, 3(2), 325–329. https://doi.org/10.5455/2320-1770.ijrcog20140607

Rao, S., Joshi, S., Bhide, P., Puranik, B., & Asawari, K. (2014). Dietary diversification for prevention of anaemia among women of childbearing age from rural India. Public Health Nutrition, 17(4), 939–947. https://doi.org/10.1017/S1368980013001006

Report, P. (2014). Committing to Child Survival: A Promise Renewed Progress Report 2014.

Rose, M. S., Pana, G., & Premji, S. (2016). Prenatal Maternal Anxiety as a Risk Factor for Preterm Birth and the Effects of Heterogeneity on This Relationship: A Systematic Review and Meta-Analysis, 2016.

Saaka, M., & Abdul, A. (2015). ROLE OF DIETARY DIVERSITY IN ENSURING ADEQUATE HAEMATOLOGICAL STATUS DURING PREGNANCY, 4(4), 749–755. https://doi.org/10.5958/2319-5886.2015.00146.0

Saaka, M., Oladele, J., Larbi, A., & Hoeschle-zeledon, I. (2017). Dietary Diversity Is Not Associated with Haematological Status of Pregnant Women Resident in Rural Areas of Northern Ghana, 2017.

Sachdeva, S., Nanda, S., & Sachdeva, R. (2013). Comparative analysis of birth weight in a hospital Over a Decade: Low birth weight still a major problem. Journal of Nepal Paediatric Society, 33(1), 15–20. https://doi.org/10.3126/jnps.v33i1.6176

Safari, Marziye et al. 2016. "The Prevalence and Related Factors of Low Birth Weight." Shahrekord University of Medical Sciences 3(3): 214–21.

Sania, A., Spiegelman, D., Rich-edwards, J., Hertzmark, E., Mwiru, R. S., Kisenge, R., & Fawzi, W. W. (2015). Original Article The contribution of preterm birth and intrauterine growth restriction to childhood undernutrition in Tanzania, 618–630. https://doi.org/10.1111/mcn.12123

Sapre, S. A., Raithatha, N. S., & Bhattacharjee, R. S. (2018). Severe anemia in late pregnancy: a retrospective study at a tertiary care rural medical college in Gujarat, India, 7(3), 1112–1115.

Smithers, L. G., Gialamas, A., Scheil, W., Brinkman, S., & Lynch, J. W. (2014). Anaemia of pregnancy, perinatal outcomes and children's developmental vulnerability: A whole-of-population study. Paediatric and Perinatal Epidemiology, 28(5), 381–390. https://doi.org/10.1111/ppe.12149

Solomons, N. W., Vossenaar, M., Chomat, A., Doak, C. M., Koski, K. G., & Scott, M. E. (2014). Stunting at birth: recognition of early-life linear growth failure in the western highlands of Guatemala, 18(10), 1737–1745. https://doi.org/10.1017/S136898001400264X

Solomons, Noel W. et al. 2015. "Stunting at Birth: Recognition of Early-Life Linear Growth Failure in the Western Highlands of Guatemala." Public Health Nutrition 18(10): 1737–45.

Stevens, G. A., Finucane, M. M., De-regil, L. M., Paciorek, C. J., Flaxman, S. R., Branca, F., & Peña-rosas, J. P. (2012). Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995 – 2011: a systematic analysis of population-representative data, 16–25. https://doi.org/10.1016/S2214-109X(13)70001-9

Sujendran, S., Senarath, U., & Joseph, J. (2015). Nutritional Disorders & Therapy Prevalence of Stunting among Children Aged 6 to 36 Months, in the Eastern Province of Sri Lanka, 5(1), 1–6. https://doi.org/10.4172/2161-

Svefors, P., Rahman, A., Ekström, E., & Khan, A. I. (2016). Stunted at 10 Years. Linear Growth Trajectories and Stunting from Birth to Pre- Adolescence in a Rural Bangladeshi Cohort. https://doi.org/10.1371/journal.pone.0149700

Tandu-Umba, B., & Mbangama, A. M. (2015). Association of maternal anemia with other risk factors in occurrence of Great obstetrical syndromes at university clinics, Kinshasa, DR Congo. BMC Pregnancy and Childbirth, 15(1), 1–6. https://doi.org/10.1186/s12884-015-0623-z

Tay, S. C. K., Agboli, E., Abruquah, H. H., & Walana, W. (2013). Malaria and Anaemia in Pregnant and Non-Pregnant Women of Child-Bearing Age at the University Hospital, 2013(September), 193–200.

Teivaanm, T. (2015). Transition between stunted and nonstunted status: both occur from birth to 15 years of age in Malawi children, 1278–1285. https://doi.org/10.1111/apa.13060

Teshome, A., & Yitayeh, A. (2016). Relationship between periodontal disease and preterm low birth weight: Systematic review. Pan African Medical Journal, 24, 1–10. https://doi.org/10.11604/pamj.2016.24.215.8727

Tiruneh, Fentanesh Nibret, Kun-yang Chuang, and Ying-chih Chuang. 2017. "Women ' s Autonomy and Maternal Healthcare Service Utilization in Ethiopia." : 1–12.

Umeh, J. C., Inyang-Etoh, P. C., Okpokam, D. C., & Otu-Bassey, I. B. (2018). Malaria and hookworm co-infection and their effects on anaemia of pregnant women attending ante-natal clinic in University Teaching Hospital, Calabar, Nigeria. Asian Journal of Medical Sciences, 9(3), 27. https://doi.org/10.3126/ajms.v9i3.19294

Victora, C. G., Villar, J., Barros, F. C., Ismail, L. C., Chumlea, C., Papageorghiou, A. T., … Bhutta, Z. A. (2015). Anthropometric Characterization of Impaired Fetal Growth Risk Factors for and Prognosis of Newborns With Stunting or Wasting, 169(7), 1–10. https://doi.org/10.1001/jamapediatrics.2015.1431

Villamor, E., & Cnattingius, S. (2016). Interpregnancy Weight Change and Risk of Preterm Delivery, 24(3), 727–734. https://doi.org/10.1002/oby.21384

Wagura, P., Wasunna, A., Laving, A., Wamalwa, D., & Ng, P. (2018). Prevalence and factors associated with preterm birth at kenyatta national hospital, 2–9.

Wardlaw, T. (2004). COUNTRY, REGIONAL AND GLOBAL ESTIMATES OF LOW BIRTHWEIGHT.

Wei, Y., Lin, L., Zhu, W., Yang, H., Su, R., Wang, C., & Feng, H. (2018). Prevalence, risk factors and associated adverse pregnancy outcomes of anaemia in

Chinese pregnant women: a multicentre retrospective study. BMC Pregnancy and Childbirth, 18(1), 1–8. https://doi.org/10.1186/s12884-018-1739-8

WHO | Stunting in a nutshell. (2015). WHO. Retrieved from http://www.who.int/nutrition/healthygrowthproj_stunted_videos/en/. Accessed on 26th. May,2019

WHO. (1995). WHO Technical Report Series 854. Physical status: the use and interpretation of anthropometry,Report of a WHO Expert Committee

WHO. (2008). Training Course on Child Growth Assessment,WHO Child Growth Standards. ISBN: 92 4 159507 8

WHO Guidelines on Drawing Blood: Best Practices in Phlebotomy. Geneva: World Health Organization; 2010. 2, Best practices in phlebotomy. Available from: https://www.ncbi.nlm.nih.gov/books/NBK138665/. Accessed on 12th. April, 2019

WHO. (2011). THE GLOBAL PREVALENCE OF ANAEMIA IN 2011.

Guideline: Daily Iron and Folic Acid Supplementation in Pregnant Women. Geneva: World Health Organization; 2012. Recommendation. Available from: https://www.ncbi.nlm.nih.gov/books/NBK132250/. Accessed on 7th. June, 2019

WHO. (2015). the Global Prevalence of Anaemia in 2011. Document, 1–43. https://doi.org/10.1017/S1368980008002401. Accessed on 7th. June, 2019

World Bank (2013). The Global Burden of Disease: Main Findings for Sub-Saharan Africa. Available from [http://www.worldbank.org/en/news/feature/2013/09/09/global-burden-of-disease-findings-for-sub-saharan-africa} (accessed on 08 May 2019)

World Health Organization. (2014). Global Nutrition targets 2015 Anaemia Policy Brief. Global Nutrition Targets 2025, 2(WHO/NMH/NHD/14.4), 8. https://doi.org/WHO/NMH/NHD/14.4

Zerfu, T. A., Umeta, M., & Baye, K. (2016). Dietary diversity during pregnancy is associated with reduced risk of maternal anemia, preterm delivery, and low birth weight in a prospective cohort study in rural Ethiopia. The American Journal of Clinical Nutrition, 103(6), 1482–1488. https://doi.org/10.3945/ajcn.115.116798

Zhou, S., Tao, Y., Huang, K., Zhu, B., & Tao, F. (2017). Vitamin D and risk of preterm birth: Up-to-date meta-analysis of randomized controlled trials and observational studies, 43(2), 247–256. https://doi.org/10.1111/jog.13239

Zini, Mudiaga E., and Lawrence O. Omo-Aghoja. 2019. "Clinical and Sociodemographic Correlates of Preterm Deliveries in Two Tertiary Hospitals in Southern Nigeria." Ghana medical journal 53(1): 20–28.

APPENDIX

A. CONSENT TO PARTICIPATE IN A RESEARCH STUDY INFORMATION SHEET

Title of Research Study: Impact of Anaemia in the third trimester of pregnancy on birth outcomes
Principal Investigators: Martin Nyaaba Adokiya (PhD); Gideon Nyaaba Abodoon (BSc)
Category of Participants: Pregnant women ≥ 33 weeks of gestation

Introduction/purpose of the study

I am a student of the University for Development Studies and I am conducting a research study on the topic "Impact of anaemia in the third trimester of pregnancy on birth outcomes in Tatale-Sanguli and Zabzugu Districts, Ghana". A research study is a way to learn more about people. If you decide that you want to be part of this study, you will be asked to provide your sociodemographic and economic data, health services received and related information, dietary information, and data on the birth outcomes of your pregnancy will be obtained at the point of delivery. Any information obtained is for the purposes of fulfilling the requirements of the academic research in the MSc/MPhil programme. The study will contribute to the knowledge gap on prevailing anaemia prevalence in the two districts. In addition, it will provide information on the impact of anaemia in pregnancy and birth outcomes. Finally, new knowledge will be useful in guiding sub-national level policymakers.

Study Procedure

The study will interview pregnant women who are in their third trimester (≥ 33 weeks of gestation). They must be 18 years and above and must be registered for antenatal care. The pregnant women will be interviewed using a questionnaire which will take about 45 minutes to answer all the questions. Also, key maternal health indicators relevant to the study, and health services received by the mother will be extracted from the maternal health record booklet on to the questionnaire. Pregnant women are expected to be candid in their responses to the questions. Data on birth outcomes will be measured and recorded by the midwives conducting deliveries at the health facility.

Benefits/Risks of the study

There is a slight risk that you may share some personal or confidential information by chance, or that you may feel uncomfortable talking about some lifestyles especially your food practices. However, I do not wish for this to happen, and you may refuse to answer any question or not take part in the interview if you feel uncomfortable. There is no direct benefit in taking part in this study. A benefit means that something good happens to you. Your participation is likely to help save the lives of many pregnant women by using the information given in the development of strategies that will improve maternal and newborn health

Confidentiality

A number will be assigned to you and so your name will not be recorded during the interview process. Your information will be collected and written down for our analysis. The information about you will be stored in a file that will not have your name written on it, but a number assigned to it instead. The information that we collect from you will be kept private. Your data will be secured from unauthorized access. When we are finished with this study, we will write a report about what was learned. This report will not include your name or that you were in the study.

Compensation

Should you agree to participate in the study, there will be no payment (either in cash or in-kind) for your participation in the study. In the event of any injury resulting directly from your participation in the study, the principal investigator will assess the situation, and together with the respondent arrive at an agreed solution. There will be no anticipated expenses on the part of the respondent for participating in the study.

Withdrawal from study

Your participation is voluntary, and it is up to you to participate or not. The choice that you make will have no bearing on your medical care in any health facility in the Tatale-Sanguli and Zabzugu Districts. You can withdraw your consent at any time, without stating any reasons and without any disadvantage for your medical care. You do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too. If the interviewer determines that your responses are not appropriate for the study s/he may terminate the interview.

Questions

Participants in the study have the full right to ask questions and to receive satisfactory answers in line with the study. Participants with questions or concerns regarding the study and their rights in the event of study-related injury may contact the study team through the information provided below.

Please contact the Principal Investigator or Local Investigator at the following addresses if you have any further questions, need clarifications about your rights or experience any problems in this study.

Gideon Nyaaba Abodoon (BSc)
Ghana Health Service,
DHA Box 4, Tatale-Sanguli District
0202819315
Email: abodoonnyaaba@yahoo.com

Martin Nyaaba Adokiya (PhD)
Department of Public Health,
UDS Box 118,
Tamale Campus.
Cell phone: 0509044041
Email: myaaba11@gmail.com

Mr Cletus Tindana
Chair-Ethical Committee
Navrongo Health Research Centre
0244712474
Email: Cletus.tindana@navrongo-hrc.org/tindana@gmail.com

CONSENT TO PARTICIPATE IN A RESEARCH STUDY
CONSENT FORM

Signature of a volunteer willing to participate

"I have read or have had someone read all of the above, asked questions, received answers concerning areas I did not understand and am willing to give consent for me, to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records"

Name:_____

Signature/thumbprint of participant/his/her Legal representative

Witness to Consent Procedures **(Anybody who is not affiliated with the study)**
Name:
Signature

The investigator or attending Health Care Professional's Affidavit
"I certify that I have explained to the above individual (s) the nature and purpose of the study, potential benefits and possible risks associated with the participation in this research project. I have answered any questions that have been raised and have witnessed the above signature on the date indicated below"

Name: _____
Signature: Date:

B. QUESTIONNAIRE

TOPIC: Impact of Anaemia in Third Trimester of Pregnancy on Birth Outcomes in Tatale-Sanguli and Zabzugu Districts, Northern Region

NUMBER	QUESTION	PARTICIPANT'S RESPONSE (S)
SECTION A. SOCIO-DEMOGRAPHIC CHARACTERISTICS		
1.0	Unique code number	_____
2.0	District of the respondent	Tatale Zabzugu
3.0	What is the name of the community where you live?	_____ _____
4.0	What is the age of pregnant woman in completed years?	_____ _____
5.0	What is the height of the pregnant woman at registration as recorded in the antenatal care booklet?	Height in centimeters_____ ___
6.0	What is the weight of the pregnant woman in kilograms at registration? Record only weight before the 12th. Week of gestation	Weight in kilograms_____ Not applicable
7.0	What is the highest level of school you attended?	Primary Middle JSS/JHS SSS/SHS Higher No education
8.0	What is your marital status?	Single Married Cohabitation. Divorced/widow
9.0	In addition to this current pregnancy, how many pregnancies have you had?	_____ _____
10.0	Have you ever lost any of your previous pregnancies?	Yes No Do not know
11.0	Age of pregnancy at registration in weeks as recorded in the antenatal care booklet	_____
12.0	What is the Parity as recorded in the antenatal care booklet?	_____
13.0	What is the current age of pregnancy in weeks (≥ 33)?	33 34 35 36 37 38+

SECTION B. PREVALENCE OF ANAEMIA AMONG PREGNANT WOMEN IN the THIRD TRIMESTER		
14.0	What is the Hemoglobin/dl at registration as recorded in the antennal care booklet?	_____
15.0	What is the current Hemoglobin/dl?	_____
SECTION C. SOCIO-ECONOMIC FACTORS INFLUENCING ANAEMIA IN PREGNANCY		
16.0	**What work do you do to earn a living?**	**Salary worker** **Trader** **Farming.** **Unemployed** **Other (specify)**
17.0	Who usually make decisions about making major household food purchases?	Self Husband/partner Self and husband/partner jointly Someone else (specify)_____
18.0	What type of house do members of the household dwell in?	Blockhouse Brick house Mud house Others (specify)_____
19.0	How do you dispose of waste from your home? (circle all that apply)	Waste collection dustbins Dugout and bury when it is full. Open space in front of the house River/stream/pond
20.0	What kind of toilet facility do members of the household usually use?	Flush or pour-flush toilet flush to the piped sewer system flush to the septic tank flush to the pit latrine flush to somewhere else flush, don't know where Pit latrine ventilated improved pit latrine pit latrine with slab pit latrine without slab/open pit Bucket toilet hanging toilet/hanging latrine No facility/bush/field

		Other(specify)_____ _____
21.0	What is the source of lighting for the household?	Electricity Gas Kerosene straw Others(specify)_____ _____
22.0	What type of fuel does your household mainly use for cooking?	Electricity LPG Charcoal Kerosene Firewood Straw/shrubs/grass Other (Specify)_____
23.0	What is the main source of drinking water for members of the household?	Piped water piped into dwelling piped to yard/plot public tap/standpipe Tube well or borehole Dug well protected well unprotected well Water from spring protected spring unprotected spring Rainwater Tanker truck Cart with small tank Surface water (river/dam/lake/pond/stream/canal/irrigation channel) Bottled water Sachet water Other (specify)_____ __
24.0	Where is that water source located?	In own dwelling In own yard/plot Elsewhere
25.0	Do you do anything to the water to make it safer to drink?	Yes No Don't know
26.0	If yes to question 26 what do you usually do to make the water safer to drink?	Boil Add bleach/chlorine/alum Strain through a cloth Use water filter (ceramic/

		Sand/composite/etc.) Solar disinfection Let it stand and settle Camphor/ naphthalene Purification tablet Other (specify)_____ _____ Don't know
27.0	How does your household store drinking water?	Plastic container/bucket Pot/earthenware vessel metal container Bottle/sachet Other (specify)_____ __ Don't know
SECTION D. FACTORS INFLUENCING ANAEMIA AMONG PREGNANT WOMEN: ANC EDUCATION, IFA ADHERENCE, MALARIA PREVENTION AND DEWORMING		
28.0	Who usually makes decisions about health care for yourself?	Self Husband/partner Self and husband/partner jointly Someone else (specify)_____
29.0	Does your husband usually accompany you for antenatal care visits?	Yes No Do not know
30.0	How many times have you visited this facility or other facility for antenatal care?	_____ _____
31.0	During your antenatal care visits, were you told about dietary indicators that might suggest a problem with your pregnancy?	Yes No Do not know
32.0	During this pregnancy, were you given Iron folic acid tablets or syrup?	Yes No Prescription to buy Do not know
33.0	During this pregnancy, were you asked to buy Iron folic acid tablets or syrup?	Yes No Do not know
34.0	Observe the composition of the iron and folic acid tablets/ syrup If question 33 is yes.	Only multivitamins supplied. Combined (fe3) supplied Folic acid with multivitamin without iron. Only iron fesulate Not applicable
35.0	Have you received counselling on the benefits of consuming iron and folic acid from the health	Yes No

	worker?	
36.0	If yes to question 36, can you mention benefits for consuming iron and folic acid? **Circle all that apply**	Prevent anaemia. Help baby develop fully without deformities Baby will gain adequate weight They told me nothing
37.0	Do you have challenges consuming the iron and folic acid?	Yes No
38.0	If yes to question 38, what are these challenges? **Circle all that apply.**	Fear that child will grow big. Vomiting Smell not good. Drugs are plenty. Do not know why I should take the IFA Not applicable
39.0	Were you told of these challenges by the health worker before you were given or asked to buy?	Yes No Do not know
40.0	If yes to question 40, were you taught how to manage these challenges by the health worker?	Yes No Not applicable
41.0	What are the traditional supplements for preventing anaemia in your community that you use? **Circle all that apply**	Tin tomatoes mixed with malt Boiled teak leaves mixed with milk and added sugar Cooking food using Yaa asantewa (turkey berries) Cooking food with dawawdawa Boiled getropher leaves, add milk and sugar Other
42.0	If question 42 applies, how often do you take these supplements?	Always Sometimes Other. Specify_____
43.0	Do you have challenges taking these supplements if 43 applies?	Yes No
44.0	Will you prefer traditional supplements or the iron and folic acid?	IFA Traditional supplements Both None
45.0	In the last few months have you: a) Heard about anaemia in pregnancy on the radio/Information centre? b) Seen anything about anaemia in pregnancy on the television? c) Read about anaemia in pregnancy in a	Radio/Information centre Television Newspaper or magazine Never heard about anaemia in pregnancy Other (specify)_____

	newspaper or magazine?	
46.0	Have you received counselling on malaria prevention before?	Yes No Do not remember
47.0	During this pregnancy, did you take any drug to stop malaria?	Yes No Don't know
48.0	What drug did you take?	SP/ fancidar Chloroquine Other (specify)_____ Do not know
49.0	How many times did you take (SP/Fansidar) during this pregnancy?	_____times
50.0	IPT supply status (check records on antenatal care booklet). dose per term.	Respondent given recommended Respondent not given
51.0	Do you own an insecticide-treated net at home?	Yes No
52.0	If yes to question 52, did you sleep in the mosquito's net the previous night?	Yes No Do not know
53.0	Do you have any challenge sleeping under the mosquito net at home?	Yes No
54.0	Do you use other mosquito repellants?	Yes No
55.0	If yes to question 55, please list type of repellants?	_____
56.0	During this pregnancy, did you take any drug for intestinal worms? (check deworming status from ANC booklet)	Yes No Do not remember
SECTION E. FACTORS INFLUENCING ANAEMIA IN PREGNANCY: MINIMUM DIETARY DIVERSITY SCORE-WOMEN		
57.0	Did you receive counselling on what to eat now that you are pregnant?	Yes No Do not know
58.0	What kinds of food did the health worker tell you to be eating?	Varieties of foods especially iron-rich foods Foods that I have an appetite for eating. That I should always eat well
59.0	How many times do you usually eat in a day?	Once a day with/out a snack Twice a day with/out a snack Thrice a day with/out a snack Four times a day with/out a snack (indicate as

		appropriate)
24HR dietary recall: Tell me all the food you ate from yesterday in the morning till today (indicate against the food group).		
60.0	**Foods prepared from grains, white roots and tubers, and plantain**: Bread, rice, noodles, porridge, kenkey, banku, Koko, tuo zaafi, akple, white potatoes, yam, cassava, cocoyam, plantain	Yes No
	Vitamin A rich fruits and vegetables: Pumpkin, carrots, squash or sweet potatoes that are yellow or orange inside?	Yes No
	Dark green leafy vegetables: Any dark green, leafy vegetables, such as kontomire, aleefu, ayooyo, kale, cassava leaves, Ripe mangoes or pawpaw?	Yes No
	pulses: soybeans, peas and lentils	Yes No
	Meat, poultry and fish: meat, such as beef, pork, lamb, goat, chicken, or duck, organ meat: liver, kidney, heart or other organ meat, fresh or dried fish or shellfish?	Yes No
	Eggs	Yes No
	Dairy products: milk (fresh), processed milk (tinned, powdered), yoghurt, wagashi	Yes No
	Other vegetables	Yes No
	Other fruits	Yes No
	Nuts and seeds: groundnuts koose, cowpea, kuli kuli, Neri, agushie, etc	Yes No
61.0	Are there foods in your community that you taboo to eat because you are pregnant?	Yes No
62.0	If yes to question 62, please list them	_____
SECTION F: DATA ON BIRTH OUTCOMES		
63.0	Unique coded number on antenatal care booklet	_____
64.0	Mode of delivery_____	Caesarean section Normal virginal
65.0	Delivery outcome_____	Live birth. Stillbirth
66.0	Sex of baby_____	Male Female
67.0	Birthweight in kilograms (kg) of the new born	Birthweight_____ _kg Not applicable
68.0	Birth length in centimeters (cm) of new born	Length_____cm Not applicable
69.0	Head circumference in centimeters	Head circumference (cm)_____

		Not applicable
70.0	Term of delivery_____	Full term. Preterm Not applicable
71.0	What is the Apgar score?	1minute_____ 5minutes_____ Not applicable

C. CONTACT INFORMATION SHEET

NAME OF DISTRICT_____

NAME OF SUBDISTRICT_____

NAME OF PREGNANT WOMAN	COMMUNITY NAME	HOUSE NAME/ADDRESS	GESTATION (WEEKS)	CONTACT NUMBER	PREFERRED FACILITY	VOLUNT CONTAC

D. BIRTH OUTCOME DATA SHEET

NAME OF FACILITY CONDUCTING DELIVERY_____

TYPE OF FACILITY_____

Unique coded number on ANC booklet	Mode of delivery	Delivery outcome (live/stillbirth)	Sex (M/F)	Birthweight (kg)	Birth length (cm)	Head circumference (cm)	Gestation in weeks at delivery	Apgar score (Imin)	Apgar score (5min