ENSIGN GLOBAL COLLEGE, KPONG

EASTERN REGION, GHANA

AN ASSESSMENT OF THE PREVALENCE AND RISK FACTORS OF IRON DEFICIENCY ANAEMIA AMONG ADOLESCENT GIRLS AT MADINA POLYCLINIC

IN THE GREATER ACCRA REGION OF GHANA

BY

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DECLARATION

The research work described in this thesis was performed at Ensign Global College. This work has not been submitted for any other degree. Information taken from other works has been duly acknowledged.

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DEDICATION

This work is dedicated to my heavenly father for taking me through this long journey. His grace

has been my source of strength. To my wonderful Board Chairman, Mr Cecil Osae-Kwapong, for supporting me through this program, and my earthly father, who is with the Lord, Engr. Mr Delex Papa Kwasi Arko for his support and encouragement before pursuing this program. To Mr Albert Mantey, words cannot explain how happy I am for your kind heart in providing funds to pay for this research work.

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I wish to express my sincere appreciation to the Almighty God who spared me

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LIST OF ABBREVIATIONS

ATP – Adenosine Triphosphate

ANC – Antenatal care

BMI – Body Mass Index

CBC – Complete Blood Count

DNA – Deoxyribonucleic Acid

EDHS – Ethiopian Demographic Health Survey

GDP – Gross Domestic Product

GHS – Ghana Health Service

H.B. – Haemoglobin

HIV – Human Immunodeficiency Virus

ID – Iron Deficiency

IDA – Iron Deficiency Anaemia

IRB – Institutional Review Board

L.I – Legislative Instrument

MCH – Mean Cell Haemoglobin

MCHC – Mean Cell Haemoglobin Concentration

NHIS – National Health Insurance Scheme

NCD – Non-communicable Diseases

NCCE – National Commission for Civic Education

NFHS – National Family Health Survey

OPD – Outpatient Department

PCV- Packed Cell Volume

RDA – Recommended Daily Allowance

RBC – Red Blood Cell

Rh – Rhesus

S.F. – Serum Ferritin

TIBC – Total Iron Binding Capacity

UNICEF – United Nations International Children Emergency Fund

WHO – World Health Organization

ABSTRACT

Introduction: Iron is found in every living cell and is involved in various metabolic activities, including oxygen transport and storage. The adolescent age is a particularly unique period in life because of its responsibility in contributing to intense physical, psychosocial, and cognitive development. UNICEF reports two billion people to suffer from anaemia globally, with a high number diagnosed with IDA, especially in underdeveloped/developing countries, where 40 to 50% of children under age 5 are iron deficient. Iron deficiency anaemia is a globally considered public health significance and is a major public health problem in many parts of the world.

Objectives: This study aimed to assess the prevalence and risk factors of iron deficiency anaemia among adolescent girls at Madina Polyclinic in the Greater Accra Region of Ghana.

Methods: A cross-sectional study was used to gather the needed data on potential risk factors that may result in iron deficiency anaemia in an adolescent girl child. Microsoft Excel was used as a tool for the input of the raw data before transferring it to Stata. Data were cleaned and summarized using medians, proportions, T-test mean comparison, and Chi-square test using Stata software to compare the variables. The Ethical Review Committee approved the ethical clearance, the Regional Health Directorate, and the LADMA before commencing the research.

Results: The analysis revealed that among the 45.8% of girls diagnosed with anaemia, about 10% are also iron deficient. Stating the converse, 50% (12) are also anaemic among the girls diagnosed with iron deficiency. From the sample of 263 adolescent girls, those who were diagnosed with Iron Deficiency Anemia (IDA) are 12 teenage girls corresponding to about 4.56%. In summary, 4.56% of the adolescent girls in the sample may be diagnosed with Iron deficiency anaemia, 45.8% may be considered anaemic, and 9% may be regarded as iron deficient. Moreover, IDA is more prevalent among girls in the upper adolescent age group, those in secondary school.

Conclusion: The present study reveals that anaemia among adolescent girls is a major health problem at the Madina Polyclinic. However, IDA was not the major cause of anaemia among adolescent girls at the Madina Polyclinic.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Anaemia is a condition marked by abnormally low levels of red blood cells, resulting in impaired oxygen supply to the body's organs and tissues (Lacerda *et al.*, 2016).

Adolescence is a developmental phase of growth and development between childhood and adulthood (WHO, 2015). An increase in dietary requirements is related to teenagers' up to 50% weight growth, more than 20% adult height rise, and 50% adult skeletal weight gain throughout their maturation period (Miah et al., 2014). World Health Organization (WHO) defines the adolescent years from age 10 to 19 as a formative phase in which both boys' and girls' futures are shaped (Patton *et al.*, 2016). About one-fifth of the world's population (1.2 billion teenagers) lives in this age group, which is steadily growing (WHO). More than a fifth of them (five million) reside in underdeveloped countries (WHO, 2011a). More than a third of Ghana's population is under 24 (GSS,2015). About 22.0 per cent of Ghana's population is under the age of 18 years, making it one of the youngest countries globally (GSS, 2015).

According to research conducted in the United States, iron deficiency anaemia is common, affecting 11% of teenage females and 9% of toddlers (McCann and Ames, 2007). It is identified that some consequences of IDA are exercise intolerance, stunted growth, behavioural changes, and abnormal thermogenesis (Shinton, 1998). Although the prevalence of IDA has reduced in the second world countries, there have been few changes globally (Shinton, 1998). Two billion people suffer from anaemia globally, and most are

IDA-related. IDA is predominant in underdeveloped/developing countries. 40 to 50% of children under 5 are iron deficient (Al-Sayes *et al*., 2011).

Adolescents worldwide encounter various nutritional challenges, including undernutrition, obesity, and intrauterine growth retardation in pre-adolescent females (Balci *et al.*, 2012).

Iron deficiency is the underlying cause of anaemia in between 20% and 50% of cases, according to studies conducted worldwide (Pektaş, Aral and Yenisey, 2015). In many developing countries, anaemia is a major public health issue that necessitates long-term efforts to combat it, particularly in rural areas. Increased levels of haemoglobin (11.5 g/dl), decreased mean corpuscular volume, and altered mean corpuscular haemoglobin concentration (MCH) are signs of iron deficiency anaemia (IDA) (Pippard, 2017). Many people in underdeveloped nations suffer from iron deficiency anaemia compared to those in developed countries (World Health Organization, 2011a). During adolescence, rapid growth, hormonal changes, starvation, and the onset of menstruation in females. A lack of iron can induce cognitive impairment and learning difficulties, affecting one's ability to perform well in school (Balci *et al.*, 2012). Adolescents in developing countries are more likely to be undernourished because of a lack of economic stability, frequent food shortages, child labour as a marker of poverty, and a lack of knowledge about the long-term consequences of undernutrition, as well as the quantity and quality of food available for them (Miah *et al*., 2014). Dietary expertise and Access to resources are essential to improve health and nutrition in the long term. Schools, recreational activities, and the media are more readily available to adolescents than they are later in life when it comes to health and nutrition knowledge. Families' future health and nutrition depend heavily on female teenagers' health and nutritional knowledge and good practices (Miah *et al*., 2014).

Children born undernourished by mothers who do not meet their nutritional requirements are likely to be passed down from generation to generation (Miah *et al*., 2014). The high rate of maternal mortality, the prevalence of low-birth-weight babies, the high rate of prenatal mortality, and the ensuing high fertility rates all contribute to the nutritional anaemia of teenage girls (Miah *et al*., 2014). Adolescence is crucial because the growing body of information shows that pregnant women can more easily regulate their anaemia if they maintain a healthy iron level (Kaur, 2018). Young women are deprived of the opportunity to mature to their full genetic potential when they become pregnant during their teens (Pathak *et al.*, 2003). Improving the nutritional status of adolescent females before they get pregnant can help break the malnutrition cycle generation after generation. There will be more severe consequences if the vicious cycle of malnutrition is not ended (Miah *et al*., 2014).

Studies on pregnant women and young children make up most of the research on IDA (Petry *et al.*, 2021; Pobee *et al.*, 2021). Given this, there is a lack of information on the prevalence of IDA in adolescent girls. Aiming to identify and analyze the possible risk factors for IDA, such as demographic, socioeconomic, and nutritional status, among adolescent girls to understand better how these factors may affect their risk of developing the disease.

1.2 Problem Statement

Adolescent females constitute about one-fifth of the total female population in the world (Mohite *et al.*, 2013). Adolescence is one of the most difficult chapters in human development (Mohite *et al.*, 2013). Typically, adolescents struggle to meet their dietary needs. It is important to know how to intervene throughout their growth and development, promote physical and mental growth, and avoid future cases of maternal anaemia (Olumakaiye, 2013). Some nutritional needs are greater in teenagers than in other stages of life (Olumakaiye, 2013).

During adolescence, the iron requirement is double that of younger age groups. Female adolescent iron requirements rise by two to three times from pre-adolescent levels of roughly 0.7-0.9 mg/day to 1.40-3.27 mg/day (Milman, 2011b). Red cell iron loss during menstruation is between 12.5 and 15 mg per month or between 0.4 and 0.5 mg per day. It is also characterized by a growth surge; the risk of I.D. persists throughout the full reproductive age range (Milman, 2011b).

Depending on the environment, prevalence estimates for I.D. among female teenagers vary from 9 to 40%. (Hermoso et al., 2011). Global prevalence estimates for IDA among teenagers range from 30% to 55%. (Hermoso et al., 2011). Sixty-eight percent of non-pregnant Asian women and fifty-six and one-half percent of pregnant Asian women are anaemic (De Benoist et al., 2008).

Teenagers' nutritional requirements fluctuate due to their shifting lifestyles and diets (WHO, 2005). Third, adolescent nutrient demands are affected by participation in sports, pregnancy, the development of an eating disorder, excessive diet, the use of alcohol and drugs, or other events. The World Health Organization (WHO) reports that the global death rate from iron-deficient anaemia in 2005 was 60,404,000 (McLean *et al.*, 2009).

They have a high prevalence of iron deficiency anaemia due to their rapid growth and poor feeding habits paired with menstruation (Moghaddam *et al.*, 2018). Iron deficiency anaemia is guesstimated to affect more than one-third of the world's population. Ghana is one of the countries with the highest frequency of the disease. According to the National Family Health Survey (NFHS), 75% to 80% of adolescents and 70% to 80% of pregnant women are anaemic. As a result of the country's poor nutrition, iron scarcity, and long-term blood loss from parasitic infections like hookworm and malaria, anaemia is common in Ghana. In addition to the well-known physical and cognitive impacts of anaemia on humans, the actual toll of iron deficiency anaemia lies in the poor effects on the health of pregnant women and their children. Anaemia and inadequate nutrition during pregnancy may affect future generations' well-being (McLean et al., 2009).

A study to understand the contributing factors to this health condition is highly relevant to public health. It could inform policy directives on improving the health outcomes of adolescent girl children. This research aims to determine the incidence and risk factors of iron deficiency anaemia among female adolescents at the Madina Polyclinic in the Greater Accra Region of Ghana.

1.3 Rationale of Study

Anaemia is a common public health problem associated with an increased risk of morbidity and mortality (WHO, 2017). Anaemia is a disease with several causes, both nutritional (vitamins and mineral deficiencies) and non-nutritional (infection), that frequently might appear (World Health Organization, 2017).

Anemia also impairs educational achievement and economic productivity, costing the government and families enormous amounts of money to treat related illnesses. Descriptive calculations for ten developing countries recommend that the median value of physical productivity losses annually due to I.D. is around US$2.32 per capita or 0.57% of gross domestic product (GDP). Median total losses (physical and cognitive combined) are $16.78 per capita, 4.05% of GDP. Implications for the economy of IDA are also massive (Anand *et al.*, 2014).

Anaemia and iron deficiency anaemia are indicators of poor nutrition and health (Bhanushali *et al.*, 2011). It has been associated with impaired cognitive function, decreased attention, inability to concentrate, and memory loss (Bhanushali *et al.*, 2011). Iron status and cognitive performance are currently attracting interest (Bourre, 2006).

Strategic focus on preventing IDA among adolescents is more important than productivity gains from improved physical capacity, productivity gains from increased cognitive ability, and (adolescent females) improved pregnancy outcomes and intergenerational benefits (for teenage females).

A pilot cross-sectional research was conducted with 9–19-year-old girls. The prevalence of anaemia among school-aged girls was 50.3% (Tandoh, Appiah, and Edusei, 2021), demonstrating the issue's severity and emphasising the need for immediate intervention.

Before recent years, little was known about the nutrition of teenagers, especially in low- and middle-income nations. In impoverished countries, there is a shortage of data on teenagers' nutritional status (Al-Sayes., 2011).

The teenage years are crucial for the body to undergo significant changes. Iron and folate therapies are the most successful and could serve as a model for future research to eradicate iron deficiency, according to a study conducted in Malaysia (Jalambo, Karim and Jayath, 2015).

However, no nutrition intervention program to treat I.D. and IDA and to determine its prevalence among adolescent girls has ever been carried out in the country (Jalambo, Kari and Jayath, 2015).

1.4 Conceptual Framework

A conceptual framework is a research material intended to assist the researcher in developing awareness and understanding of the situation under scrutiny and communicating it effectively and efficiently. Hence, the conceptual framework below shows the interplay of the various factors that could potentially result in iron deficiency anaemia in an adolescent girl child. This framework was carefully constructed using multiple risk factors that directly explain the prevalence of iron deficiency anaemia among teenage girls at the Madina Polyclinic.

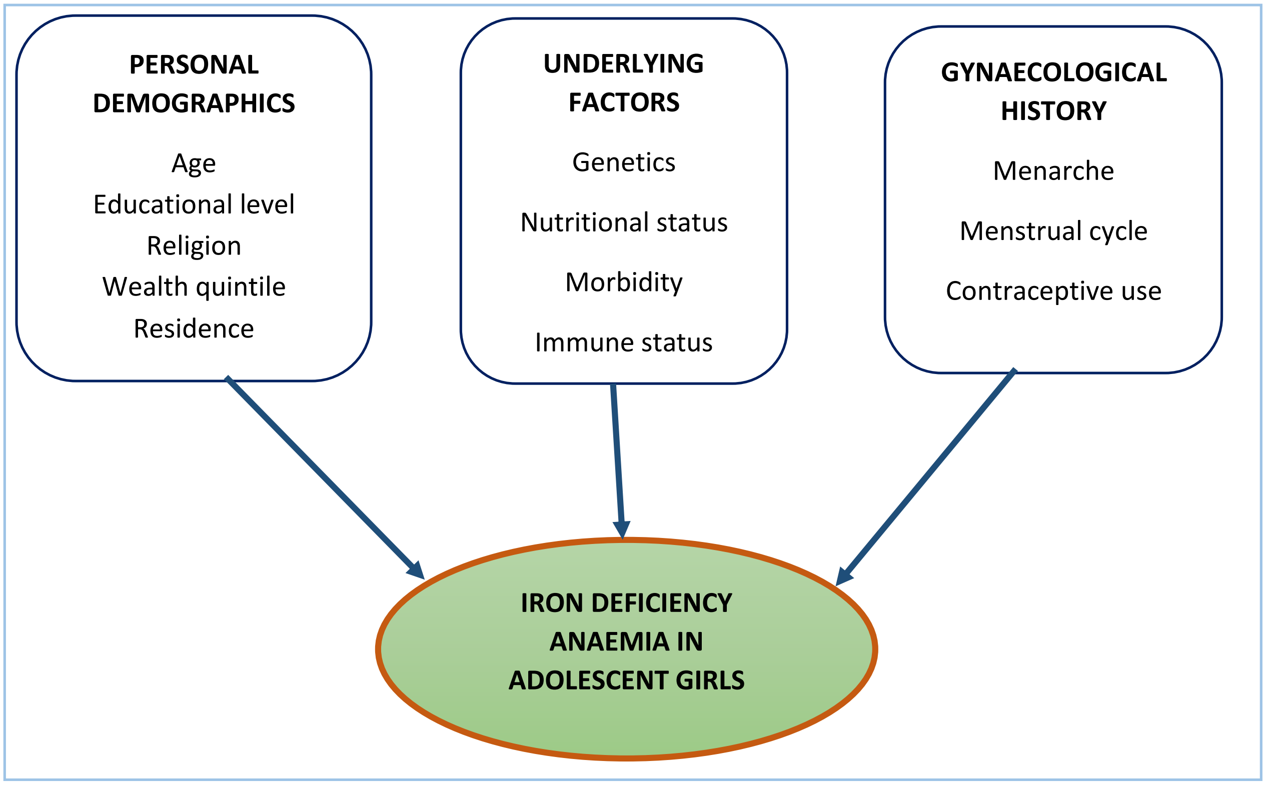

Figure 1: Conceptual Framework

Source: Author's construct.

1.5 Research Questions

1. What are the determinants of the prevalence of iron deficiency anaemia among adolescent girls?
2. What are the risk factors of iron deficiency anaemia among adolescent girls?
3. What is the relationship between the gynaecological history of adolescent girls?

1.6 General Objective

To assess the prevalence and risk factors of iron deficiency anaemia among adolescent girls at Madina Polyclinic, Greater Accra Region of Ghana.

1.7 Specific Objectives

1. To determine the prevalence of iron deficiency anaemia among adolescent girls.

2. To evaluate the gynaecological history of iron deficiency anaemia and its risk factors among adolescent girls.

3. To access the underlying risk factors of iron deficiency anaemia among adolescent girls.

1.8 Profile of Study Area

This study was conducted at the Madina Polyclinic in the La-Nkwantanang-Madina Municipal District. This district was originally part of the then-larger Ga East District until the eastern part was divided to create La-Nkwantanang-Madina Municipal District on 28 June 2012, which was entrenched by Legislative Instrument (L.I.) 2131. The last part has been retained as Ga East Municipal District. The Municipality is in the western part of the Greater Accra Region and has Madina as its capital town. The district is surrounded to the north by Akuapim South (in the Eastern Region), east by Kpone Katamanso and Adenta Municipal District, south by the Accra Metropolis District, and west by Ga East Municipal District. The sum area of the district is 70.887 square kilometres. The 2010 population Census of the community is 111,926, with 54,271 male and 57,655 female. Madina Polyclinic Kekele is a government hospital in Kekele Park, Ghana. It offers a general service. This clinic is NHIS accredited and established by an act of parliament to provide first-line health care to the people of Madina and refer when necessary to tertiary institutions providing complex services. The facility comprises of Outpatient Department (OPD), an Inpatient department (Admissions and detaining), Antenatal care (ANC); a well-structured public health unit; a Childcare unit; and a general administration within the facility. The structure is made up of the: (Administrator, Medical Director, medical officers, Matron, Pharmacist, Laboratory Scientist, Nurses, Midwives, and nursing assistants) all forming part of the organizational structure. The facility has a total staff population of about 89, who are all actively engaged as full-time workers employed by Ghana Health Service, and about 21 non-permanent staff comprising national service personnel and attachment students. The total number of inpatients received per month is approximately 540, and the out-patient is 1200 (directory.mogcsp.gov.gh).

1.9 Scope of The Study

This study emphasizes the prevalence of iron deficiency anaemia among adolescence at the Madina Polyclinic. It determines the prevalence of iron deficiency anaemia among adolescent girls at the Madina Polyclinic and assesses the underlying risk factors of anaemia among teenage girls. The study also evaluates the gynaecological history of iron deficiency anaemia and risk factors among adolescent girls at Madina Polyclinic.

1.10 Organizational Report

This study is made up of six main chapters that tackle various sections of the research.

Chapter One provides an essential aspect of the study, comprising the background of the study, the problem statement, the objectives of the research, the rationale of the study, the research questions, the profile of the study area, and the scope of the study. Chapter Two provides the literature of the study, as well as concepts and definitions providing details on iron deficiency anaemia. This review takes account of discussions, comments, and ideas by academic researchers in the topic area. Chapter Three introduces a detailed outline of the research methodology used by the researcher to arrive at the study's objective.

Chapter Four provides findings in various forms based on some indicators. Chapter Five summarizes and discusses the results gathered from the analyzed data and provides grounds for comparison of existing literature done by other researchers.

Finally, Chapter Six involves a conclusion, important recommendations, and some limitations to stakeholders for possible intervention implementation and grounds for further research in iron deficiency anaemia among adolescents at the Madina Municipality.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Anemia and Iron Deficiency Anemia

The molecule is present in practically all living cells. It is essential for metabolic processes such as the movement of oxygen throughout the body and the generation of ATP and DNA in the electron transport chain, which provides energy to the organism (Theil, 2004; Clark, 2008). According to estimates, men and women require 3.8 g and 2.3 g of iron daily. This translates to 50 mg/kg for a guy who weighs roughly 75 kg and 42 mg/kg for a girl who weighs 55 kg (Theil, 2004). The body has around 70% or more available iron, with the remaining 30% believed to be stored as ferritin or hemosiderin. The body can use about 80% of the iron as haemoglobin, which is found in red blood cells. Myoglobin or intracellular respiratory enzymes (such as cytochromes) include the 20% still present (Hogrey, 2018).

Haemoglobin levels below two standard deviations for the patient's age and gender are anaemic. Iron is a crucial component of the haemoglobin molecule (Weaver, 2019). Undernutrition in the form of stunting and thinness, catch-up growth, intrauterine growth retardation in pre-adolescent girls, iron deficiency and anaemia, iodine deficiency, vitamin A deficiency, calcium deficiency, other specific nutrient insufficiencies, zinc, folate, and obesity are the main nutrition issues affecting adolescent populations. During adolescence, iron deficiency anaemia (IDA) is the most common anaemia (Miah et al., 2014). The main reasons for this time are accelerated growth, hormonal changes, starvation, and the beginning of a girl's menstrual cycle. Iron deficiency is the most frequent cause of anaemia worldwide, which results in microcytic. The peripheral smear had hypochromic red cells. Due to the importance of iron to the operation of several organs, the iron shortage may lead to impaired perception and learning problems, resulting in decreased academic achievement (Balci et al., 2012). Multiple iron deficiency reasons vary by age, gender, and socioeconomic situation (Long and Koyfman, 2018). Iron deficiency is the most significant cause of anaemia on a global scale (I.D.). The onset of anaemia due to iron deficiency represents around 50% of all occurrences of anaemia globally (McLean et al., 2009). Both malnutrition and bad circumstances cause anaemia. Due to fast development and physical changes, increased iron needs, an enhanced incidence of infection and helminth infestation, early marriage and teenage pregnancy, recurring food issues are the leading cause of anaemia throughout adolescence (Kambarami, Schmale and Namaste, 2018).

Severe bleeding, acute and ongoing infections, low iron consumption, and poor iron absorption all contribute to iron deficiency. Parasite infections such as (malaria, TB, and Human Immunodeficiency Virus) may reduce blood haemoglobin levels, i.e., vitamin A and B12, folate, riboflavin, and copper deficiency raises the risk of anaemia (McLean et al., 2009). Other research indicates that the prevalence of anaemia among teenage females varies from 78.5% to 78.8%. (Habtegiorgis et al., 2022). Teenage anaemia may harm cognitive function, development, adolescent pregnancy, maternal health, maternal mortality, and newborn outcomes (WHO, 2011a). Moreover, via its effect on mental and occupational performance, anaemia may affect the nation's present and future economic output (Maqbool et al., 2019). In developing countries, poor household financial conditions, periodic food shortages, child labour (a marker of household income-poverty), the burden of disease, insufficient knowledge about the long-term consequences of adolescents' undernutrition, Access to health and nutrition services, as well as the amount and quality of food are associated with adolescents' undernutrition (Moise et al., 2017). Initiatives to prevent anaemia concentrate on newborns, young children, and pregnant and breastfeeding mothers, not teenagers. Consequently, the effects of teenage anaemia continue to be significant (WHO, 2010).

Clients who report feeling weary or short of breath after exerting themselves are examples of nonspecific complaints. Iron supplements and addressing the underlying cause of the disease are used to treat this problem. While oral iron supplements are widely available, intravenous iron may be necessary for certain circumstances. An iron deficiency has been linked to a lengthier hospital stay and more patient complications (Wawer et al., 2018). Iron plays an essential role in a wide variety of metabolic processes and is critical to almost all forms of life (Naigamwalla et al., 2012).

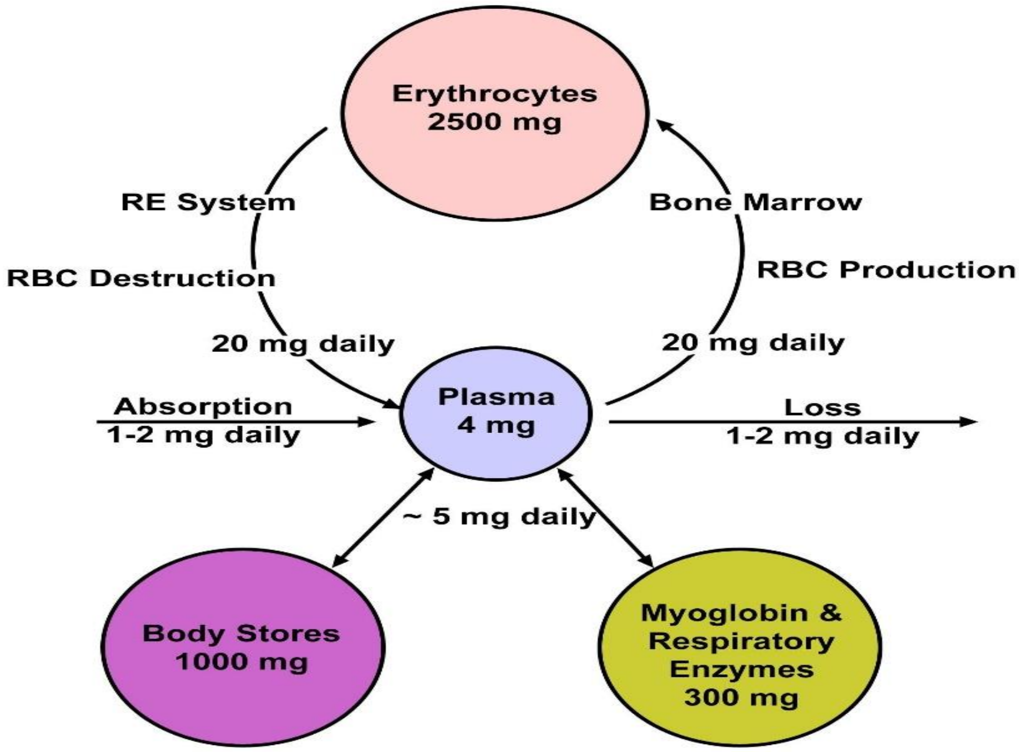

Figure 2.1: Iron transportation into cells

Source: Medscape

2.2 Iron Deficiency Anaemia

The deficit in iron In some regions of the globe, anaemia is a disorder often regarded as having public health relevance (Milman, 2011a). It may be visible at any point of the life cycle but is more common during pregnancy and in young children (Al-Sayes et al., 2011). Nearly half of all anaemias globally are estimated to be caused by iron deficiency, according to the WHO (Acham, Tumuhimbise and Kikafunda, 2013; HOGREY, 2018). The most prevalent kind of malnutrition, iron deficiency, affects 1.62 billion people worldwide, or 28.4% of the world's population (Stoltzfus, 2001). From 1990 to 2010, iron deficiency anaemia was one of the top 7 causes of anaemia, accounting for 8.8% of all years lived with disability globally (Kassebaum et al., 2014). Additionally, it was responsible for 35,057,000 lost disability-adjusted life years and 841,000 deaths (Stoltzfus, 2001).

Anaemia affects around 40.7% of the population in Africa (McLean et al., 2009). Due to the observed high frequency of anaemia, Ghana has major public health implications. According to the most recent demographic health census, adolescent girls (15–19 years old) had the greatest incidence of anaemia (47.3%) among Ghanaian women aged 15–49. (GSS, 2015). There are three stages to the body's iron shortage. The first phase starts when the body records a low level of iron, followed by iron loss, which ultimately leads to the development of iron deficiency anaemia in iron-deficient erythropoiesis (Clark, 2008). Iron deficiency anaemia in a person is diagnosed using several criteria. Serum iron concentrations have been used for years to estimate the body's iron reserves (Beutler and Waalen, 2006). Serum iron levels often fall in cases of iron insufficiency.

Tests for haemoglobin, which are used in haematology and are based on the properties of (red blood cells, breadth of the dispersion of red blood cells, average cell volume, haemoglobin level, and hematocrit level), as well as biochemical tests such as serum ferritin levels, erythrocyte protoporphyrin concentrations, It is used to measure transferrin saturation and transferrin concentration (WHO, 2011b). Biochemical tests are utilised to identify early changes in iron status. The indices haemoglobin and hematocrit measure the quantity of accessible iron in the body. Haemoglobin measures the amount of iron-containing protein in circulating red blood cells. The fraction of whole blood made up of red blood cells is more directly and accurately measured by the hematocrit (also known as packed cell volume, or PCV). Hematocrit and haemoglobin identify iron deficits in their latter phases (WHO, 2011b).

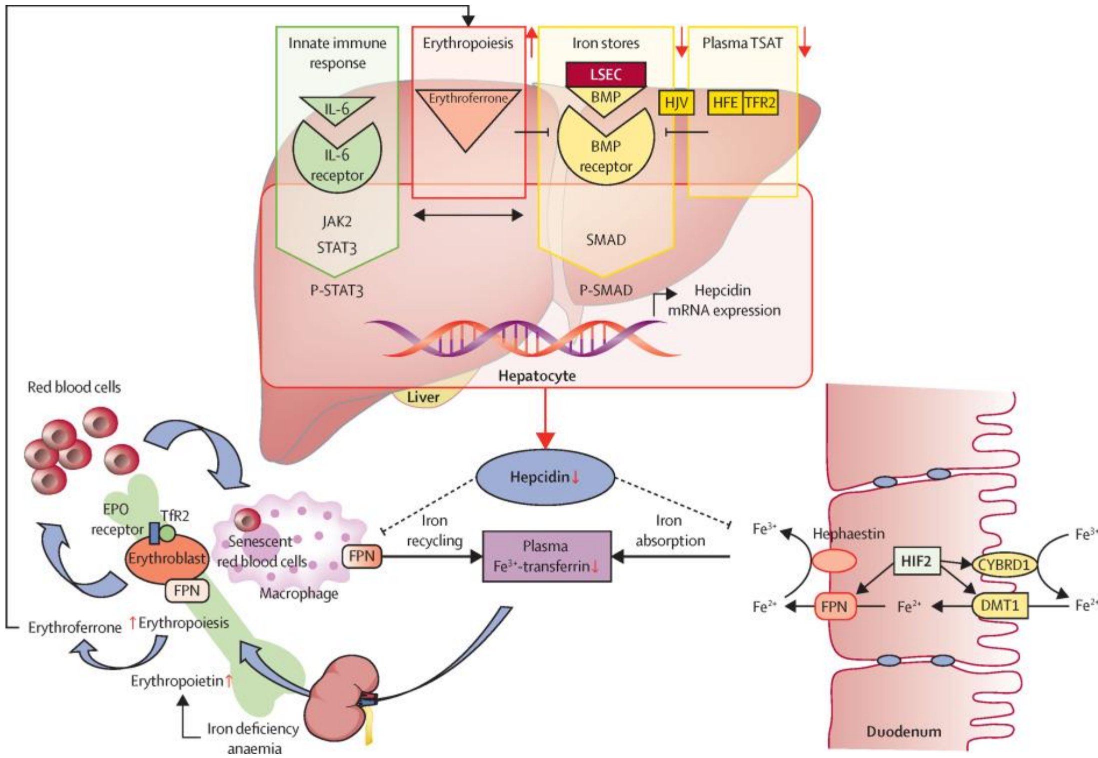

Figure 2.2: Defective haemoglobin synthesis

2.3 Causes of Iron Deficiency

Age, gender, and socioeconomic level all affect what causes iron deficiency anaemia. Adolescent females with IDA and iron insufficiency have a variety of causes. These include parasite infection, increased need during puberty, inadequate intake or absorption of iron, excessive blood loss during menstruation, and increasing demand (Ganz, 2003). To satisfy the body's physiological needs, nutritional requirements, for example, rise sharply during pregnancy and adolescence. Numerous studies have shown a connection between anaemia and inadequate dietary iron consumption (HOGREY, 2018). Further evidence of poor dietary iron intakes compared to RDA came from research carried out in two villages in Ghana. The researchers also linked the insufficient dietary intake of iron to the high frequency of anaemia (Nti et al., 2002)

Additionally, it has been shown that inadequate body use and excessive blood loss both contribute to iron deficiency. Blood loss has been linked to several medical illnesses known to cause internal bleeding and may be connected to GIT and peptic ulcer malignancies. Fibroids and heavy menstrual loss may also exacerbate iron loss. Malabsorption-related diseases, including celiac and Crohn's, are also found to cause iron depletion. Other reasons include congenital atransferrinaemia, which is brought on by a polymorphism that interferes with typical transferrin function (Shamsian et al., 2009).

IDA affects both sexes and occurs at all ages, although teenage females are more likely to develop it. According to Kumari et al. (2017), the WHO defines teenagers as those between the ages of 9 and 19; around 34% of adolescent girls do not satisfy dietary requirements (Oppenheimer, 2001). Due to its rapid growth and physical development throughout adolescence, high iron needs, high rates of illness and helminth infestation, early marriage, and teenage pregnancy, anaemia is mostly brought on by recurrent dietary issues (Benedict et al., 2018).

2.4 Role of Iron Deficiency in Pathogenesis of Anaemia

As mentioned, there are three phases of iron deficiency anaemia: a lack of store iron, erythropoiesis, and iron deficiency anaemia (Clark, 2008). Because erythrocytes, or red blood cells, cannot develop without iron, anaemia is promoted. The bone marrow produces 200 billion erythrocytes daily, each needing roughly 25 mg of iron (Camaschella et al., 2016). Body iron reserves are preferred to speed up erythropoiesis in conditions of blood loss (Naigamwalla, Webb and Giger, 2012). Erythropoiesis and the formation of myoglobin, an iron-containing protein, are restricted when body reserves are reduced

(Anderson, Aronson and Jacobs, 2000). The result of this procedure is iron-deficiency anaemia. Because iron-deficient erythrocytes are brittle and have a shorter lifetime, anaemia is exacerbated. Hypochromic and microcytic cells originate from inadequate haemoglobin production caused by iron-deficient erythrocytes (Naigamwalla et al., 2012)

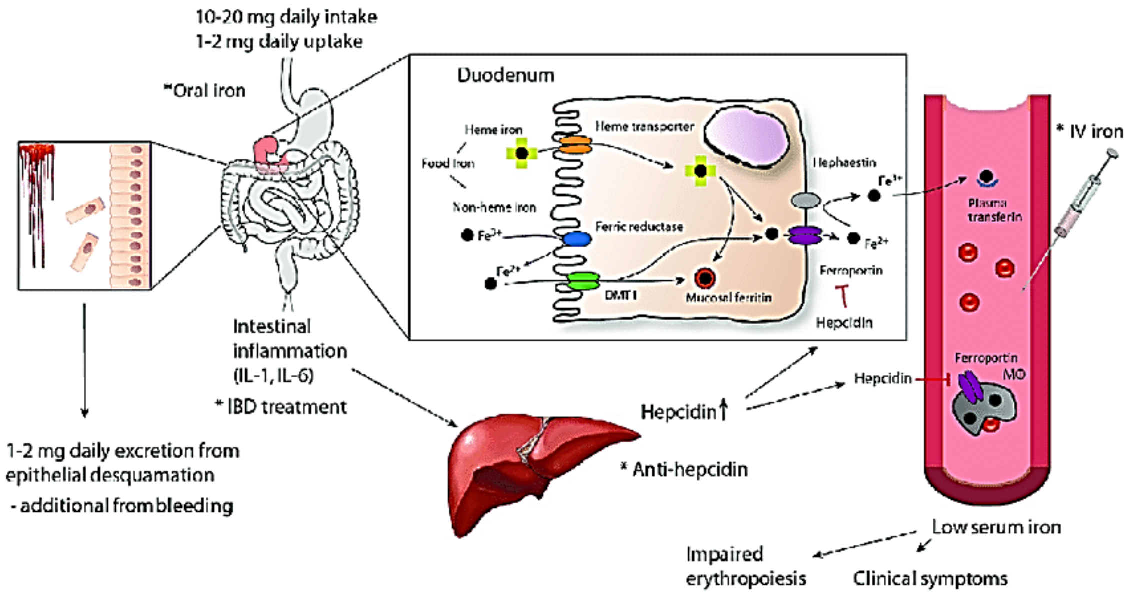

Figure 2.3 Determination of Iron

2.5 Indices for Determining Iron Deficiency Anaemia

Iron deficiency anaemia is diagnosed using conventional indicators such as serum and plasma iron, transferrin saturation, and ferritin. The serum-soluble transferrin receptor is another marker (Thomas and Thomas, 2002). Iron deficiency anaemia may be recognized by hypochromia and microcytosis of the red blood cells, low serum ferritin, decreased transferrin saturation, or high serum soluble transferrin receptor (Thomas and Thomas, 2002). It is often helpful to offer details on the person's iron status over an extended period when red blood cell morphology is used as an indicator to determine anaemia. It is a late sign of erythropoiesis with iron restriction (Macdougall, 1998; Yamamoto et al., 2017).

More than 10% hypochromic red cells and low serum ferritin levels are signs of insufficient erythropoiesis supply, which is inadequate to sustain normal red cell levels. The body's iron reserves may have been severely reduced in this situation (Schaefer and Schaefer, 1998; HOGREY, 2018). To assess iron shortage and when there is a suspicion of iron excess, serum iron tests are often conducted in addition to other iron assays. Iron deficiency is indicated by tests that reveal low ferritin levels, high transferrin or total iron binding capacity, low per cent transferrin saturation, and low serum iron levels. In essence, the total iron binding capacity (TIBC), the transferrin test, and the transferrin saturation all measure the same thing. They demonstrate the body's capacity to bind and transport iron and its storage (HOGREY, 2018).

2.6 Contributing Factors of Iron Deficiency Anemia

The main causes that contributed the most to the development of IDA have been identified. Inadequate dietary iron intake, iron loss from the blood, pharmaceutical use, GI disorders, and GI surgery are a few of these (Miah, 2014). Poor household economic conditions, periodic food shortages, child labour (a sign of low household income and poverty), the burden of disease, a lack of understanding of the long-term effects of adolescent undernutrition, the quantity and quality of food available, as well as Access to health and nutrition services are all factors that contribute to undernutrition in developing nations (HOGREY, 2018).

Compared to higher socioeconomic divisions, lower working-class groups eat fewer types of fruits and vegetables and consume them less often. One of the most significant factors impacting iron intake is poor socioeconomic status, which lowers the consumption of meat, fish, poultry, and other animal items that contain iron. Increased iron intake from all animal sources, such as meat, fish, and poultry, leads to higher household incomes (Giskes et al., 2002). Teenage girls may be more impacted than boys by nutritional deficiencies, especially iron. Professionals recommend iron supplements as a temporary fix since only significant improvements in family income might permit a larger consumption of non-staples to satisfy iron needs (WHO, 2005). Anaemia, on the other hand, is strongly linked to poverty. The danger is twice as great for members of lower working-class groups as it is for middle- or upper-class individuals. A major risk factor for anaemia in female teenagers is heavy menstruation lasting more than five days (Bhargava, Bouis and Scrimshaw, 2006). Compared to extended families, nuclear families had a lower anaemia prevalence.

Additionally, the frequency of anaemia increases with the size of the family. The number of family members, particularly when there is a low monthly income, impacts the quality and amount of food consumed (Gupta and Kochar, 2008). The percentage of teenagers with anaemia was lowest among those with a university degree (42.2%) and greatest among those with the most deficient education (52.2%); this finding indicates that the estimated risk of anaemia rose considerably with a lower level of education. As one's degree of education increased, the chance of anaemia dropped. Teenagers from common socioeconomic classes were 1.4 times more likely to develop anaemia than those from high categories (Jalambo, Karim and Jayath, 2015).

2.8 Dietary Risk Factors

Anaemia is mostly brought on by inadequate dietary consumption, particularly in developing countries. Many nutritional components prevent iron from being absorbed, a concern for many people who eat many plant-based meals. The requirement for extra iron in pregnant women is widely acknowledged. Additionally, the need for iron rises with fast development throughout childhood and infancy. During puberty, there is a significant rise in the demand for iron; for females, the start of menstruation adds load (Jalambo et al., 2018).

Twelve to seventeen-year-old teenagers who consume meat and fruit infrequently—fewer than four times per week—are more likely to have an iron deficiency than those who do so more regularly, according to a study done in Benin (Alaofè et al., 2008). Fewer than 2% of teens consume enough of each food group, while more than 20% of females do not consume enough of each food group's portions, according to prior studies (Jalambo et al., 2018).

Students who ate meat regularly (more than twice per week) had higher haemoglobin levels than those who ate meat seldom (2-3 three times per month). On the other hand, compared to rare consumption of the same factors, frequent eating of citrus fruits and green leafy vegetables was also substantially related to greater haemoglobin concentration. Additionally, there was no conclusive evidence linking the consumption of milk or dairy products to haemoglobin levels. The same research discovered that consuming tea was linked to reduced haemoglobin levels among teenage students. Heavy tea users (>5 cups per day) were shown to have about 11.5% lower haemoglobin concentration than non-tea drinkers (Sirdah, 2008). Recent research conducted in Kuwait and Palestine found a link between frequent tea and coffee drinking and anaemia.

2.9 Prevalence of Iron Deficiency Anemia Among Adolescent Girls

Depending on the situation, the prevalence of iron deficiency (I.D.) among female teenagers varies from 9 to 40%. At the same time, estimates of IDA prevalence in teenagers range from 30 to 55 per cent globally (Hermoso et al., 2011). Over two billion people, or roughly one-fourth of the world's population, are believed by the World Health Organization (WHO) to be anaemic (McLean et al., 2009). About 29.4% of women of reproductive age suffer from anaemia (WHO, 2011). The most frequent cause of anaemia and blood disorders in developing nations is iron deficiency anaemia (iron deficiency accounts for 75% of anaemia). One of the most common chronic human diseases, iron deficiency anaemia, affects 30% of people worldwide (Nader Soleimani, 2000).

A study of 1051 young Kuwaiti girls found that 30% had anaemia, with iron deficiency anaemia affecting 25% of them. According to other research on 478 teenagers in Shanghai, China, iron deficiency anaemia was more frequent in females than in 46.8% of youngsters (Nader Soleimani, 2000). In Iran, 30 and 50 per cent of women and children, particularly those from low-income households, were iron deficient. According to reports, anaemia affects up to 30% of teenage girls and 45% of women aged 15 to 45. (Shakori Rad et al., 2009).

Female adolescents in Saudi Arabia had a 21.8% anaemia prevalence rate. However, in Kuwait, 25% of teenage anaemia was iron-deficient anaemia, making up 30% of the total. However, in Seri Lanka, the frequency was 58.1%. Iranian female students had a 30%

anaemia incidence, although IDA affected 21.5% of teenage girls (Jackson and Mousa, 2000). Teenage females from south Asia were anaemic in most cases; in Bangladesh, India, and Nepal, anaemia was found in 70, 51.8, and 67.7% of teenagers, respectively (Gonete et al., 2018). Anaemia is a public health concern in Ghana due to the prevalence of anaemia, which was measured at 50.3% in research to determine the incidence of stunting, weight loss, and anaemia among adolescent girls in schools in Ghana (Tandoh et al., 2021). According to the 2011 Ethiopian Demographic Health Survey (EDHS), 13.4% of teenage females were anaemic (Central Statistical Agency and ICF International, 2012). Similar to this, many district-level studies revealed a significant frequency of teenage anaemia (15.2-32%) (Teji et al., 2016).

In 8 Asian and African nations, including Ghana, Indonesia, Malawi, Mozambique, Tanzania, and Vietnam, anaemia prevalence among adolescents is above 40%, according to research by Hall et al. (2008) on the academic progress of children with anaemia (Hall et al., 2008).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Design

A cross-sectional study design was used to gather the needed data on potential risk factors that may result in iron deficiency anaemia in an adolescent girl child in the targeted studied population.

3.1.2 Study Site

This research was carried out at the Madina Polyclinic in the Greater Accra Region of Ghana's La-Nkwantanang-Madina Municipal District. Before the creation of the Municipality on June 28, 2012, mandated by Legislative Instrument (L.I.) 2131, the Municipality was a component of the then-larger Ga East District, which was established in 2004. The remaining portion of that district is still known as Ga East Municipal District. The Municipality's capital city is Madina, located in Ghana's Greater Accra Region west of the country. The Accra Metropolis District borders the district to the north, as does Akuapim South District (in the Eastern Region) to the east, Kpone Katamanso Municipal District and Adenta Municipal District to the south, and to the west, Ga East Municipal District. The district has 70.887 square kilometres in total area. The district has 111,926 residents, 54,271 of whom are men and 57,655 of them are women, according to the 2010 National Population and Household Census. 137,975 is the current population-based Ghana Statistical Service record.

3.2 Sampling Technique:

A systematic sampling method was used for selecting participants by selecting every second person using the Madina polyclinic to be part of the research project.

3.2.1 Data Collection

Questionnaire

A well-structured questionnaire was used to obtain relevant information on adolescent girls. The questionnaire was structured into five sections: Socio-demographic data, Knowledge, attitude, and practice towards iron deficiency anaemia, and Food Frequency.

3.3 Study Population

The study population includes adolescent girls attending the Madina Polyclinic in the La-Nkwantanang-Madina Municipal District located on the western side of the Greater Accra Region, with Madina as its capital town.

3.4.1 Inclusion criteria

1. Adolescent girls who have the consent forms signed by their parents/guardians.
2. Adolescent girls have stayed in the La-Nkwantanang-Madina Municipal District for more than a year.
3. Adolescent girls without any underlining chronic health condition

3.4.2 Exclusion criteria

1. Adolescent girls whose parents/guardians have not signed the consent forms.
2. Adolescent girls who are not residents stayed in the La-Nkwantanang-Madina Municipal District for more than a year.
3. Adolescent girls with a history of chronic diseases, blood diseases, married, pregnant, lactating, with disabilities, and receiving iron supplements within the past month were excluded from the study.
4. Adolescent girls with diabetes, hypertension, heart disease, thyroid disorder, tuberculosis, or cancer.

3.4.3 Sample Size

The sample size was calculated using the information on the prevalence rate from an earlier study (34.21%), Shamim *et al.*.; 2014) and determined by the formula (Naing *et al.*, 2006):

$$n = \frac{Z^2(pq)}{d^2}$$

Where:

n =sample size

Z = 1.96, the normal value corresponding to the 95% confidence interval

p = prevalence of 34.21% from the previous study

q = 1-**p** = 65.79%

d= the desired or required size of standard error allowed (6%)

Hence,

$$n = \frac{(1.96)^2\ (0.3421 \text{ x } 0.6579)}{(0.06)^2} = 240$$

A 10% non-respondent rate (24) was added to the projected sample size, bringing the total number to 264 required study participants.

3.4.4 Anthropometric Measurements

Weight was measured in kilograms (kg), and height was measured in centimetres (cm) using a Filizola anthropometric scale (So Paulo, SP, Brazil). The body mass index (BMI) was computed by dividing weight in kilograms by square height in meters.

3.5 Sample Collection and Analysis

A qualified phlebotomist was used to collect four millilitres (4ml) of venous blood from each participant's antecubital vein following an overnight fast (8-12h) and immediately transfer 3ml to gel separator tubes (plain tube) and 1ml to Ethylenediamine tetraacetic acid tubes. EDTA samples were handled right away for full blood cell test determination. The clotted sample in the gel separator tubes was centrifuged for 5 minutes at 3000 rpm. The serum was stored at -80°C until serum ferritin and C-reactive protein assays were done. Privacy was given to the client during blood sample collection and questionnaire filling.

3.6 Laboratory Investigation

3.6.1 Measurement of haematological parameters

The concentrations of haemoglobin were determined using a haemoglobinometer (HemoCue201+). Teenage females with haemoglobin values below 11.5 g/dL were termed anaemic. Mild anaemia was defined as haemoglobin values between 11.0 g/dl and 11.4 g/dl, moderate anaemia as 8.0 g/dl to 10.9, and severe anaemia as less than 8.0 g/dl.

Samples collected from a patient were used for the person of this research and no other purpose.

3.6.2 Biochemical analysis

After freezing, the quantities of serum ferritin and C-reactive protein were determined using AccuBind ELISA microwells (Monobind Inc, Lake Forest, CA 92630, USA) according to the manufacturer's instructions. Following the manufacturer's recommendations, these tests were performed to support a diagnosis of anaemia caused by iron deficiency.

Serum iron status was measured using serum ferritin (S.F.). Individuals were diagnosed with IDA when their S.I. or S.F. levels went below the cutoff threshold and were classified as iron deficient. A person must be anaemic and iron deficient in having IDA. Haemoglobin level less than 11.5 g/dl, serum iron less than 7.1 g/l, serum ferritin less than 30 ng/ml, and total iron-binding capacity more than 13.1 mol/l determined IDA (14, 22, 23).

3.6.3 Clinical and Bio-Chemical Assessment

The most important part of any nutrition survey is the clinical examination, which is based on examining the subject for changes believed to be related to various nutrient deficiencies that can be seen or felt in superficial epithelial tissues, particularly skin, eyes, hair, tongue, teeth, and so on. All samples were tested for haemoglobin using the Sahli technique, a well-known clinical laboratory. Using the WHO's classification criteria, the result was compared to the sample's current level of anaemia.

3.6.4 Menstrual History

This section pertains to the respondent's menstrual history. This section had questions on the menopausal symptoms, length of blood flow, and time between subsequent menstrual cycles.

3.6.5 Dietary Behavior Assessment

Information on the intake of several nutrients, including calories, proteins, calcium, fat, and iron, was gathered using the 24-hour recall. This included recording the respondents' food consumption in household items such as cups, spoons, ladles, serving spoons, katories, and plates. The diet sheet's entries for the previous 24 hours' worth of food were recalled by respondents. Through these standardized containers, the amount was determined. These were afterwards converted to metric weight, and the food consumption chart was used to determine the nutritional value.

3.7 Data Handling

The researcher was responsible for ensuring the confidentiality of standard protected information from the health directorate and ensuring privacy concerning the integrity of cases. The researcher is obligated under no circumstance to reveal information regarding data to any person who was not part of the study. Data were saved, encrypted and backup in a secured computer

3.8 Statistical Analysis

Data were imported into Microsoft Excel, and the STATA statistical analysis program was used to evaluate them (StataCorp.2007. Stata Statistical Software. Release 17. StataCorp L.P., College Station, TX, USA). The prevalence and risk factors of iron deficiency anemia in teenage females were determined using Pearson's chi-square test. Analyzing numerical data with a p-value of 0.05 or below was done using the student t-test.

3.9 Ethical Consent

The Ghana Health Service Ethical Board-National, Madina Polyclinic, and Ensign Global College Ethical Review Board approved the study's ethical conduct. The research objectives were discussed with the respondents, and their caregivers and assured anonymity and confidentiality of all information gathered. Participants were assured to withdraw from the research without damaging their image and self-esteem.

3.10 Limitation of Study

Although the research had specified timelines to be followed strictly, it was not easy to match to the said time reasons been a delay in obtaining the clearance from the IRB of Ensign Global College and also a hectic process at the Regional Health Directorate of the Ghana Health Service for ethical consent and approval at the district to allow Access to the facility which to a long time to start data. Nevertheless, the cost of measuring all the variables which can sufficiently explain iron deficiency anaemia in adolescents for which this study was carried out was not performed; hence I have decided to re-visit this work in my post-doctoral degree which time and grant will be available to properly deal with this issue and provide substantive recommendation for policymakers.

The findings from the study cannot be generalizable to any larger population, given the limited sample size obtained for the study.

3.11 Assumptions

At the end of the study, there is expected to be a strong and significant association between iron deficiency anaemia among adolescent girls. The findings of this study will influence the decision of policymakers to put in more resources for education and intervention to iron deficiency anaemia which can reduce morbidities and mortalities among adolescent girls.

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

The overall sample size for this study was 264 adolescent girls in the La-Nkwantanang-Madina Municipal District. Due to the process of sampling adopted and the efficiency pursued, only one adolescent could not participate in the study, thus bringing the sample size to 263, yielding a study response rate of about 99.62%. This chapter presents the study's data and discusses the analysis's results. The analysis and presentation are structured to provide a detailed understanding of the data and methodologically answer the research questions to achieve the study's objectives.

4.2 Descriptive Statistics

The study included various variables cited in the literature as factors associated with anaemia, iron deficiency, and iron deficiency anaemia. These variables span diverse categories, including demography, blood components, eating habits, and gynaecological history. Table 4.1 presents a summary of the demographical variables considered in the study. These are Age, Educational level, and Religion. From a sample of 263 adolescent girls, 83.0% (218) are between the ages of 9-13 years, and 17.0% (45) are within the 14-19 age group. For education level, 35.0% (92) are in secondary level; 30.0% (78) are at tertiary level; 20.0% (53) are at primary level; and 15.0% (40) reported no education. Furthermore, among the sample, 70.0% (183) identify as Christians; 24.0% (64) are Islamic, 3.0% (9) are Traditionalists, and 3.0% (7) identify as other religions groups.

Table 4.1: Summary of Demographical Variables

Variable	Frequency	Percentage
Age		
09 - 13	218	83.0
14-19	45	17.0
Education Level		
No Education	39	15.0
Primary	78	30.0
Secondary	92	35.0
Tertiary	53	20.0
Religion		
Christianity	183	70.0
Islamic	64	24.0
Traditionalist	9	3.0
Others	6	3.0

Source: Author's construct, 2022

Table 4.2 also summarises the different components of blood and iron level. The blood component parameters are obtained from a complete blood count test, which is essential in diagnosing and classifying anaemia and other diseases. Among them is the haemoglobin (Hb) level, which is one of the main variables of interest to this study. Haemoglobin level was used in this study to characterize the adolescent girls as anaemic and non-anaemic. As presented in Table 4.2, the average haemoglobin level among the sample is 11.6 g/dL, ranging from 3.4 g/dL to 26.3 g/dL. With a mean of 11.5 g/dL, we can say that the average girl in the sample is above the cut-off point (11.5 g/dL) to be considered anaemic. Another important variable is the serum ferritin level, which measures the amount of iron in the blood. The table reports that serum ferritin levels of the girls in the sample range from 17.6

(µg/L) to 1256 (µg/L) with a mean of 207.4 (µg/L). Other variables include red blood cell count, hematocrit levels, and mean corpuscular volume, which is reported in the table.

Table 4.2: Summary Statistics of Blood Components and Iron Level

Variable	Abbreviation	Obs	Mean	Std. Dev.	Min	Max
Red Blood Cell (million/mm3)	RBC	263	3.673384	0.829651	0.84	8.11
Hemoglobin (g/dL)	HB	263	11.61103	2.644927	3.4	26.3
Hematocrit (%)	HCT	263	33.51065	7.225979	7.6	73
Mean Corpuscular Volume (µm3)	MCV	263	91.49506	8.57456	70.3	110.5
Mean corpuscular haemoglobin (pg/cell)	MCH	263	31.5	3.174817	21.6	40.1
Mean corpuscular haemoglobin concentration (% Hb/cell)	MHC	263	34.50418	2.0273	29.1	39.1
Serum Ferritin (µg/L)	SF	263	207.4312	270.4937	17.6	1256

Source: Author's construct, 2022

4.3 Prevalence of Anemia and Iron Deficiency Anemia

4.3.1 Anemia

The Hb levels of the 263 adolescent girls included in the study range from 3.4 g/dL to 26.3 g/dL, with an average of 11.6 g/dL and a standard deviation of 2.6 g/dL. Using the Hb level of 11.5 g/dL as a reference point below, in which an adolescent girl is considered anaemic, we find that 121 girls representing 45.8% of the sample, are anaemic. Among those anaemic, 79.3% are 14-19 years old, and 19% are 9-13. Furthermore, seven girls in the 14-19 years age group with Hb levels higher than 16 g/dL.

As already established in this study, an individual is considered iron deficiency anaemic if she is both anaemic and iron deficient. In the study, iron deficiency is measured by the serum ferritin level in the blood. Ferritin is a protein inside the cells that stores iron. An individual is diagnosed with iron deficiency when serum ferritin is below 30 µg/L. The data shows that serum ferritin levels among adolescent girls range from 17 µg/L to 1256 µg/L with a mean of 207.43 µg/L. It was observed that 24 girls have ferritin levels below 30 µg/L. That is, about 9% of the girls in the sample may be considered iron deficient. Among those considered iron deficient, 72% (18) are in the 14-19 age group, and 20.8% (5) are in the 9-13 age group.

4.3.2 Iron Deficiency Anemia (IDA)

The analysis revealed that among the 45.8% of girls diagnosed with anaemia, about 10% were also iron deficient. Stating the converse, among the girls who may be diagnosed with iron deficiency, 50% (12) are also anaemic. From the sample of 263 adolescent girls, those diagnosed with Iron Deficiency Anemia (IDA) are 12, corresponding to about 4.56%. Among those with IDA:

1. Age: 75% (9) within 14-19 years olds and 16% (1) within 9-13 years
2. Education Level: Secondary - 33.33% (4), Primary - 25% (3), Tertiary - 25% (3), and No education - 8.33% (1)
3. Religion: Christianity - 66.7% (8), Traditionalist - 16.7% (2), and Islamic - 8.3% (1)

Moreover, IDA is more prevalent among girls in the upper adolescent age group, those in secondary school, and Christians.

4.3.3 Hematology Complete Blood Count Characteristics

A complete blood count determines the haematological characteristics of the blood (CBC). A complete blood count (CBC) is a blood test used to evaluate your general health and identify conditions, including leukaemia, anaemia, and infections. The test measures red blood cells, haemoglobin, hematocrit, mean corpuscular volume and mean corpuscular haemoglobin concentration. In reality, several categories of anaemia employ these factors.

Table 4.2 presents a summary of the statistics of the entire sample. In contrast, Table 4.3 compares the complete blood count indices among adolescent girls in the sample who are considered anaemic and non-anaemic and may be diagnosed with iron deficiency anaemia.

Table 4.3 Blood Components and Anemia (T-tests Mean Comparison Tests)

Parameter	Overall Sample (Obs = 263)	Anemia Group (Obs = 121)	Non-Anemia Group (Obs = 142)	T-tests statistic (p-value)	Normal Reference Range for females
Red Blood Cells	3.67	3.22	4.06	-9.56 (0.00)	3.5 - 5.5 million/mm3
Haemoglobin	11.6	9.78	13.17	-13.50 (0.00)	11.5 - 16.0 g/dL
Hematocrit	33.51	28.98	37.37	-11.49 (0.00)	36% - 46%
Mean Corpuscular Volume (MCV)	91.49	90.23	92.56	-2.19 (0.015)	80 - 100 µm3
Mean Corpuscular Hemoglobin (MCH)	31.5	30.21	32.6	-6.52 (0.00)	25.4 - 34.6 pg/cell
Mean Corpuscular Hemoglobin Concentration (MCHC)	34.5	33.59	35.28	-7.36 (0.00)	31% - 36% Hb/cell

Source: Author's construct, 2022

From Table 4.3, we observe that for the entire sample of 263 adolescent girls, all but the Hematocrit level falls within the normal reference range for females. Observe that the average Hematocrit level for the whole sample is 33.51%, below the lower limit of 36%. Hematocrit is a percentage of red cells in the blood, and at a low level, it suggests the presence of anaemia. Grouping the sample into two, i.e., Anemic and Non-anemic, provides more information about the haematological characteristics of the sample.

For the Non-anemia group, notice that all the parameters fall within the normal reference range. On the other hand, for the Anemia group, only three parameters fall within the reference range, i.e., Mean Corpuscular Volume (90.23 µm3), Mean Corpuscular Hemoglobin (30.21%), and Mean Corpuscular Hemoglobin Concentration (33.59%). On average, red blood cells, haemoglobin, and hematocrit levels for the Anemia group fall below the reference range with values of 3.22 million/mm3, 9.78 g/dL, and 28.98%, respectively. Like the Anemia group, those in the Iron Deficiency Anemia Group have average red blood cells, and haemoglobin and hematocrit levels for the Anemia group fall below the reference range. We conclude that among the adolescent girls at Madina Polyclinic, those categorized as Anemic and Iron Deficiency Anemia have lower levels of red blood cells, haemoglobin, and hematocrit than those classified as non-anaemic, on average.

4.3.4 Classification of Anemia

We classify anaemia as moderate, mild, and severe anaemia based on the haemoglobin concentration level. For adolescents, mild anaemia corresponds to a haemoglobin concentration of 10 - 11.6 g/dL. Moderate anaemia corresponds to haemoglobin concentration levels of 7.0 - 9.9 g/dL, and severe anaemia corresponds to levels less than 7.0 g/dL.

We found that among the 121 adolescent girls who are considered anaemic, 57.02% (69) are mild, 37.1% (45) are moderate, and 4.1% (5) are severe. The severity of anaemia varies across demographic variables. The cases of severe anaemia were only present among anaemic girls in the 14-19 age group, making up 5.21% (5) of the group. Mild and moderate anaemia represents 55.21% (53) and 37.50% (36) of the 14-19 age group. For anaemic girls in the low adolescence age group, 60.87% (14) are Mild, and 39.13% (9) are Moderate cases. At the educational level, severe anaemia was prevalent only among girls in the Secondary (9.3%) and Tertiary (4.75%) levels. Furthermore, cases of severe anaemia were only prevalent among Christians (3.53%) and Islam (8%).

Considering the relationship between Iron Deficiency Anemia and Anemia Severity, we observe that 66.67% (8) of the girls categorized as iron deficient anaemic have mild anaemia, and the remaining 33.33% (4) have moderate anaemia.

4.4 Underlying/Risk Factors and Anemia Prevalence

Risk factors are determinants associated with an increased risk of disease. That is, risk factors of anaemia or iron deficiency anaemia increase the chance of the prevalence of anaemia. These can be genetic or an aspect of personal behaviour, lifestyle, or environmental exposure.

4.4.1 Iron Deficiency Anemia, Sickling Status, and Blood Groups.

By comparing the mean Hb levels across blood groups, we find that blood group O has an average Hb level of 10.20 g/dL, A has 9.8 g/dL, AB has 9.74 g/dL, and B has 8.98 g/dL. This finding conforms with that of Ramalingam & Raghavan (2020), i.e., the O blood group has higher haemoglobin values than the A and B blood groups. Furthermore, we find that the prevalence of anaemia among the blood groups is as follows; O - 55.56%, A - 46.94%, AB - 43.4%, and B - 34.29%. However, the Pearson chi-squared test revealed that this association is not statistically significant.

Table 4.4: Blood Group, Sickling Status, and Prevalence of Anemia

Variable	Anaemia Status		Chi-Squared (p-value)
	Anaemic	Non-anemic	
Blood Group			
A	46.94%	53.06%	
AB	43.40%	56.60%	3.0935 (0.377)
B	34.29%	65.71%	
O	55.56%	44.44%	
Sickling Status			
Negative	43.07%	56.93%	2.18 (0.14)
Positive	53.33%	46.67%	

Source: Author's construct, 2022

Another underlying factor considered is the sickling status. Sickled cells prevent red blood cells from doing their job, the ability to carry oxygen throughout your body. Sickled cells also don't live as long as normal red blood cells. As a result, there are not enough healthy red blood cells, leading to anaemia, the condition that gives sickle cell anaemia its name.

From the data, the average Hb levels for girls with positive and negative sickling status are 11.2 g/dL and 11.73 g/dL, respectively.

Similarly, red blood cell levels are marginally higher among girls with negative sickling status (3.7 million/mm3) than those with positive status (3.6 million/mm3). Among girls with positive sickling status, 53.33% are anaemic compared to 43.07% of those with negative status. Also, the analysis shows that severe anaemia is more prevalent among girls with positive sickling status (6.06%) than those with negative status. Also, we find that iron deficiency anaemia is more prevalent among girls with positive sickling status (5.0%) compared to those with negative status (3.96%), although this association is not statistically significant.

Table 4.5: Blood Group, Sickling Status, and IDA

Variable	IDA Status		Chi-Squared (p-value)
	Negative	Positive	
Blood Group			
A	95.92%	4.08%	
AB	96.23%	3.77%	0.245 (0.970)
B	94.29%	5.71%	
O	96.30%	3.70%	
Sickling Status			
Negative	96.04%	3.96%	0.74 (0.39)
Positive	95.00%	5.00%	

Source: Author's construct based on field data, 2022

4.4.2 Iron Deficiency Anemia and Eating Habits

4.4.2.1 How often do you eat in a day?

Considering the association between daily eating frequency and prevalence of anaemia, we found that 87.39% (104) of the girls in the anaemic category eat adequately. i.e., have three or more meals daily. Similarly, 88% (126) of girls in the non-anaemic group eat adequately. Furthermore, all girls in the iron deficiency anaemia group eat three or more daily meals. This result suggests that daily eating frequency is not associated with anaemia or iron deficiency anaemia among the girls in Madina Polyclinic, confirmed by Pearson's chi-squared test.

Table 4.6 Association between Eating Habits and Prevalence of Anemia

Variable	Anaemia Status		Chi-Squared Test (p-value)
	Anaemic	Non-anemic	
Eating Frequency			
Adequate	87.39%	88.11%	0.0311 (0.86)
Inadequate	12.61%	11.89%	
Fruits and Vegetable Intake			
Daily	60.00%	40.00%	
Twice	50.00%	50.00%	1.44 (0.697)
Very Rare	45.24%	54.76%	
Weekly	42.76%	57.24%	
Iron Supplementation			
No	45.61%	54.39%	0.0075 (0.931)
Yes	45.05%	54.95%	

Source: Author's construct based on field data, 2022

4.4.2.2 How often do you eat fruits and vegetables?

The distribution of frequency of fruit and vegetable intake is presented as follows: Daily - 1.91% (5), Twice per week - 26.72% (70), Very Rare - 16.03% (42), and Weekly - 55.34% (145). We generally observe poor fruit and vegetable eating habits characteristic of developing countries. As shown in the table below, there is no conclusive association between the frequency of eating fruits and vegetables and the occurrence of anaemia and iron deficiency. For example, the table shows that anaemic girls eat fruits and vegetables more frequently than non-anaemic.

4.4.2.3 Do you take an iron supplement?

About 65.27% (171) of the girls reported not taking an iron supplement, while 34.75% (91) took iron supplements. From the table, there is almost no difference in the prevalence of anaemia between those who supplement and those who do not, i.e., approximately 45%. However, we observe that iron deficiency anaemia is more prevalent among girls who do not supplement with iron (5.26%) than those who do (2.2%).

Table 4.7 Eating Habits and IDA Prevalence

Variable	IDA Status		Chi-Squared (p-value)
	Negative	Positive	
Eating Frequency			
Adequate	95.22%	4.78%	
Inadequate	100.00%	0.00%	1.596 (0.206)
Fruits and Vegetable Intake			
Daily	60.00%	40.00%	
Twice	98.57%	1.43%	
Very Rare	97.62%	2.38%	
Weekly	95.17%	4.83%	17.756 (0.000)

Source: Author's construct based on field data, 2022

4.5 Gynecological History and Anemia Prevalence

This section examines the relationship between anaemia and the gynaecological history of adolescent girls at Madina Polyclinic. The gynaecological variables included in this analysis are age at menarche, duration of menstrual blood flow, regularity of cycle, contraceptive use, and type of contraceptive.

4.5.1 Age at Menarche and Anemia

Age at menarche is when a girl experiences her first menstrual flow. Among the sample, the average age at which the girls experienced their first flow was approximately 13 years and eight months. The average age for menarche among the anaemic is 13.6 years, while that of the non-anaemic girls is 13.7 years. From the t-test of means, the difference in average age at menarche among anaemic and non-anaemic girls at Madina Polyclinic is insignificant (p-value = 0.65). On the other hand, girls characterized with iron deficiency anaemia have an average age of menarche (14 years) marginally higher than those without iron deficiency anaemia (13.7 years). However, it is not statistically significant (p-value = 0.71).

4.5.2 Duration of Flow and Anemia

Flow duration measures the days an adolescent girl experiences discharge of menstrual blood. Among the 210 girls that provided information on their period of flow, 42.75% (112) reported 3-5 days, 37.4% (98) reported 5-7 days, and 19.85% (52) reported 1-3 days. Among those who reported: 1-3 days: 50% are Anemic, and 50% are not; 3-5 days: 41.07% are Anemic, and 58.93% are not; 5-7: 47.96% are Anemic, and 52.04% are not.

Also, we observe that among those who reported 1-3 days for the flow duration, 7.69% have IDA; among 3-5 days of flow, 3.57% have IDA; and 5-7 days, 3.06% have IDA. Hence, we can conclude that IDA is more prevalent among adolescent girls who reported a 1-3 day flow duration. However, Pearson's Chi-Squared test shows that the association between IDA and flow duration is not statistically significant, with a p-value of 0.37.

Table 4.8: Gynecological History and Prevalence of Anemia

Variable	Anaemia Status		Chi-Squared(p-value)
	Anaemic	Non-anemic	
Duration of Flow			
Three days	50.00%	50.00%	
Five days	41.07%	58.93%	1.549 (0.461)
Seven days	47.96%	52.04%	
Regularity of Cycle			
21-24	46.07%	53.93%	
25-29	43.95%	56.05%	0.9091 (0.635)
30-33	56.25%	43.75%	
Contraceptive Use			
No	45.65%	54.35%	0.0135 (0.908)
Yes	44.87%	55.13%	
Type of Contraceptive			
Emergency	47.62%	52.38%	
Injectable	35.00%	65.00%	2.05 (0.562)
IUD	56.52%	43.48%	
Oral	43.75%	56.25%	

Source: Author's construct based on field data, 2022

4.5.3 Regularity of Cycle

33.97% (89) of the adolescent girls reported having a regular cycle of 21-24 days; 59.92% (157) reported 25-29 days, and 6.11% (16) reported 30-33 days. Among those who reported 21-24 days, 46.07% are anaemic; for those who reported 25-29 days, 43.95% are anaemic;

and among those who reported 30-33 days, 56.25% are anaemic. Notice that anaemia is more prevalent among the 30-33 days group. Also, the prevalence of IDA among the three groups is as follows; 5.62% for the 21-24 days group, 3.18% for the 25-29 days group, and 6.25% for the 30-33 days group. Similarly, IDA is more prevalent among the 30-33 days group. Therefore, the results suggest that anaemia and IDA are more prevalent among adolescent girls with longer cycles. Unfortunately, Pearson's Chi-Squared test reveals that this association is not significant. The p-values of the Pearson's Chi-Squared test statistic are 0.635 and 0.602 for associations between regularity of cycle and anaemia and IDA, respectively.

4.5.4 Contraceptive Use and Anemia

About 78 girls corresponding to 29.77% of the sample, reported having used conceptions. Among the 78 girls, 28.75% have used IUDs, 26.25% used Emergency contraceptives, 25% used Injectable, and 20% used Oral contraceptives. 45.65% of girls reported non-usage contraceptives are anaemic compared to 44.87% who use contraceptives. This difference is the prevalence of anaemia among the two groups is not statistically significant (p-value = 0.908). Furthermore, we observe a 7.69% prevalence of IDA among contraceptive users compared to 2.72% for non-contraceptive users. The association between the plurality of IDA and contraceptive use is statistically significant at a 10% level. This may be because the prevalence of iron deficiency is significantly associated with contraceptives. We record that the prevalence of iron deficiency is 14.1% among contraceptive users compared to 6.52% among non-contraceptive users. Additionally, we find no significant association between the type of contraceptive used and the prevalence of anaemia or IDA.

Table 4.9: Gynecological History and IDA Prevalence

Variable	IDA Status		Chi-Squared (p-value)
	Negative	Positive	
Duration of Flow			
Three days	92.31%	7.69%	
Five days	96.43%	3.57%	2.00 (0.367)
Seven days	96.94%	3.06%	
Regularity of Cycle			
21-24	94.38%	5.62%	
25-29	96.82%	3.18%	1.01 (0.602)
30-33	93.75%	6.25%	
Contraceptive Use			
NO	97.28%	2.72%	3.37 (0.066)
YES	92.31%	7.69%	
Type of Contraceptive			
Emergency	95.24%	4.76%	
Injectable	90.00%	10.00%	0.49 (0.921)
IUD	91.30%	8.70%	
Oral	93.75%	6.25%	

Source: Author's construct based on field data, 2022

CHAPTER FIVE

5.0 DISCUSSION

5.1 Introduction

This study primarily examines the prevalence and risk factors of iron deficiency anaemia among adolescent girls at Madina Polyclinic in the Greater Accra Region of Ghana. Particularly, the study examined the prevalence and risk factors of iron deficiency anaemia and the gynaecological history of risk factors of iron deficiency anaemia among adolescent girls at Madina Polyclinic. In fulfilling these objectives, standard laboratory tests and questionnaires were administered to 264 adolescent girls between the ages of 10–19 years who resided in the La-Nkwantanang-Madina Municipal District for more than a year. In particular, these teenagers must have attended the Madina Polyclinic. This chapter summarises the study's findings and makes recommendations for the study.

5.2 Discussion of findings

According to the findings, the prevalence of anaemia is significantly indicated among 45.8% of the respondents, in line with previous empirical findings. The USAID (2016) found in Ghana that the overall prevalence of anaemia is 42 per cent among women of reproductive age. Just as Borrow *et al.*(2008) found in 8 Asian and African countries, anaemia prevalence is about 40% in adolescents in Ghana, Indonesia, Malawi, Mozambique, and Tanzania.

However, IDA prevalence among the anaemia group and the entire respondents is weakly represented, indicated among just 4.5%. In other words, anaemia was found to be highly prevalent among the respondents, but the nature of the study could not adduce enough evidence for IDA indications. The nature of the study is such that a one-time laboratory test was conducted for haemoglobin levels (Hb), serum ferritin (S.F.), hematocrit, mean corpuscular volume (MCV), and mean corpuscular haemoglobin (MCH), among others, instead of a standard experiment over time. Limited resources could not allow for a full-blown controlled investigation over some time.

Even though iron deficiency anaemia was found to be more prevalent among girls who do not supplement with iron, the findings of the study point to risk factors of anaemia beyond iron deficiency; the first is that in line with the results of Ramalingam & Raghavan (2020), and Reshmaranil & Chimkode (2019), certain blood groups are more prone to anaemia. This study found that respondents with blood group B representing about 10%, were the highest prone to iron deficiency anaemia, followed by respondents with blood group A, 57%, being more prone to anaemia than the A.B. blood group. Respondents with blood group O being 12.4% were found to have the highest haemoglobin values. These findings align with Ramalingam and Raghavan (2020), who found higher haemoglobin values in the O blood group than in the A and B blood groups.

The second risk factor is the sickling status of the respondents. This study's findings confirm that iron deficiency anaemia is more prevalent among girls with positive sickling status. Sickle cell anaemia is a rising prevalent non-communicable disease (NCD) recently added to the National Health Insurance Scheme (NHIS). Kyerewaa *et al.*, (2011) found in Ghana that one in three Ghanaians has the haemoglobin S and C gene, while Asare *et al.*, (2018) found that 15,000 Ghanaian newborns are diagnosed with sickle cell anaemia annually.

The third risk factor away from iron deficiency is eating habits leading to deficiencies in micronutrients. According to Abbaspour *et al.*, (2014), Michelazzo *et al.,* (2013), and Simpson *et al.* (2010), anaemia can result from food micronutrient deficiencies because these nutrients are necessary for the formation and maturation of red blood cells, the production of new red blood cells and the transport of iron throughout the body. The study considered daily eating frequency, fruit and vegetable consumption, and iron supplementation as proxies of proper dieting to examine eating habits as a risk factor. On daily food consumption, the study found 87.39% who are anaemic and eat adequately daily and 88% who are non-anaemic and eat enough daily. Chi-square analyses, therefore, show no significant difference between anaemia prevalence for the anaemic and non-anaemic groups concerning the frequency of eating daily. The result is, however, limited by the lack of information on the nutritional value of daily food consumed among the two groups. The study found generally poor fruit and vegetable eating habits among anaemic girls, which is significant. There is a possibility they started eating more fruits and vegetables after being diagnosed with anaemia.

5.3 Summary of Major Findings

5.3.1 Prevalence of iron deficiency anaemia

Overall, anaemia was generally significant among about half of the adolescent girls. However, this overall anaemia health outcome issue could not be accounted for as a proportion of IDA. IDA prevalence was minimal at about 5% of the 10% iron deficient. Thus, indicating an idea of low IDA prevalence in the Greater Accra study setting for the one–time clinical test. Among the few, IDA is more prevalent among girls in the upper adolescent age group, those in secondary school, and Christians.

It was found that the split anaemia statuses of the adolescent girls at Madina Polyclinic were generally explained by the proportions of red blood cells and hematocrit levels between the anaemia and non-anaemic group. On average, those categorized as anaemic have lower red blood cells and hematocrit levels than those classified as non-anaemic.

5.4 The risk factors of IDA prevalence

It was observed that the risk factors of IDA prevalence were also for anaemia prevalence. The risk factors were lack of iron supplementation, having blood group B or A instead of O, having a positive sickling status, and poor fruit and vegetable eating habits. These prevalence levels were, however, observed at weak significant levels.

5.5 Gynecological history to risk factors of IDA

It was found that the average age at menarche among the IDA average age group is 14 years. In comparison, the age for the non-IDA group is 13.7 years, clearly showing that the differences in average age at menarche are insignificant. The differences were, however, weakly observed. It was found that even though there were clear differences in menstrual flow for the anaemic and non-anaemic groups, IDA is more prevalent for girls with 1-3 days of flow. The results are similar for differences in the regularity of cycles, suggesting IDA is more prevalent among adolescent girls with longer cycles. These differences were, however, weakly observed.

It was particularly observed that the use of contraceptives is significantly associated with IDA prevalence.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The present study reveals that anaemia among adolescent girls is a major health problem, even though the proportional association with IDA prevalence was weakly justified. In line with other studies, the risk factors are improper dieting because adolescents have a habit of skipping meals. As found in this study, anaemia and IDA prevalence could also result from menstrual cycles and reduced iron intake, including supplementation. The MOH and the GHS should promote public health programs that will lead to healthy eating patterns and the selection of appropriate foods.

Noteworthy is the finding that a positive sickling status highly predisposes adolescents to anaemia. This is consistent with the high cases of newborn sickle cell anaemia in Ghana, leading to the migration of the disease to the NHIS. According to this study, blood group types (B or A) support other existing evidence of the relationship between blood group type and anaemia risks. There are, however, healthy coping mechanisms, and the role of public health is key to public awareness.

6.2 Recommendations

Since these are adolescents of school-going age and the majority are in school according to this study, the study makes recommendations for the following;

1. improvement of the school feeding programme in Ghana. Since proper dieting is important for avoiding anaemia, the inclusion of iron-rich foods and the regularity of meals need to be improved in the school feeding programme. Foods like green leafy vegetables, meat, chicken, pulses, and eggs must be consumed abundantly to

improve the body's nutritional stores. Moreover, vitamin C-rich fruits should be consumed to enhance iron absorption.

2. The study also recommends the fortification of widely consumed foods with iron/folate, as well as supplementation with iron.
3. At the household level, individuals must be informed on the right food choices and iron supplementation dosages for adolescent girls.
4. The study, therefore, calls on the MoH, GHS, and the National Commission for Civic Education (NCCE) to step up public education to engage the public on these issues. Empowering adolescents to take charge of their lives is the way to go.
5. The study, therefore, recommends selective targeting and empowerment of adolescent girls through education on improved and adequate nutrition and adherence to supplementation, which is necessary for achieving the Global Nutrition Target of 50%.
6. Since food and nutrition are critical to the subject, the issue of food insecurity prevalent at 2 million people annually in Ghana must be addressed (FAO, 2020). The current economic downturn could worsen the food insecurity projection.
7. While addressing this challenge at the appropriate ministerial level, effective monitoring of food industries to ensure food fortification is according to standards by the Food and Drugs Authority is essential.

6.2.1 Recommendations for further research

As reiterated, this study is mainly a clinical study of anaemia prevalence conducted at one time instead of an experiment over a period. A drawback of this kind of study is that random procedures may produce different samples of different characteristics, thus, additional findings at other times. Interestingly, previous clinical results and associations of adolescent features showed weak correlations. Another random sample taken from the same study, certain at a time, will surely yield different results. Therefore, data collected over some time in a standard research experiment is the solution. However, limited resources and the thesis deadline could not extend this research into a full-blown investigation over time.

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APPENDIX I

QUESTIONNAIRE

SECTION A: DEMOGRAPHICS

1. **AGE**

   9-19 [ ] 14-19 [ ]

2. **EDUCATIONAL LEVEL**

   NONE [ ] PRIMARY [ ] SECONDARY [ ] TERTIARY [ ]

3. **RELIGION**

   CHRISTIANITY [ ] ISLAMIC [ ] TRADITIONALIST [ ]

   OTHERS: (Specify): ……………..

UNDERLYING FACTORS

4. **SICKLING STATUS**

   AA [ ] AS [ ] SS [ ] SC [ ] AC [ ]

5. **BLOOD GROUP**

   A [ ] B [ ] O [ ] AB [ ] RH: POS [ ] NEG[ ]

6. Do you have any chronic conditions? If yes specify………………….

   EATING HABITS

7. How often do you eat in a day?

   2 Times a day [ ], 3 Times a day [ ] 4 Times a day [ ] More frequently [ ]

8. How often do you eat fruits and vegetables?

   Daily [ ] Twice a week[ ] Weekly [ ] Very rare [ ]

9. Do you take an iron supplement?

   Yes [ ] No [ ]

GYNAECOLOGICAL HISTORY

10. Age at menarche (First menstrual flow)? ……………

11. Duration of flow

    1-3 days [ ] 3-5 days [ ] 5-7 days [ ]

12. Regularity of Cycle

    21-24 days [ ] 25-29 days [ ] 30-33 days [ ]

13. Do you use contraceptive

    Yes [ ] No [ ] ,

14. If **Yes,** what type?

    Daily oral [ ] Emergency [ ] IUD [ ] Injectables [ ]

APPENDIX II

Consent form

Medical Research Consent	
Participant's name	
Research protocol	Protocol number
Investigator name	
Title of study	An assessment of the prevalence and risk factors of anaemia among adolescent girls at Madina Polyclinic-Kekele
	A qualified phlebotomist will collect four millilitres (4ml) of venous blood from each participant's antecubital vein following an overnight fast (8-12h) and immediately transfer 3ml to gel separator tubes (plain tube) and 1ml to EDTA tubes. EDTA samples will be handled right away for full blood cell test determination. The clotted sample in the gel separator tubes will be centrifuged for 5 minutes at 3000 rpm. The serum will be stored at -80°C until the iron profile, which includes serum ferritin, serum iron, and serum TIBC assays, is done.

Health information

The person undergoing the activity will give their medical history. They should be willing to undergo Tests and carry out experiments.

Who will disclose, use and/or receive my health information?

After signing the form, the participant is assured of full disclosure from the team handling their information.

Participants Confidentiality

Some laws protect this group of people to ensure that privacy is assured. This form was used during the three-month research period, after which results will be communicated to participants and institutions on request. Participants should be assured that no one will have access to their details provided, and samples collected will be used for the research.

NB//:

Participants should note that all Covid-19 protocols will be strictly adhered to during sampling and laboratory investigations.

Potential risk to participants

The risks involved would be verbally communicated to clients. Nevertheless, the aseptic technique will be used throughout the sample collection process to sample analysis.

Can I see my health information?

You have a right to request to see your health information. However, to ensure the scientific integrity of the research, you will not be able to review the information until after the research protocol has been completed.

Signature of participant   Date

Name of facility   Madina Polyclinic Kekele

Investigator's signature

Timeline by authors construct