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DEPARTMENT OF BIOMEDICAL LABORATORY SCIENCES

ASSESSMENT OF PREVELENCE AND ASSOCIATED RISK FACTORS OF NUTRITIONAL ANAEMIA AMONG CHILDREN UNDER FIVE YEARS OLD

Case study: Kibogora Level II Teaching Hospital.

Period; 2023-2024

Undergraduate Research Dissertation presented in partial fulfillment of the requirements for the bachelor's degree with honor in biomedical laboratory sciences

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DECLARATION

Declaration by the candidate

I, KAMBANDA Sylvere hereby declare that this is my own original work and not a duplication of any similar academic work. It has therefore not been previously or concurrently submitted for any other degree, diploma or other qualification to Kibogora Polytechnic or any other institution. All materials cited in this paper which are not my own have been duly acknowledged.

Names: KAMBANDA Sylvere
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Date…….

Declaration by the Supervisor

I declare that this work has been submitted for examination with my approval as KP Supervisor

Supervisor's name: HITAYEZU Elysee

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Date…….

ABSTRACT

This study intended to assess the prevalence and risk factors associated with nutritional anemia among children under five years' old attending Kibogora Level Two Teaching Hospital. The objectives of this study were to determine the prevalence of nutritional anemia among children under five years' old, to assess the risk factors associated with nutritional anemia among children under five years' old and to identify the nutritional status among children under five years 'old attending Kibogora Level Two Teaching Hospital. The study adopted cross-sectional study using both qualitative and quantitative approach, The target population were 100 children who were suspected and diagnosed with nutritional anemia attending laboratory and pediatric department at KDH in 2023 from which a sample size of 50 selected. The study revealed the prevalence that equal to 8.1% of the children in the study population were affected by nutritional anemia. Key risk factors identified included malnutrition stemming from an unbalanced diet, inadequate or excessive food intake, non-potable water, poor food quality, unsanitary practices, and frequent infectious diseases. These factors were found to significantly contribute to increased disease burden, disability, and early mortality among the children. The outcomes of the study shows that iron deficiency anemia remain the most prevalent type of nutritional anemia in children aged between 6-59 months old. The results showed that the demographic factors such as residence of the participants, parents' knowledge on nutritional anemia, types of meal that a child is given (inadequacy of micronutrients such as iron, folic acid, and vitamin B12, C, and D) and the source of meal that a child is given are the most important factors that influence nutritional deficiencies and leading to the prevalence of nutritional anemia in respondents. Community is encouraged for the good eating habit for their children (life style) in order to decrease risk of nutritional anemia. Malnutrition screening as early as possible is also recommended, Conducting additional studies and establishing appropriate intervention strategies to improve the nutritional status and increase the intake of food that contains adequate quantities of micronutrients, particularly iron intake are also recommended.

DEDICATION

This thesis was dedicated to:

My family

My friends

My classmates.

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First and the fore Most, I give a grateful thanks to Almighty God for His blessing, and protection. My sincere gratitude is expressed to my supervisor HITSYEZU Elysee who kindly accepted to supervise this research thesis. His directions provided me with the necessary support to work hard in order to produce this research. Furthermore, I extend my appreciation to Kibogora polytechnic (KP) in providing us with knowledge on different aspects of surveying and also for the completion of my research project. I would like to extend a personal word of appreciation to the staff of the department Health sciences because without their support we could have not completed this research project. My sincere appreciation goes to all lecturers who gave us knowledge and skills to be who I am. ways in bringing this work into fruition, especially the General director I spoke to, those that helped in collecting information in questionnaires particularly people of Kibogora Level Two Teaching hospital, I implore the blessing of the Almighty, to all those who offered various support in bringing this work into reality. My special thanks go to classmates for their invaluable contributions, motivation and moral support throughout my course at the university

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CHAPTER ONE: GENERAL INTRODUCTION

1. O INTRODUCTION

This chapter presents the background of the study, problem of statements, Research objectives, Research questions, and significance of the study, Limitations of the study and scope of the study.

1.1 BACKGROUND OF THE STUDY

Globally, in 2020, it was anticipated That 149 million children under the Age of five were stunted, 45 million were wasted and 38.9 million were overweight or obese. More than half of all stunted and more than two thirds of all wasted under-five children remained in Asia. In South Asia, the prevalence of Child wasting remains a serious public health issue as It exceeds the critical level of 15%. The pooled prevalence of underweight and overweight in South Asia 28% and 17% respectively whereas in South East Asia both underweight and overweight was 20%. According to national level survey in Nepal, 36% of children under age 5 are stunted, 10% are wasted, 27% are underweight, and 1% are overweight. The study conducted among under five years' children in Dolakha and Kavre districts of Nepal revealed that 18.9%, 39.9% and 7.0% children were underweight, stunted and wasted respectively.

In Rwanda, malnutrition among the underprivileged children imposes greater burden in rural areas where 38% of young children are affected. Particularly rural children are more vulnerable to malnutrition because they receive foods having low nutritional values. Also, in early childhood due to lack of appropriate care they suffer from recurrent infections and multiple diseases either causing delayed development or fatal effect (**De and Chattopadhyay 2019**). The demographic and socio-economic factors influence the nutritional status and neuro-development of the vulnerable children (**Mandre 2020**).

Anemia during childhood period is strongly associated with poor health and physical development, mild and moderate mental retardation, and poor motor development and control leading to reduced academic achievement and work capacity thereby reducing earning potential and damaging national economic growth in the future (Nshimyiryo *et al*., 2019). Since the end of civil war and genocide in 1994, the Government of Rwanda (GOR) has embarked on rebuilding the country and improving the quality of life for its people. Rwanda's long-term development goals are defined in "Vision 2020," a strategy that seeks to transform the country

from a low-income, agriculture-based economy to a knowledge based, service-oriented economy with middle-income country status by 2020 (**Ansoms and Cioffo 2016**).

These goals build on remarkable development successes over the last decade that include high growth, rapid poverty reduction, and reduced inequality. Between 2001 and 2015, real GDP growth averaged about 8 percent per annum. Strong economic growth has been accompanied by substantial improvements in living standards, with a two-thirds drop in child mortality and near universal primary school enrolment (**Dollar 2015**). Anemia is defined as a decrease in the amount of red blood cell (RBC) volume or hemoglobin concentration below the range of values occurring in healthy persons. During the stages of accelerated growth between 1 and 5, and 10 to 13 years, all children have mild anemia. In children under five, anemia is present when hemoglobin is below 11.0g/dl (**Aspuru et al., 2011**).

The most common types of anemia are: iron deficiency anemia, thalassemia, aplastic anemia, hemolytic anemia, sickle cell anemia, pernicious anemia, fanconi anemia, megaloblastic anemia, and hypochromic anemia (**Lanzkowsky 2016**). Nutritional anemia refers to a reduced red blood cell count due to a poor diet which is deficient in iron, folic acid, and /or vitamin B12. It is common among infants and children, from 0-59 months of age. Effects of anaemia in many fields of studies done in many countries like Indian, Somalia and Ethiopia and in some of the East African countries has been associated with delayed psychomotor development and impaired cognitive performance in school children which leads to poor performance in language skills, motor skills, and coordination corresponding with a low intelligent Quotient (IQ) score in this group of children (**Nkeshimana *et al.*, 2018**).

1.2 PROBLEM STATEMENT

Anemia remains a major public health problem in the world especially in developing countries. Societies are often ignorant of anemia's capacity to cause permanent cognitive defects, denying children their right to full mental and emotional development, before they ever reach a classroom. Studies in Nigeria showed the prevalence of nutritional anemia among children to be 10% - 60% depending on geopolitical zones. Studies in northern Nigeria revealed the prevalence to be higher than those in the southern region, but the prevalence was higher in rural areas than urban areas in both geopolitical zones (**Watkins 2016**).

Rwanda has made significant progress in the fight against malnutrition. Between 2010 and 2015, rates of chronic malnutrition among children under 5 years known as 'stunting' decreased from 44 per cent to 38 per cent. However, the current rates are still too high. Close to 800,000 Rwandan children less than 5 years are stunted. Data shows that the older a child

gets, the more likely they are to be stunted. Just 18 per cent of children between 6-8 months are stunted, but this peaks at a staggering 49 per cent for children aged 18-23 months. However, gaps exist in knowledge of the extent of different types of micronutrient deficiencies among all populations in this area across the life cycle and whether the delivery of nutrients through current programs is meeting actual needs (**Kapur *et al*., 2016**).

Anemia has been a big problem in India and the National Family Health Survey (NFHS) III data showed the prevalence of anemia among children less than five years of age to be around 70% (**Kotecha, 2011**). When we look at the data for anemia prevalence among children under three years of age, it jumps to 79% and this is five percent more than the NFHS II survey done six years prior to the NFHS III survey, which was done in 2005 – 2006. However, it is noteworthy that there has been a slight reduction in the prevalence of severe anemia, while there has been an increase in the overall anemia, over the last seven years (**Kotecha 2017**).

Nutritional education to improve dietary intakes in family for receiving needed macro/micro nutrients as protein, iron and vitamins like folic acid, B12, A and C for hemoglobin synthesis is important. Use of iron in boiling milk, cooking vegetables may contribute significant amount of dietary iron. As an immediate measure medicinal iron is necessary to control anemia. Addition of folate with iron controls anemia and is neuroprotective. Evidence in early childhood suggests vitamin B12 deficiency anemia; thus, it may also be given along with iron and folate. National programs to control and prevent anemia have not been successful. Experiences from other countries in controlling moderately-severe anemia guide to adopt long-term measures i.e. fortification of food items like milk, cereal, sugar, salt with iron (**Bailey *et al*., 2015**).

1.3 OBJECTIVES OF THE STUDY

1.3.1 General objective

The general objective of this study is to assess the prevalence of nutritional anemia and its associated risk factors among children under five years' old attending Kibogora Level Two Teaching Hospital.

1.3.2 Specific objectives

1) To determine the prevalence of nutritional anemia among children under five years' old attending Kibogora Level Two Teaching Hospital.
2) To assess the risk factors associated with nutritional anemia among children under five years' old attending Kibogora Level Two Teaching Hospital.
3) To identify the nutritional status among children under five years'old attending Kibogora Level Two Teaching Hospital.

1.4 RESEARCH QUESTIONS

1) What is the prevalence of nutritional anemia among children under five years' old attending Kibogora Level Two Teaching hospital?
2) What are the associated risk factors of nutritional anemia among children under five year's old attending Kibogora Level Two Teaching hospital?
3) What are the nutritional status among children under five years' old attending Kibogora Level Two Teaching hospital?

1.5 SIGNIFICANCE OF THE STUDY

This research will provide the deep knowledge on nutritional anemia and to be familiar in practical works related to the field of hematology service.

1.5 .1 To the researchers

By conducting this research study, all information's related to nutritional anemia, the types and prevalence of micronutrient deficiencies among populations across the life cycle in Rwanda will be assessed. This will provide the deep knowledge

1.5.2 To the caregivers

It will help caregivers to identify the risk factors based on research findings, and it will help also to improve health care providers and patient knowledge on risk factors associated to nutritional anemia

15.3 To the public

This study facilitates the population to have more information about nutritional anemia how to prevent the nutritional anemia, and how it can be treated, and even the causes of nutrition anemia.

1.6 SCOPE OF THE STUDY

This study was limited to the Geographical scope, Time scope and domain scope

1.6.1 Geographical scope

This study was being limited at Kibogora Level two teaching Hospital which located in Gataba village, kibogora cell, Kanjongo sector, nyamasheke District in Western Province.

1.6.2 Time scope

It was conducted in the period of six months from march to august 2024

1.6.3 Domain scope

This study was focused on an assessment of the prevalence of nutritional anemia and its associated risk factors among children under five years' old attending Kibogora Level Two Teaching Hospital in the domain of hematology and biochemistry.

CHAPTER TWO: LITERATURE REVIEW

2.0 INTRODUCTION

This chapter presents the definitions of key terms, literature related to the specific objectives and conceptual frame work.

2.1 DEFINITIONS OF KEY TERMS

2.1.2 Hemolytic anemia

Hemolytic anemia refers in this anemia; your red blood cells break down or die faster than usual. **(Baker, J, 2017)**.

2.1.3 Aplastic anemia

This anemia happens when stem cells in your bone marrow don't make enough red blood cells **(Juliano, Y, 2018).**

2.1.4 Autoimmune hemolytic anemia

In autoimmune hemolytic anemia, your immune system attacks your red blood cells **(DeMaeyer, E. M, 2017).**

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2.1.5 Sideroblastic anemia

In Sideroblastic anemia, you don't have enough red blood cells and you have too much iron in your system **(Bailey, R, 2015)**.

2.1.6 Macrocytic anemia

Macrocytic anemic refers as the anemia happens when your bone marrow makes unusually large red blood cells **(West. P, 2015).**

2.1.7 Microcytic anemia

Microcytic anemia refers as anemia happens when your red blood cells don't have enough hemoglobin so they're smaller than usual **(Black, R, 2015).**

2.1.8 Normocytic anemia

Normocytic anemia refers as the type of anemia, you have fewer red blood cells than usual, and those red blood cells don't have the normal amount of hemoglobin **(Carlos, C,2018).**

2.2 The Prevalence of Nutritional Anemia Among Children Under Five Years'Old

In developing countries having low-and middle-income, the prevalence of anemia among 6–59-month age children was >20% based on latest demographic and heath survey (DHS) report rounds between 2005–2018, and it is classified as severe public health problem. The problem is alarming in Sub-Saharan African Countries such as Kenya 48.9%; Mali 55.8% and Tanzania 79.6%. Lack of awareness among the mothers about the problem coupled with their low educational status, poor nutritional practices and unhealthy food habits, low iron bioavailability of the diet, decreased physical activities, malaria and parasitic infestations are additional factors associated with lower hemoglobin (Hgb) level in children. Factors including family size, low socio-economic status, illiteracy and ignorance are associated with anemia among under five children. Infection with Hook worm and intestinal helminthes causes gastro-intestinal blood loss resulting in depletion of iron stores and consequently also impaired erythropoietin. This leads to mal-absorption and inhibition of appetite, there by worsening micronutrient deficiency and children anemia. The consequence of anemia in under five age children include: decrease mental performance, low tolerance to infection, death from anemic heart failure **(Kelishadi, R,2014).**

Although anemia remains a widespread public health problem in developed countries, it contributes significant proportion of children death in most developing countries including Ethiopia. As such, various factors like parasite have impact on cognitive development and physical growth, studies on the magnitude of anemia among under-five age children have paramount importance. Meanwhile, there is a limited study on the prevalence and associated factor of anemia among children under-five age in our study area. Therefore, this study aimed to determine the prevalence of anemia and its associated factors among under-five children in Shanan Gibe Hospital, Southwest Ethiopia. **(Abbaspour N, 2014).**

The current anemia prevalence among under five children was analogous with studies indicated in Palestine 33.5%, South Kivu 39.6%, Ghan41%, Cape Verde 51.8% and in Ethiopia 44.83%, Wollo 41.1%, Filtu Town, Somali region 41.7%, Duggina Fanigo District of Wolaita Zone 51.4% and Amhara region 41.43%. In contrast, a high prevalence e of anemia had been reported

in sub-Saharan Africa 64.1%, East Africa 75%, Brazil 56.6%, Malawi 56.9%, Togo 70.9%, Tanzania, Bugando Medical Centre 77.2%, Arusha District in Tanzania 84.6%, Kenyan Coast 76·3%, Mali 58%, Tanzania 57%, and Mozambique 54%, Ghana 78.4%. This variation might be due to the mothers having the problem with their low monthly income or parasitic infestations of children which are contributing factors associated with lower hemoglobin (Hgb) level in children **(Hurrell, R.,2014).**

According to factors in the current study, being rural residence (AOR = 6.11; $P = 0.002$) was associated with anemia in the current study. Beside this, analogs association of rural residence finding was reported in Amhara region. As such, studies indicated that the distribution of anemia is more prevalent among children from rural resident compared to urban sones. This is because of low socioeconomic status, low serving of iron-rich foods, lack of adequate nutrition information or dietary intake and due to and a high number of illiterates in rural areas as compared to urban **(Braga, J, 2018).**

Iron deficiency (ID) is the most common nutritional deficiency and is a major cause of morbidity and mortality that is responsible for the majority of cases of anemia, ~20% of perinatal and ~10% of maternal mortalities in developing countries (1). The National Health and Nutrition Examination Survey (NHANES) found that the prevalence of ID in the US females 20-49 yr. and children 1-2 yr. increased from 11% and 9%, respectively, in 1988-1994 to 14.4% and 15.7%, respectively, in 2002-2004 (2, 3). ID, with or without anemia, adversely affects cognitive performance, the behavior and physical growth of infants, preschool and school-aged children, decreases immunity, and increases perinatal risks during pregnancy (4-6). In addition to the effects on health, ID reduces work capacity and productivity of adolescents and adults of any age, and has a negative impact on overall national socioeconomic development **(Vitalle, M, 2018).**

Surprisingly, even though ID is one of 10 most common risk factors related to the worldwide disease- and injury-burden **(Amancio, O, 2012).** the prevalence for ID is not known for most countries due to the high cost of the biochemical tests required to precisely define an individual's iron status. Due to this, the prevalence of anemia is commonly used as an indirect indicator of ID, based on the assumption that ~50% of all cases of anemia are iron deficient (IDAs). The Korea National Health and Nutrition Examination Survey (KNHANES) is a large-scale, cross-sectional nationwide survey by the Korean Ministry of Health and Welfare. It was first conducted in 1998 and then conducted every 3 yr. until the present. Since 1998, the KHANES has identified the prevalence of anemia as 7.4%-9.5% overall, with a prevalence of 2.2%-4.8% in males and 11.9%-16.5% in females (8). Among participants of the fourth

KHANES in 2008 (KHANES IV-2), Kim et al. found that the prevalence of ID in females was 17.2% at 10-14 yr., 24.1% at 15-17 yr., 33.0% at 18-49 yr., and 5.7% at ≥70 yr. In males the prevalence of ID was 8.6% at 10-14 yr., 3.9% at 15-17 yr., and 2.6% at ≥70 yr. (9). This is the only nationwide report of ID in Korean populations. However, a major limitation of this study (9) is that ID was defined solely by the ferritin level (<15 ng/mL), and there was no analysis of other indicators to assess iron status such as serum iron, total iron-binding capacity and transferrin receptors.

In order to plan interventions to reduce the prevalence of iron deficiency anemia (IDA), particularly in susceptible populations, serum iron and total iron-binding capacity tests were added to KNHANES in 2010 (KNHANES V-1). The goal of the current study was to analyze KHANES V-1 data to accurately determine the prevalence of ID and IDA, identify at-risk groups for IDA and their degree of risk. In addition, we sought to identify novel socioeconomic and nutritional factors for **(Carlos, C, 2012).**

2.3 Risk Factors Associated of Nutritional Anemia among Children Under Five Years Old

2.3.1 Frequently donating blood

Although donating blood is great and often encouraged, doing it too many times in a short span of time can negatively affect your own health. Remember to always donate within frequencies having a set schedule is the best way to do so to maintain your own safety **(Brahman, G,2012).**

2.3.2 Age

Young children require more iron and growth for development. This is why consuming dairy and following a proper nutritional diet is key when younger children are developing. Getting less than the recommended value of iron and vitamins could lead to anemia in the long run. Teenagers are also at a slightly higher risk due to their tendency to disregard sleep. A lack of sleep can cause more stress on the body in the long run and can cause anemia **(Laxmaiah, A,2012).**

2.3.3 Menstruation

Any woman who is still viable to have menstruation is at a higher risk of iron deficiency anemia than men or postmenopausal men. Menstruation causes the loss of red blood cells, placing youat an increased risk for the condition **(Balakrishna, N, 2012).**

2.3.4 Pregnancy and childbearing years

Due to the excessive blood loss through menstruation and greater demands of blood supply for a developing fetus, pregnant women tend to suffer more from anemia and have a higher chance of getting the condition due to iron-deficiency (**Arlappa, N, 2012).**

2.3.5 Malnourishment

Although younger children are more prone to anemia, anyone who is consistently lacking the essential nutrients and minerals in their body can develop anemia. This is especially true for people who are malnourished in developing nations. Getting the proper amount of nutrients and minerals daily will help those fighting this condition **(Tewabe, T, 2020).**

2.3.6 Victims of sickle cell

Sickle cell anemia is when the patient's red blood cells are misshaped and cause them to get stuck in smaller blood vessels. Unfortunately for victims of sickle cell, they will most certainly already have some level of anemia by default **(Belachew, A, 2020).**

2.3.7 Family history

Although you may keep your body nourished properly, having a family member with anemia places you at an inheritably higher risk of the condition when compared to someone who does not have any family history with the disease. Unfortunately, anemia is a possibly inherited disease, placing your risk levels a bit higher than the rest. Request an appointment here: https://lindenbergcancer.com or call Landenberg Cancer & Hematology Center at (856) 475-0876 for an appointment in our Marlton office. Check out what others are saying about our services on Yelp: Read our Yelp reviews **(Sacri A,2017).**

2.4 Nutritional Status among Children under Five Years' Old

Good nutrition is a prerequisite for the optimal health and growth, cognitive development, academic performance, productivity, socioeconomic development of individuals and national development of countries, however problems related to poor nutrition affect the entire population. Malnutrition is a serious public health problem throughout the developing world predominantly in South Asian countries. It is one of the most widespread causes of morbidity and mortality among children and adolescents throughout the world. Malnutrition in children is mainly due to unbalanced diet, inadequate or excessive food intake, non-potable water, poor and unhygienic food quality as well as sanitary practice, severe and repeated infectious diseases. Malnutrition is a major contributing factor to disease, disability and early deaths for women and children. **(Brousse.V,2017).**

Poverty, literacy and social status of mother are key factors contributing to malnutrition in children and this factors significantly contribute to the cause of propensity for malnutrition in an individual. Malnourished children who survive may suffer from recurrent illness and faltering growth, with permanent damage to their development and cognitive abilities. Infants and young children bear the brunt of chronic malnutrition and suffer the greatest consequences, that is, the highest risks of morbidity and mortality. Malnutrition early in life clearly has major consequences for future educational, income and productivity outcomes Adults who were malnourished during their early childhood have impaired intellectual performance. Under nutrition during childhood followed by later overweight increases the risk of having non communicable diseases and for women increase the risk of childbirth complications. Indicators of over nutrition such as overweight and obesity in children and adolescents now occur simultaneously with underweight, stunting and wasting. The inconsistency of these two boundaries, repeatedly referred to as the "double burden of malnutrition **(Allali , S, 2017).**
Globally, in 2020, it was anticipated that 149 million children under the age of five were stunted, 45 million were wasted and 38.9 million were overweight or obese. More than half of all stunted and more than two thirds of all wasted under-five children remained in Asia [23]. In South Asia, the prevalence of child wasting remains a serious public health issue as it exceeds the critical level of 15%. The pooled prevalence of underweight and overweight in South Asia 28% and 17% respectively whereas in South East Asia both underweight and overweight was 20%. According to national level survey in Nepal, 36% of children under age 5 are stunted, 10% are wasted, 27% are underweight, and 1% are overweight. The study

conducted among under five years' children in Dolakha and Kavre districts of Nepal revealed that 18.9%, 39.9% and 7.0% children were underweight, stunted and wasted respectively **(CK Bhusal,2023)**

The Muslim population constitute of 4.4% of the overall population in Nepal, putting them in eighth position numerically. Rautahat, Bara, Pars, Kapilvastu and Banked are the five districts which have highest number of Muslim populations. The Muslim populations in Nepal was given a lower marginal status in the legal code, and they were shunned, discriminated against, and attacked violently. Muslims, as a vulnerable demographic group, demanded social justice and the establishment of a Muslim branch of the National Inclusion Commission. Muslim populations in Nepal have poor health outcomes and highest mortality rate. **(NN Pandey, 2018)**

Kapilvastu district of Lumbini province is one among the five districts of Nepal which have highest number (18.2%) of Muslim populations. Malnutrition is a silent emergency and one of the most common causes of morbidity and mortality among children throughout the world especially in developing countries like Nepal. If unanswered, this challenge will endanger poverty reduction measures taken by governments, civil society, and aids based organizations and threaten their long-term growth prospects. In order to eliminate or reduce the risk of malnutrition, it is crucial to first understand and identify the causes and underlying factors of malnutrition. Among the Muslims community in Nepal in relation to health very few studies had been conducted which includes studies in family planning and maternal fertility. However, according to researcher knowledge no research has been conducted to investigate the causes/reason of having malnutrition among Muslim children in Nepal. Hence this study aims to find out nutritional status and its associated factors among under 5 Muslim children of Kapilvastu district Nepal **(Bhattarai, 2019)**

2.3 Description of Nutritional Anemia

Nutritional anemia is defined as a condition where there is a reduction in hemoglobin concentration or hematocrit below that which is normal for the individual, due to the inadequate supply of hemopoietin nutrients. In a given healthy individual who ingests and absorbs adequate amounts of hemopoietin nutrients, the hemoglobin concentration will be at a level optimal for that individual and further ingestion of hemopoietin nutrients will not increase the hemoglobin concentration. Red blood cells are responsible for transferring oxygen to all the body's organs through hemoglobin. This, in turn, transports oxygen to the tissues, contributing to their proper functioning **(Baker, 2016).**

Anemia of nutritional origin is acquired problem caused by diets that lack sufficient quantity of bioavailable essential hematopoietic nutrients to meet the need of hemoglobin and red blood cell synthesis. Although many nutrients are involved in the production of red cells and hemoglobin, iron deficiency is by far the commonest cause of nutritional anemia all over the world **(Ifeanyi 2018).**

The first year of life is crucial for children's growth. Nutritional deficiencies can be very significant to the overall health of infants and children because growth and development can be seriously hindered by shortages in essential vitamins or nutrients. Inadequate erythropoiesis and reduced hemoglobin concentration characterize nutritional anemia. This is due to inadequate supply of nutrients like iron, folic acid and vitamin B12. During intra-uterine life, the source of these nutrients is entirely maternal in origin, whereas post-natally they are obtained through the breast milk and diet. Many other nutrients and cofactors are involved in the maintenance of hemoglobin level. However, iron deficiency is the main etiological factor responsible for nutritional anemia in the community **(Ifeanyi 2018).**

Iron deficiency is not only the most common nutritional anemia but also the most common cause of anemia in infancy and childhood. Iron deficiency anemia has important health ramifications including effects on neurodevelopment. Dietary modifications can prevent iron deficiency, and if iron deficiency develops, simple interventions help prevent cognitive detriments (**Mitchell *et al*., 2021**). Protein, amino acids and calorie malnutrition stateshave been associated with several other micronutrient deficiencies resulting in altered erythropoeises. Depending upon the deficiencies normocytic, microcytic,megaloblastic or dimorphic anemias are observed in marasmus, kwashiorkor etc. Protein deficiency in animals impairs erythropoeitin response in hypoxia. Thus in protein deprivation, decreased amino acids substrate affects erythropoeitin synthesis. Amino acid methionine deficiency is associated with megaloblastic anemia in kwashiorkor. In anorexia nervosa, a situation of starvation, patients may develop moderate anemia, leucopenia and thrombocytopenia; bone marrow is usually hypoplastic (**Mitchell et al., 2021**).

2.4 Types of nutritional anemia

There are several types and classification of nutritional anemia. Iron deficiency is the most common nutritional deficiency leading to anemia. Other nutritional deficiencies that can also lead to anemia include deficiencies of vitamins A, B6, B12, C, D and E, folate, riboflavin and copper, though some of these nutrient deficiencies are uncommon and may not play a significant role in the burden of anemia globally. In many cases, where diets are poor in micronutrients, multiple micronutrient deficiencies are likely to have a synergistic effect on the development of anemia (**Moll and Davis 2017**).

2.4.1 Iron deficiency anemia

Iron is a key nutrient required for hemoglobin, and thus production of red blood cells; it is an essential part of the hemoglobin molecule. Conditions that require an increase in red blood cells (for example, growth of tissue mass of an infant, or growth of a fetus during pregnancy) increase iron requirements. Iron deficiency develops when dietary iron intake cannot meet iron needs (e.g. owing to poor diet), especially during periods of life when iron requirements are especially high (i.e. during infancy), or iron losses exceed iron intake (e.g. childbirth) over a period of time. In the late stages of iron deficiency, when the body's store of iron has been depleted, the supply of iron to support production of red blood cells is compromised and, as a result, hemoglobin concentration decreases (**Gupta 2014**).

Iron-deficiency anemia is characterized as a hypochromic, microcytic anemia. Poor iron status can be transferred inter-generationally from mother to child. The extent to which maternal iron deficiency and/or iron-deficiency anemia during pregnancy affects fetal iron status is debated; infants born to women with iron-deficiency anemia have been shown, in several studies, to be at increased risk of iron deficiency and anemia but not all studies show a relationship between maternal iron deficiency and later infant/child iron status. Infants who are born prematurely or with low birth-weight (40%, especially in rural populations; this suggested that the proportion of anemia associated with iron deficiency could be lower than the previously assumed 50% in countries with low, medium or high Human Development Index ranking (**Gupta 2014**).

Furthermore, in some countries, for example Cambodia, it has been suggested that the high prevalence of anemia in children cannot be explained solely by micronutrient deficiencies and hemoglobin disorders. The role of iron in cases of severe anemia is greater (>50% for children). Thus, while in many cases, iron-deficiency anemia and anemia are viewed synonymously, it is important to remember that roughly half of anemia cases will not be caused by iron deficiency nor can they be corrected by providing additional iron (**Wieringa et al., 2016**).

2.4.1.1 Symptoms of Iron deficiency anemia

The symptoms of iron deficiency anemia can be mild at first, and you may not even notice them. According to the American Society of Hematology (ASH), most people don't realize they have mild anemia until they have a routine blood test. The symptoms of moderate to severe iron deficiency anemia include: general fatigue, weakness, pale skin, shortness of breath, dizziness, strange cravings to eat items that aren't food, such as dirt, ice, or clay, a tingling or crawling feeling in the legs, tongue swelling or soreness, cold hands and feet, fast or irregular heartbeat, brittle nails, headaches (**Stoltzfus 2014**).

2.4.2 B vitamins (riboflavin, B12, folate, B6) deficiencies

Deficiencies of several B vitamins may play a role in the development of anemia. Riboflavin (vitamin B2) deficiency may contribute to development of anemia, through its effects on iron metabolism, including decreasing iron mobilization from stores, decreasing iron absorption and increasing iron losses, as well as impairing globin production. Riboflavin supplements provided along with iron supplements have been shown to have a greater effect on hemoglobin concentration than iron supplements alone. Riboflavin deficiency is particularly common in areas where intakes of meat and milk/dairy products are low, and has been documented in infants as whereas school-aged children (**Wieringa et al., 2016**).

Iqbal et al. (2009) showed that both vitamin B12 (cobalamin) deficiency and folate deficiency can lead to macrocytic (megaloblastic) anemia, as deficiencies of these nutrients affect DNA synthesis, cell division and thus erythropoiesis. Vitamin B12 deficiency most commonly results from low dietary intake of the nutrient, particularly if the diet is low in animal-source food, but can also result from malabsorption, particularly in the elderly, among whom gastric atrophy is common. Data on the prevalence of vitamin B12 deficiency at the national level are lacking; however, in five out of seven countries with national data, the reported prevalence of vitamin B12 deficiency is 5% or greater among different age and biological groups.

Similarly, folate deficiency was estimated to be of public health significance in six out of eight countries with national data. Folate deficiency tends to be more common in populations that rely on unfortified wheat or rice as a staple food and that also consume low amounts of legumes and green leafy vegetables. Pregnant women, preterm infants and individuals living in malaria endemic regions are also at high risk of folate deficiency. However, the contribution of deficiencies of vitamin B12 and folate to the global incidence of anemia is thought to be minimal, except in the case of women and their infants and children consuming vegetarian diets that are deficient in vitamin B12 (**Allen 2018**).

A review of the evidence for deficiency of vitamin B12 and folate and anemia indicates that a high prevalence of vitamin B12 or folate deficiency does not necessarily correlate to a high prevalence of these types of anemia. Vitamin B6 is essential for synthesis of haem, and can cause the same microcytic, hypochromic anemia as iron deficiency, as well as normocytic or sideroblastic anemia. Vitamin B6 deficiency is rare, and the public health significance of this deficiency for anemia is unknown (**Allen 2018**).

2.4.2.1 Symptoms of B vitamins (riboflavin, B12, folate, B6) deficiencies

Symptoms of B vitamin deficiencies may include Getting sick from infections more often (because B6 helps support your immune system), getting cracks or sores in the skin around the corners of your mouth or a swollen and sensitive tongue, fatigue, a feeling of numbness or tingling in your hands and feet (this is known as "paresthesia's"), depression, anxiety, and/or irritability, a red itchy rash often oily or flaky that, usually appears on the upper body or face. Small areas of your skin might also swell, resulting in white patches, convulsions, decreased alertness, weakness, mouth sores, mood changes, blurry vision, loss of breath, dizziness, pale skin (**Balch 2016**).

2.4.3 Vitamins C, D and E deficiencies

Vitamin C is known to affect iron metabolism, particularly enhancing absorption of non-haem iron, but also increasing mobilization of iron from stores. Vitamin C deficiency can also contribute to hemolysis, through oxidative damage to erythrocytes and also capillary hemorrhaging leading to blood loss. Populations at risk of vitamin C deficiency include pregnant women, infants fed exclusively with cow's milk, the elderly and smokers. Vitamin C supplementation has been shown to increase hemoglobin concentration and serum ferritin in children and non-pregnant women (**Green and Mitra 2017**).

Low levels of vitamin D have been associated with anemia in children and adults from the USA, and individuals with chronic kidney disease, end-stage heart failure, and type 2 diabetes from several countries. The mechanism linking vitamin D deficiency to decreased hemoglobin concentration is not entirely understood, but there is evidence indicating that low levels of vitamin D may lead to decreased local calcitriol production in the bone marrow, which may limit erythropoiesis **(Green and Mitra 2017).**

Anemia associated with vitamin E deficiency is characterized as a hemolytic anemia, owing to the protective effect of vitamin E on polyunsaturated fatty acids in the membranes of red blood cells. Deficiency of vitamin E is thought to be largely limited to premature and low-birth-weight infants, and individuals with pathological malabsorption syndromes, as vitamin E is common in foods, particularly vegetable and seed oils. Vitamin E is routinely provided to premature/low-birth-weight infants in high-income countries, to avoid "anemia of prematurity" (**Balch 2016**).

2.4.3.1 Symptoms of Vitamins C, D and E deficiencies

The most common symptoms of anemia of vitamins C, D and E deficiencies are Bleeding gums; Infection; Dry hair and skin; Gingivitis; Nosebleeds; Weight gain, Painful joints; Weakened tooth enamel; Weak and brittle bones; Bone pain; Muscle weakness; Lowered resistance to infection; Slowed wound healing; Dry, splitting hair; Weight gain; Painful joints; Scurvy (**Moll and Davis 2017**).

2.5 Causes of nutritional anemia

The major hematopoietic nutrients are iron, vitamin B_{12}, and folic acid. Because of the particular steps in hematopoiesis where these nutrients function, the causes of nutritional anemias are suggested by the morphologic appearance of cells in peripheral blood or bone marrow smears. The mean corpuscular volume (MCV) provides the first clue to the etiology of anemias. Anemias are classified as microcytic (small-cell) when the MCV is less than 80 fl. The major nutritional cause of microcytic anemias is iron deficiency, and minor ones are pyridoxine and copper deficiencies (**Green and Mitra 2017**).

Normocytic anemias (MCV 80 to 96 fl) are common in patients with protein-energy malnutrition (PEM) and various chronic diseases, and macrocytic anemias (MCV greater than 96 FL) can be caused by vitamin B_{12} or folic acid deficiencies. Microcytic and macrocytic cells can coexist; for example, a patient can have both iron and folate deficiencies. In these cases, the MCV may be deceptively normal and suggest a normocytic anemia, but the blood

smear shows a dimorphic population of RBCs. The diagnosis of a nutritional anemia is confirmed by measuring the blood level of the suspected nutrient and sometimes by examination of the bone marrow. Final proof of the diagnosis is provided by a therapeutic response to replacement of the deficient nutrient **(Green and Mitra 2017).**

Anemias have many etiologies, so underlying causes must be investigated. My study has focused on anemia caused by nutritional deficiencies where erythropoiesis (RBC production) is diminished. Thus, anemia is a manifestation of not only nutritional deficiencies, but many different conditions. An anemia is considered nutritional in origin when one or more nutrients essential to RBC formation is deficient. Such deficiencies may occur with normal dietary intake if increased requirements (e.g., pregnancy, hemolysis, or alcohol abuse) or external losses (e.g., chronic gastrointestinal blood loss) exist. The major mechanisms by which an individual becomes nutrient deficient include inadequate ingestion, malabsorption, impaired utilization, elevated requirements, increased excretion, or increased destruction **(Allali *et al.*, 2017).**

2.6 Laboratory diagnosis

A complete blood count (CBC) is a blood test that shows the number of blood cells. Anemia is diagnosed if RBC levels are too low. It may also suggest what type of anemia is present. Other tests or questions will help to confirm an anemia due to nutrition. Tests to rule out other causes include: Blood smear (blood is taken from your finger and smeared on a slide. RBCs can be looked at in a lab to look for problems in shape or size), Reticulocyte count which counts young RBCs to see how fast RBCs are being made, serum iron, iron binding capacity, and ferritin to see if you have enough iron in your blood, Folic acid and B12 levels, hemoglobin electrophoresis which looks for any issues that may be caused by problems with your genes, RBC fragility Looking for weak RBCs that have a higher chance of being destroyed, Coombs tests to finds antibodies that make RBCs more fragile (**George-Gay & Parker, 2013**).

2.7 Treatment of nutritional Anemia

2.7.1 Nutritional treatment

Treating anemia of nutritional origin is a matter of how food we eat aid in hemoglobin synthesis. In general, to treat anemia of nutritional origin, focus should be placed on foods that are good sources of iron, copper, zinc, folic acid, vitamin B12 and proteins. The combination of iron and B vitamins is especially good for treating anemia of nutritional origin (**Moll and Davis 2017)**.

2.7.1.1 Vitamin C

Vitamin C helps the body to absorb the iron. Good sources of vitamin C include vegetables and fruits, especially citrus fruits. Citrus fruits include oranges, grapefruits, tangerines and similar fruits. Flesh and frozen fruits, vegetables and juices usually contain a lot of vitamin C compared to canned ones. Other fruits rich in vitamin C include kiwi fruits, strawberries and cantaloupes. Vegetables rich in vitamin C include broccoli, peppers, brussels sprouts, tomatoes, cabbage, potatoes, and leafy green vegetables like spinach (**Iqbal *et al.*, 2009**).

Low level of vitamin B12 leads to pernicious anemia. This condition is often treated by vitamin B12 supplements. Vitamin B12 is found in breakfast cereals with added vitamin B12, meats such as beef, liver, poultry, fish, eggs, and dairly products such as milk, yogurt and cheese, foods fortified with B12 vitamin, such as soy-based beverages and vegetarian burgers (**Aspuru *et al.*, 2011**).

2.7.1.3 Vitamin B9 (Folic acid)

Folate helps to form DNA and RNA and is involved in protein metabolism. It plays a key role in breaking down homocysteine, an amino acid that can exert harmful effects in the body if it is present in high amounts. Folate is also needed to produce healthy red blood cells and is critical during periods of rapid growth, such as during pregnancy and fetal development. Good sources of folate include, dark green leafy vegetables (turnip greens, spinach, romaine lettuce, asparagus, Brussels sprouts, broccoli), beans, peanuts, sunflower seeds, fresh fruits, fruit juices, whole grains, liver, seafood, eggs, fortified foods and supplements (**Bailey *et al.*, 2015**).

2.7.1.4 Iron

Most people should be able to get all the iron they need by eating a varied and balanced diet. Good sources of iron include, liver, red meat, beans, such as red kidney chickpeas, nuts, dried fruit such as dried apricots, fortified breakfast cereals, soy bean flour. Eating a balanced, healthy diet including good sources of iron helps to prevent any deficiencies. Combination of vegetarian sources of iron with vitamin C in the same meal is of importance. For example: a bell pepper-bean salad, spinach with lemon juice, or fortified cereal and berries (**Carvalho et al., 2010**).

2.7.1.4 General Nutritional Treatment of Anemia

No single food will cure anemia. But eating an overall healthy diet rich in dark, leafy greens, nuts and seeds, seafood, meat, beans, and vitamin C-rich fruits and vegetables can help you get the iron you need to manage anemia. Eat iron-rich foods with foods that contain beta carotene,

such as apricots, red peppers, and beets, to improve absorption. Eat a variety of heme and non-heme iron foods throughout the day to up your iron intake and to increase iron absorption. Foods rich in folate and vitamin B-12 should be added to support red blood cell production (**Dwyer 2017**).

According to expert nutritionist from Bangalore, Dr. Anju Sood, "anemia is caused by iron deficiency. To fuel the iron in the body, ascorbic acid acts as a carrier. Adding ascorbic acid or vitamin C rich fruits can help in regulating iron intake and eventually increasing the hemoglobin. «Apart from the normal foods, it is imperative to add fruits in the daily diet to increase the red blood cell count. Some fruits suggested by Dr. Sood that the child should eat regularly are, Pomegranate which helps boosting the blood count, banana which stimulates the production of hemoglobin in the blood and apples which are a rich source of iron with various other health-friendly components that are required for stimulating hemoglobin count (**Abbaspour *et al.*, 2014**).

2.8 Prevalence of anemia associated with nutrition

The importance of the problem was recognized by WHO and FAO at the first meeting of the Joint Advisory Committee in 1949, and at each subsequent meeting through the late 1950s. Between 1955 and 1958, WHO sponsored a national survey of anemia in Mauritius, identifying a prevalence of 15 to 64% for anemia, with a hypochromic microcytic variety prevailing and associated with hookworm infection? The anemia subsequently was shown to respond to bread enrichment with iron. WHO followed up with investigations of nutritional anemia among pregnant women in India, 38% of whom were anemic; half of those who were severely anemic showed megaloblastic changes in their bone marrow, which were responsive to combined iron and folic acid prophylaxis (**Baker and DeMaeyer 2017**).

These studies prompted WHO to establish internationally acceptable standards for the study of anemia based on hemoglobin levels, but the standards set were general for age and sex categories. Consequently, hemoglobin has emerged as the fair-weather surrogate in most national and regional surveys of nutritional anemia, particularly in developing countries, because of ease of measurement in comparison with other specific causative nutrients. The databank available at the WHO which estimates the global and regional prevalence of anemia, therefore, does not allow differentiation of nutritional etiology or that caused by non-nutritional factors (**Underwood 2011**).

2.9 EMPIRICAL LITERATURE

2.9.1 International empirical literature

Carvalho *et al*. (2010) did a study related to iron-deficiency anemia in 301 children aged six to fifty-nine months attending public day-care in the city of Recife, North-east Brazil. 92.4% of the children had anemia with Hb<11.g/dl and 28.9% had moderate/severe anemia with Hg<9.0g/dl. Among these, only 58.1% had anemia of iron deficiency, 34.2% were anemic of nutritional origin other than iron deficiency and 2.3% had anemia of other origin. About 51% of subjects had an inflammation and only ferritin was significantly associated with CRP. High ferritin levels were significantly associated with high CRP levels. The mean ferritin concentration was significantly higher in subjects with inflammation when compared with those without inflammation.

The study conducted among 595 children with age-range between 6-59 months in children attending one hospital in Recife, Brazil with the objectives of identifying the prevalence of anemia and associated risk factors among undernourished children reveals that about 56.6% were anemic and only 34.1% students were aware of being anemic. Anemia was significantly correlated with low weight and a diagnosis of acute lower respiratory disease and low food intake (**Carvalho et al., 2010**).

A community based cross-sectional study on prevalence of anemia with nutritional origin among rural pre-school children of Maharashtra, India showed that the mean hemoglobin level among children with the age ranging between 1-5years was 10.4g/dl (10.2-10.6) with 9.6g/dl (9.3-9.9) in 1-3 years old and 10.6g/dl (10.4-10.8) in 4-5 years' age-group. The mean hemoglobin values are significantly different between different age groups ($p<0.01$). The results showed that the overall prevalence of anemia among the rural pre-school children of Maharashtra was 59.2%, and the prevalence was significantly ($p<0.001$) higher (76.5% with CI between 68.1-84.9) among 1-3years children as compared to 53.6% in 4.5 years old children and among them a higher proportion of girls (63%) were anemic compared to boys (57%). The prevalence of nutritional anemia was decreased with increase in age where significantly ($p<0.01$) a higher proportion (90.9%) of 1+ years old children were anemic compared to the children of 4+ years old (48.1%) (**Arlappa *et al.*, 2012**).

Pala *et al*. (2016) reported that the prevalence of nutritional anemia in children under 2 years old in rural Bangladesh was 62% (765/1.237) when a single hemoglobin parameter level<11.0g/dl was used. However, considering other parameters of low iron status such as ferritin levels <12mg/L and C-reactive protein <5mg along with low hemoglobin level, only 28% cases were reported to have iron deficiency anemia. When low hemoglobin and high serum transferrin receptor>5mg/L were considered as indicator of iron deficiency, 34% of anemic children had iron deficiency anemia. The study team compared the 235 iron deficiency anemic children with 2019 non-anemic children matched for age, sex, weight height and village. Diagnosed iron deficiency anemic children received 30mg ferrous sulfate syrup daily for six months. All the enrolled children were reassessed for their iron status 6months later and found responded adequately to 6months of iron treatment. Mothers of anemic children scored low in intelligence test compared to mothers of non-anemic children and they were also from poorer economic conditions. Children with iron deficiency anemia were more likely to be stunted compared to others.

Less than five years old children's mothers in rural areas and urban slums in Indonesia were assessed for their knowledge of nutritional anemia and the study revealed that in urban slums, 28.7% of mothers and 62.3% of children were anemic whereas in rural areas, 25.1% of mothers and 55.2% of children were anemic. Maternal knowledge of nutritional anemia was associated with child anemia in rural and urban areas respectively (OD 0.90, 95% confidence interval of 0.79, 1.02, P=0.10 or 0.93, 95% CI 0.87, 0.98 with p=0.01) in multivariate logistic regression models adjusting for potential confounders (**Souganidis 2018**).

The study conducted in under-five anemic patients in Ethiopia showed that the prevalence of under-five anemia ranges from 13.6% of 628 under-five children in Amhara region to 72% of 397 under-five children in Somalia region. The Der Simonian-Laird random-effect model pooled prevalence of under-five anemia in Ethiopia was 44.83% (95% CI 36.71, 52.95). In subgroup analysis, 50.36% of anemia was found in the age range of 6–23 months old and 43% of them were from the age range of 6–59 months old (Fig. 3). The level of severity of anemia in this study was 17.56% (I2 = 92.9%), 26.12% (I2 = 93.5%), and 8.8% (I2 = 82%) had mild, moderate, and severe anemia, respectively. Regarding the sex of the child, anemia was more prevalent in male (31.3%) (I2 = 85.6%) compared with females (26.86%) (I2 = 55.2%) (**Belachew and Tewabe 2020)**.

2.9.2 Regional empirical literature

A study conducted to find out the prevalence of anemia and to investigate possible etiologies including malnutrition, intestinal helminthes infection and *Helicobacter pylori* infection in the under five children presenting for well-child examination at a community health Centre in Thohoyandou, Limpopo Province. The results reveal 75% of children had anemia and among them girls were significantly more anemic than boys. The medium hemoglobin concentration was 9.65±2.6 b/dl. Anemic children were significantly less likely to be underweight compared with their peers (32/38 v. 5/12 respectively, p=0.007). There was no significant association between anemia and infection with H. pylori (p=0.729), intestinal helminthes (p=1.000) or food insecurity (p=0.515) (**Heckman *et al.*, 2017**).

Parulian (2015) conducted a study and found 70.5% of under-five children aged 6 to 59 months were anemic in Imo state of Nigeria, and among them 48.1% were iron deficient. These results revealed that the overall mean hemoglobin of the subjects investigated (n=400) aged 12-59 months were 10.4g/dl. The most affected age-group was 12-23 months (84.8%). Nutritional anemia was found much more prevalent in rural (78.7%) than urban (61.3%) areas. The prevalence of nutritional anemia decreased with age-group i.e. 84.8%, 78.4%, 69.7% and 65.9% for the 12-23, 24-35, 36-47, and 48-59 months' age-group, respectively. There was no difference in anemia among boys and girls in Imo state **(Amancio, O. M, 2018)**

The study carried out to determine the prevalence of nutritional anemia and associated risk factors among under-five years old and their mothers in a rural area of Bushenyi district, Western Uganda was of greater importance. According to Kikafunda *et al.* (2009), the overall prevalence of iron deficiency anemia among children and their mothers was 26.2% and 17.9%, respectively **(Juliano, Y, 2018).**

There was a significant correlation (r=50.5, p=0.008) between the hemoglobin levels of the mothers and their children. Place of birth, age of the child, factors related to complementary foods, and formal education and nutritional knowledge of mothers were the major factors that were significantly associated (r=50.05, p=50.05) with low hemoglobin levels among the children. The findings revealed that iron deficiency anemia was a major problem of these children and mothers compared to other types of nutritional anemia. Dietary factors and socio demographic factors were the major factors associated with the high levels of nutritional anemia among the children and their mothers. This study recommended that rural mothers

should be sensitized on best practices for the prevention of anemia among children and others (**Kikafunda *et al.*, 2009**).

2.9.3 Local empirical literature

Rwanda Demographic and Health Survey carried out a research study to estimate the relative contribution of malaria and other potential determinants to anemia prevalence in Rwanda. The mean altitude-adjusted Hb level in the overall study sample was 11.30 g/dl (95% CI: 11.25–11.36 g/dl). The weighted prevalence of anaemia was 38.1% (95% CI: 36.3%–39.8%), with mild anaemia present in 24.3% (mean Hb: 10.5 g/dl), moderate anaemia in 13.4% (mean Hb: 9.2 g/dl) and severe anaemia in 0.5% children (mean Hb: 5.9 g/dl). The prevalence of anaemia was approximately 6% higher among boys, and was more than double in the youngest age group compared to the oldest age group; both associations were statistically significant. Anaemia prevalence varied by region and wealth quintile, but not by rural *vs*. urban residence. Although only 1.4% children tested positive for malaria, the proportion anaemic in this subgroup was significantly higher (79.2%, compared to 37.5% with a negative malaria test; $P < 0.0001$). Prevalence of *severe* anaemia was 4.0% in children with malaria, compared to 0.4% in those without (**Nkulikiyinka *et al.*, 2015**).

In the overall study population, malaria was strongly associated with anemia (OR = 6.83, 95% CI: 2.90–16.05), but population impact was modest (population-attributable fraction = 2.5%). Factors associated with lower odds of anemia were recent de-worming medication (six months; OR = 0.60, 95% CI: 0.49–0.74), female sex (OR = 0.76, 95% CI: 0.66–0.87), increasing age, residence in North Province and educated mother. Being underweight and recent fever (two weeks) were associated with higher odds. In the subpopulation with diet data, odds were lower with consumption of vitamin A-rich foods (OR = 0.66, 95% CI: 0.50–0.88); and higher in households with many young children (**Nkulikiyinka *et al.*, 2015**).

Erigene *et al.* (2019) conducted a study on prevalence of iron deficiency anaemia and associated factors among children aged six to fifty nine months seen at Kabutare District Hospital, Rwanda .The result of this study revealed the prevalence of iron deficiency anaemia was 20.6% among respondents. Prevalence of anaemia was 25.4% with 81.2% of these cases having iron deficiency. No socio-demographic factor was associated with iron deficiency anaemia. The factors found to be associated with iron deficiency anaemia history of recent blood transfusion in past year [AOR = 5.81; 95%CI = 1.566 - 21.577; p = 0.009]. Children who

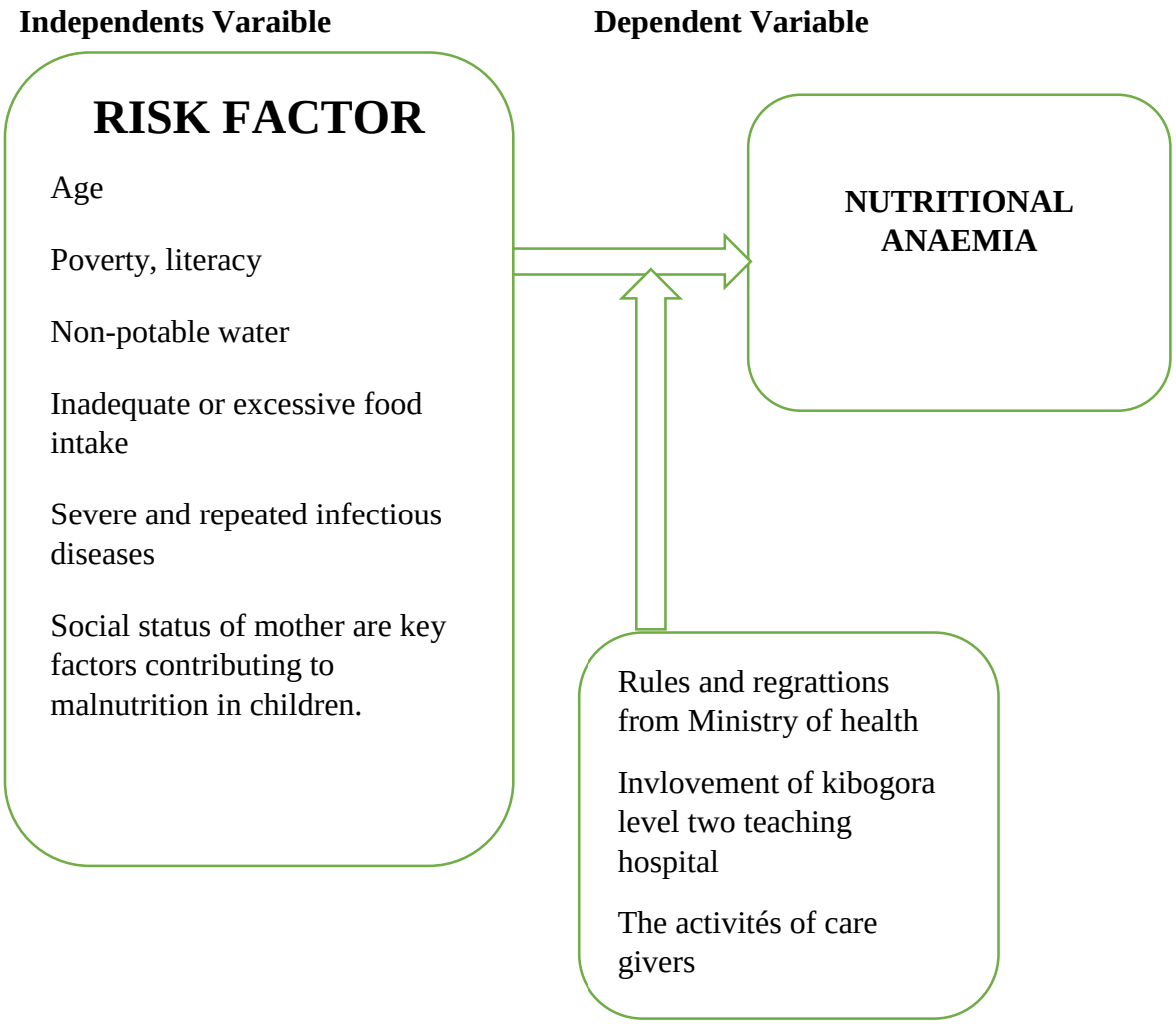
consumed cow milk before six months were three times more likely to have iron deficiency anaemi, but no statistical significance observed.

Conceptual Frame Work

A conceptual framework is a representation of the relationship you expect to see between your variables, or the characteristics or properties that you want to study. Conceptual frameworks can be written or visual and are generally developed based on a literature review of existing studies about your topic

ASSESSMENT OF PREVELENCE AND RISK FACTOR OF NUTRITIONAL ANAEMIA AMONG CHILDREN UNDER FIVE YEAR'S OLD

Figure 1: Conceptual frame work



Adapted Conceptual frame work

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. INTRODUCTION

There are a number of approaches used in research design. The purpose of this chapter is to design the methodology of the research approach. The research approach also supports the researcher on how to come across the research result findings. In this chapter, the general design of the research and the methods used for data collection are explained in detail. It includes three main parts. The first part gives a highlight about the dissertation design, the second part discusses about quantitative data collection methods. The last part illustrates the general research framework. The purpose of this section is to indicate how the research was con-ducted throughout the study periods.

3.2 RESEARCH APPROACHES AND DESIGN

This study was Retrospective quantitative approach. Researchers will be interested in this design and approach to quantify and analyze the data collection. Data will be collected in the documents of the patients who were suspected and diagnosed with nutritional anemia among under 5 years' children by laboratory department (hematology service), pediatric service and archiving unity. The study was conducted in 2023 were included in the study.

DESIGN

This was a cross-sectional study and was conducted in a period of six months from march to August 2024

3.3 STUDY AREA

This study was carried out at Kibogora District hospital in pediatric and laboratory department, located in Western Province, Nyamasheke District, Kanjogo sector and Kibogora cell. It is built in front of the Kibogora Polychnique University. The hospital receives referred patients from 12 Heath centers of Nyamasheke district and others from neighboring health centers of mukoma, muyange and patients from Kamonyi and mugera health center.

3.5 TARGET POPULATION

This study include all children aged 6-59 months with caretakers attending Kibogora District Hospital who fulfilled inclusion criteria during the study period. The target population were the children who were suspected and diagnosed with nutritional anemia attending laboratory and pediatric department at KDH in 2023.

3.6 SAMPLING PROCEDURE

Up to 4 ml of venous blood was collected into EDTA and dry test tubes. After maintenance of Sysmex and Abbott 1000i architect machines, the serial number of patients was put created, the patient's examination tests were ticked and saved, and samples were examined. Full Blood count and serum ferritin Levels were expressed.

3.7 SAMPLE SIZE

All children attended pediatric and laboratory departments at kibogora district hospital in 2023 suspected and diagnosed with nutritional anemia will be the target of the study. However, all clients who met with inclusion criteria and concerted will be selected for the study participation.

The sample size was reduced according to the Fisher's formula

$N=z^2. p. q/e^2$

Consider :

N= sample

Z= the score associated with the desired confidence level 95%

Z=1.96

P : expected prevalence of viral hepatitis B and C among immunocompromised patient

P= 3% or 0.0300

e= margin error equal to 5% = 0.05

n= 23.4416*0.03*0.17/0.0025

n= 50

Sampling interval=100/50

Sampling interval= 2

The sampling interval of this study was 2 regarding to the total population.

3.8 INCLUSION

Children were eligible if they; were at least in the age group of 6 months to 59 months with hemoglobin level less than 11 gm/dl.

3.9 EXCLUSION CRITERIA

Children were excluded if they; were in the age group below 6 months and above 59 months with hemoglobin level above 11 g/dl.

3.10 DATA COLLECTION

Upon obtaining consent, written questionnaires in native language were distributed to caregivers to obtain the information regarding risk factors associated to nutritional anemia. Participants were informed of the general purpose and benefits of the study. Middle Upper Arm Circumference (MUAC) was used to assess the nutritional status of children. Up to 4 ml of venous blood was collected into EDTA and dry test tubes. After maintenance of sysmex and Abbott 1000i architect machines, the serial number of patients was put created, the patient's examination tests were ticked and saved, and samples were examined. Full blood count and serum ferritin levels were expressed.

3.11 ETHICAL CONSIDERATION

A recommendation letter of data collection was obtained from Kibogora Polytechnic and this study was approved by the hospital research committee prior to being done and presented in department of biomedical laboratory sciences from Kibogora Polytechnic.

3.12 STATISTICAL ANALYSIS

Statistical package for the social sciences (SPSS) for windows version 24 software was used to analyze data in order to determine the frequency and statistical significance of records. Data were presented in terms of frequency, tables and percentages.

CHAPTER FOUR: DATA PRESENTATION, ANALYSIS, DISCUSSION AND INTERPRENTATIONS

4.0. Introduction

This chapter present the analysis and interpretation of results from data collected in relation to the study objectives the data collected was presented in form of descriptive statistical tables and percentages and frequency, this chapter is divided into three parts, the first parts were present the different data gathered while carrying out this research their interpretation and analysis, part two presents the discussion of the result and part three deals with summary of Findings.

4.1 DATA PRESENTATION AND ANALYSIS

4.1.1 Introduction

The researcher presents the gathered data from the respondents by considering the demographic information of respondents about the Gender, age, number of years in current position, Education level, current Marital status and attitude of respondents about the contribution

4.1.2 Distribution of respondents related to the sex

While carrying out this research the ideas of both sex (male and female) were used by considered to put the practical the policy and regulations of gender balance, it was shown by the figure below with the percentages and frequency.

Table 1: Gender of respondents

Gender group	**Frequency**	**Percentages**
Male	27	54%
Female	23	46%
Total	**50**	**100%**

Source Primary data

The table above show the number of respondents according to the Gender, 27(54%) was the number of respondents who were male and 23(46%) was the number of respondents who were Female

4.1.3 The age group regarding Months children

Regarding to the months of children leads to the risk factors of nutritional anemia and its associated risk factors among under five years' children like 6-16 months, 17-27 months, 28-38 months.

Table 2: The Age children

Age group	**Frequencys**	**Percent**
6-16 Months	21	42%
17- 27 months	14	28%
28-38 months	6	12%
39-49 months	7	14
50-59 months	2	4%
Total	50	100%

The table above show number according to the age children

4.2 FINDINGS RELATED TO THE SPECIFIC OBJECTICES

This was shown according to Three specific objectives that are mentioned below: the prevalence of nutritional anemia among under five years' children, to assess the risk factors associated with nutritional anemia among under five years' children and to determine the nutritional status among under five years' children.

4.2.1 The prevalence of nutritional anemia among under five years' children

The table below show the number of number of respondents were the

Table 3: The prevalence of nutritional anaemia among under five years' children (n=50)

Under 5 years grouped in months	**Frequency**	**Percent**	***Prevalence of nutritional anaemia among under five years' children***	
			frequence	***%***
6-16 Months	21	42%	2	4
17- 27 months	14	28%	0	

28-38 months	6	12%	1	2
39-49 months	7	14	0	
50-59 months	2	4%	1	2
Total	50	100%	4	8

The table provides a breakdown of the prevalence of nutritional anemia among children under five years old, segmented by age groups. It shows that out of a total sample of 50 children, 4 were diagnosed with nutritional anemia, resulting in an overall prevalence rate of 8%. The prevalence varies across different age groups: for children aged 6-16 months, the prevalence is 4% (2 out of 21), for 17-27 months it's 0%, for 28-38 months it's 2% (1 out of 6), for 39-49 months it's 0%, and for 50-59 months it's 2% (1 out of 2). The distribution of anemia cases is thus sparse, with no anemia detected in the 17-27 and 39-49 months age groups, and relatively low rates in the other groups, indicating that while the overall prevalence is 8%, it is unevenly distributed among different age ranges.

4.2.2 The risk factors associated with nutritional anemia among under five years' children

The risk factors associated with nutritional anemia among under five years' children were Malnutrition in children is mainly due to unbalanced diet, Inadequate or excessive food intake, Non-potable water, poor and unhygienic food quality as well as sanitary practice, severe and repeated infectious diseases, contributing factor to disease, disability and early deaths for women and children, Poverty, literacy, Social status of mother are key factors contributing to malnutrition in children, factors significantly contribute to the cause of propensity for malnutrition in an individual, Social status of mother, factors significantly contribute to the cause of propensity for malnutrition in an individual, factors significantly contribute to the cause of propensity for malnutrition in an individual, Social status of mother are key factors contributing to malnutrition in children.

Table 4: the risk factors associated with nutritional anaemia among under five years' children (n=50)

Risk Factor	Frequency	Percent	P-Value
Malnutrition in children is mainly due to imbalanced diet	4	8%	0.053
Inadequate food intake	4	8%	0.053
Non-potable water	6	12%	0.181
Poor and unhygienic food quality as well as sanitary practices	2	4%	0.270
Severe and repeated infectious diseases	5	10%	0.058
Contributing factor to disease, disability, and early deaths for women and children	7	14%	0.282
Poverty, literacy	5	10%	0.058
Social status of mother is a key factor contributing to malnutrition in children	3	6%	0.089
Factors significantly contribute to the cause of propensity for malnutrition in an individual	2	4%	0.270
Social status of mother is a key factor contributing to malnutrition in children	1	2%	0.491
Factors significantly contribute to the cause of propensity for malnutrition in an individual	4	8%	0.053
Factors significantly contribute to the cause of propensity for malnutrition in an individual	3	6%	0.089
Social status of mother is a key factor contributing to malnutrition in children	4	8%	0.053

The analysis of risk factors associated with nutritional anemia reveals that most factors do not show statistically significant associations, as indicated by p-values greater than 0.05. Specifically, factors such as non-potable water (P = 0.181), poor and unhygienic food quality (P = 0.270), and others are not significantly different from what would be expected by chance. The social status of the mother (P = 0.491) has the highest p-value, suggesting minimal evidence of significance for this factor. However, factors with p-values slightly below 0.05, such as malnutrition due to imbalanced diet (P = 0.053), inadequate food intake (P = 0.053), severe and repeated infectious diseases (P = 0.058), and poverty and literacy (P = 0.058), show a trend toward significance, indicating potential associations with nutritional anemia, though they are not conclusively significant. These findings should be interpreted with caution, and further research with larger sample sizes and refined risk factor categories is recommended for more definitive conclusions.

4.2.3 The nutritional status among under five years' children.

The nutritional status among under five years' children were at what level of nutritional anemia among children under five years old, why nutritional anemia cannot be eliminated permanently, what can we do in order to eliminate nutrition anemia among children under five years old, how can nutrition anemia among under five years can be prevented, the treatment of nutrition anemia among under five years old and it be prevented from children among under five years' old

4.3 DISCUSSION OF FINDINGS

4.3.1 Prevalence of Nutritional anemia

Anemia is an important comorbidity in under-five children with severe acute malnutrition (SAM). The data on evaluation of SAM are limited. About 95% of anemia prevalence was found among children with SAM and most cases were of nutritional anemia (81.79%). About 54.33% of the children had mild anemia, with 79.75% had iron deficiency as the most common cause, followed by Vitamin B12 and folic acid deficiency (**Chellan and Paul 2017**). The purpose of this research was to determine the prevalence and factors associated with nutritional among children attending Kibogora Level Two Teaching Hospital. In this representative survey of 100 Children aged 6-59 months we have found 24% of children diagnosed with anemia

However, nutritional anemia has remained a severe public health problem based on the WHO classification. This study suggests that Kibogora District Hospital has not achieved the national

nutritional strategy, which is aimed at reducing the prevalence of childhood nutritional anemia by 30% and 20% in 2015 and 2020, respectively (**Gupta 2014**). Similarly, according to a survey report on micronutrient problems in 10 provinces in 2006, it was found that the prevalence of nutritional anemia in pre-school age children in Indonesia was 26.3% of all under-five children. Based on the results of Basic Health research, the prevalence of nutritional anemia in under-five children in Indonesia increased in 2022 to 28.1%. In addition, the results of the South East Asian Nutritional Survey in 2020 found that the prevalence of nutritional anemia in Indonesia in children aged 6-48 months was 25% (**Iswati & Roshida, 2019**).

4.3.2 Risk factors associated with nutritional anemia among under five years' children

risk factors associated with nutritional anemia among under five years' children, 4(8%) was the number of respondents who were Malnutrition in children is mainly due to imbalanced diet, 4(8%) was the number of respondents Malnutrition in children is mainly due to unbalanced diet, 6(12%) were Non-potable water, 2(4% p) was the poor and unhygienic food quality as well as sanitary practice, 5(10%) was the Poverty, literacy, 7(14%) were contributing factor to disease, disability and early deaths for women and children, 5(10%) was Poverty, literacy, 3(6%) was Social statuts of Mother are key factors contributing to malnutrition in children, 2(4%) was the factors significantly contribute to the cause of propensity for malnutrition in an individual, 1(2%) was the Social status of mother are key factors contributing to malnutrition in children, 4(8%) was the factors significantly contribute to the cause of propensity for malnutrition in an individual, 3(6%) was the factors significantly contribute to the cause of propensity for malnutrition in an individual and 4(8%) was the Social status of mother are key factors contributing to malnutrition in children.

4.4 SUMMARY OF FINDINGS

The evidence were conclude that the prevalence of nutritional anemia in pre-school age children in Indonesia was 26.3% of all under-five children. Based on the results of Basic Health research, the prevalence of nutritional anemia in under-five children in Indonesia increased in 2022 to iron deficiency anemia remain the most prevalent type of nutritional anemia in children aged between 6-59 months old. The results showed that the demographic factors such as residence of the participants, parents' knowledge on nutritional anemia, types of meal that a child is given (inadequacy of micronutrients such as iron, folic acid, and vitamin B12, C, and D) and the source of meal that a child is given are the most important factors that influence nutritional deficiencies and leading to the prevalence of nutritional anemia in respondents8.1%,The risk factors associated with nutritional anemia among under five years' children were Malnutrition in children is mainly due to unbalanced diet, Inadequate of food intake, Non-potable water, poor and unhygienic food quality as well as sanitary practice, severe and repeated infectious diseases, contributing factor to disease, disability and early deaths for women and children and level of nutritional anemia among children under five years old, Why nutritional anemia cannot be eliminated permanently, What can we do in order to eliminate nutrition anemia among children under five years old, How can nutrition anemia among under five years can be prevented, the treatment of nutrition anemia among under five years old and it be prevented from children among under five years old

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.0 INTRODUCTION

This chapter presents the conclusion, Recommendations and suggestions for further reserachers

5.1 CONCLUSION

The outcomes of the study shows that iron deficiency anemia remain the most prevalent type of nutritional anemia in children aged between 6-59 months old. The results showed that the demographic factors such as residence of the participants, parents' knowledge on nutritional anemia, types of meal that a child is given (inadequacy of micronutrients such as iron, folic acid, and vitamin B12, C, and D) and the source of meal that a child is given are the most important factors that influence nutritional deficiencies and leading to the prevalence of nutritional anemia in respondents.

5.2 RECOMMENDATIONS

To the community (Parents)

Community is encouraged for the good eating habit for their children (life style) in order to decrease risk of nutritional anemia. Malnutrition screening as early as possible is also recommended, Conducting additional studies and establishing appropriate intervention strategies to improve the nutritional status and increase the intake of food that contains adequate quantities of micronutrients, particularly iron intake are also recommended.

To kibogora

Kibogora level two teaching Hospital should increase skills of caregivers about the nutritional anemia

Kibogora level two teaching Hospital should set direct diognosis about people or chridren have nutritional anemia

5.3 SUGGESTION TO FURTHER RESEARCHER

- We suggest to others researchers to conduct a deep study about nutritional anamia in children under five years old and to investigate much associated factors.
- We propose to other researchers to conduct a deep study about risk factors nutritional anamia in children under five years old and to investigate much associated factors.
- We recommend other researchers to conduct a study on the abnormal growth such as mental retardation due to nutritional anamia in children under five years old.

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APPENDICES 1:RESEARCH LETTER

KIBOGORA POLYTECHNIC

Kibogora, August 07th, 2023

To the DG of Kibogora Level Two Teaching Hospital

RE: Request of conducting Research

Dear sir,

We write this letter to humbly request to allow **Mrs. Rosemary MUTESI and Mrs. Slyvere KAMBANDA** to conduct research in your institution.

The above mentioned are bonafide students of Kibogora Polytechnic pursuing Bachelor's degree in Biomedical Laboratory sciences.

These students are currently conducting a research topic **"ASSESSMENT OF PREVENTION AND RISK FACTORS OF NUTRITIONAL ANAEMIA AMONG UNDER FIVE YEARS CHILLDREN ATTENDING KIBOGORA LEVELL TWO TEACHING HOSPITAL IN 2022''**

We are convinced that your institutionn will constitute a valuable source of information pertaining to their research, the purpose of this letter is to humbly request you to avail them the pertinent information they may need. we pledge to ensure that all provided information will be confidential and used in the strict academic purpose.

Any assistance rendered to the candidates will be highly appreciated.

Yours sincerely,

On behalf of KP Management

KIBOGORA POLYTECHNIC SCIENCE FAITH · CONSCIENCE

Mr. NSENGIYUMVA Jean Paul
Ag. Dean of Health Sciences Faculty
Kibogora Polytechnic

APPENDICES 2: APPROVED LETTER

KIBOGORA POLYTECHNIC

Kibogora, August 07th, 2023

KIBOGORA LEVEL TWO TEACHING HOSPITAL RECEPTION
DATE 07 AUG 2023
Names :
Signature :

To the DG of Kibogora Level Two Teaching Hospital

RE: Request of conducting Research

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Mr. NSENGIYUMVA Jean Paul
Ag. Dean of Health Sciences Faculty
Kibogora Polytechnic

APPENDICES 3: PLAGIARISM

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