# DIETARY PRACTICES, ANAEMIA AND NUTRITIONAL STATUS AMONG DAY-SECONDARY SCHOOL ADOLESCENT GIRLS IN MACHAKOS COUNTY, KENYA

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## DECLARATION

This thesis is my original work and has not been presented for any degree or other award in any other University.

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# DEDICATION

I dedicate this work to my dear husband David and our children Faith, Mercy, Victor and Joy for their patience, support and encouragement.

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## ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| **AOR** | **:** | Adjusted Odds Ratio |
| **ASAL** | : | Arid and Semi-Arid Land |
| **BAZ** | : | BMI-for-Age Z-score |
| **BMI** | : | Body Mass Index |
| **CBC** | **:** | Complete Blood Count |
| **CDC** | **:** | Centres for Disease Control and Prevention |
| **FAO** | **:** | Food and Agriculture Organization |
| **FFQ** | : | Food Frequency Questionnaire |
| **FGD** | : | Focus Group Discussion |
| **HAZ** | : | Height-for-Age Z-score |
| **Hb** | : | Haemoglobin |
| **HFSS** | **:** | High Fat, Salt or Sugar |
| **IDA** | **:** | Iron Deficiency Anaemia |
| **KDHS** | : | Kenya Demographic and Health Survey |
| **KNBS** | : | Kenya National Bureau of Statistics |
| **MCH** | : | Mean Cell Haemoglobin |
| **MCHC** | : | Mean Corpuscular Haemoglobin Concentration |
| **MCV** | : | Mean Corpuscular Volume |
| **MDD-W** | : | Minimum Dietary Diversity-Women |
| **MOALF** | **:** | Ministry of Agriculture, Livestock and Fisheries |
| **MOEST** | **:** | Ministry of Education, Science and Technology |
| **MOH** | **:** | Ministry of Health |
| **NACOSTI** | **:** | National Council for Science, Technology and Innovation |
| **PEM** | **:** | Protein–Energy Malnutrition |

| | | |
|---|---|---|
| **PSES** | **:** | Parental Socio-Economic Status |
| **RBC** | **:** | Red Blood Cell |
| **RDA** | **:** | Recommended Dietary Allowance |
| **RDW** | : | Red Cell Distribution Width |
| **SES** | : | Socio-Economic Status |
| **SPSS** | : | Statistical Package for Social Sciences |
| **UNICEF** | : | United Nations Children's Fund |
| **WHO** | : | World Health Organisation |
| **WHZ** | : | Weight-for-Age Z-score |
| **WRA** | : | Women of reproductive age |

## OPERATIONAL DEFINITIONS OF TERMS

**Adolescent** - A young person between the ages of 10 and 19 years.

**Anaemia** - Low haemoglobin concentrations of less than 12g/dL of whole blood for non-pregnant adolescent girls 12 years and above after altitude adjustment.

**Anthropometric indices** - BMI-for-age Z-scores (BAZ) and height-for-age Z-scores (HAZ) for those aged <18 years; and body mass index (BMI) for those aged ≥18 years were used in this study. BAZ > +2 Z-score or BMI ≥30 was termed as obesity, BAZ > +1 Z-score or BMI 25.0 - 29.9 was overweight, BAZ < -2 Z-score or BMI < 18.5 was underweight while HAZ < -2 Z-score was stunting (WHO, 2016b).

**BMI-for-age Z score -** The interpretation of BMI for persons aged 5-17 years depending on age and sex.

**Dietary practices -** Habitual decisions made by an individual or family regarding choice of food to eat, amount of food, number of meals and diversity of diet.

**Haemoglobin (Hb)** - The protein molecule in red blood cells that carries oxygen from the lungs to the tissues and carbon dioxide from the tissues back to the lungs.

**Haemoglobin concentration** - The amount of haemoglobin (in grams) in one decilitre (dL) of whole blood.

**Morbidity status** - Presence or absence of an incidence of disease within the previous two weeks prior to data collection.

**Menstrual profile** - Menstrual characteristics as described by menarche status, menarche age, duration of menstrual flow and cycle regularity.

**Nutrient intake** - This study focused on the intake of selected nutrients namely carbohydrates, proteins, fat, zinc, iron, folate, vitamin C, A and B12.

**Nutritional status -** Individual's physiological state as determined by dietary intake, anthropometric indices and biochemical markers of Hb in this study.

## ABSTRACT

Adolescence is a critical phase of growth and development and anaemia during this stage can cause irreversible negative outcomes on learning, work capacity and parenthood. Poor diet remains a major risk factor for anaemia and malnutrition among adolescent girls. Adoption of good dietary habits in adolescence enhances optimal growth and development, and is linked with better health outcomes in adulthood. This study aimed to determine anaemia and nutritional status among day-secondary school adolescent girls in Matuu ward, Machakos County; describe their dietary practices and establish the associated risk factors. A cross-sectional analytical study design was adopted and a sample of 238 girls was randomly selected from the day schools by proportion to size. A researcher administered questionnaire was used for data collection. Data on nutrient intake and dietary practices was generated using a 24 hour dietary recall questionnaire and a 7-day food frequency questionnaire (FFQ). Anthropometric data of weight and height was used to determine nutritional status while haemoglobin (Hb) concentration was used to assess anaemia. Respondent's age was calculated using WHO AnthroPlus software. Data entry and analysis was done using SPSS version 20. BMI-for-Age (BAZ) > +2 Z-score / BMI ≥30 was termed as obesity, BAZ > +1 and < +2 Z-score / BMI 25.0 - 29.9 overweight and BAZ < -2 Z-score / BMI <18.5 underweight. Height-for-Age Z-score (HAZ) < -2 Z-score was stunting. Haemoglobin concentration <120g/L after altitude adjustment was termed as anaemia. Data from 24hr recall was analysed using Nutri-survey and transferred to SPSS. Pearson correlation and Chi-square tests were used to determine relationships and association between variables. Binary logistic regression was used to predict outcomes. The p-value for statistical significance was set at 0.05. Data was presented in form of percentages, frequencies, and means. The mean age of the study subjects was 16.79 ± 1.38. Dietary intakes for energy and iron were below RDA while carbohydrate intake was above RDA. A proportion of 44.4 % achieved the minimum dietary diversity for women of reproductive age (MDD-W). The prevalence of anaemia was 28.6%. About a fifth (21.6%) of the respondents were either underweight, overweight or obese. BAZ was positively related to carbohydrate intake ($r$ = 0.429, p-value = <0.001) while iron intake ($r$ = 0.61, p-value = 0.0013) and dietary diversity score ($r$ = 0.175, p-value = 0.012) were positively related to Hb levels. Household size (AOR=0.21(95%C.I; 0.06–0.70), p = 0.030), morbidity status in previous 2 weeks (AOR =2.70(95%C.I; 1.24 – 5.90), p = 0.013), dietary diversity tertile (AOR= 0.12(95%C.I; 0.02 – 0.79), p = 0.039) and adequacy of iron (AOR=10.4(95% C.I; 2.12–199.08), p = 0.009) were the determinants of anaemia. Based on these study findings, it is concluded that the problem of anaemia among the day-school adolescent girls is higher than the national level of 23.8% and their overall nutritional status is poor. Intervention strategies to improve nutrient intake and diversification of diet among adolescent girls in learning institutions are therefore recommended.

# CHAPTER ONE: INTRODUCTION

## 1.1 Background to the Study

Adolescents are a sub-set of children within the age range of 10 to 19 years (WHO, 2013). They represent a sixth of the global population today, nearly a quarter of the population in sub-Saharan Africa and 24% of the population in Kenya (Kenya National Bureau of Statistics (KNBS) - Ministry of Planning, 2009; WHO, 2017). Majority (90%) of these adolescents live in low and middle income countries where they face a higher burden of health challenges including malnutrition (Ismail et al., 2020). Projections estimate a rapid growth of youth (15-24 years) and children (19 years and below) population in Africa such that 40% of the world's children will live in Africa by the year 2050 (E. C. Keats et al., 2018; WHO & UNICEF, 2019). Being the largest generation in the history of humanity today, adolescents are undoubtedly critical in impacting global health and development. As such, focus should be directed on their health and wellbeing so as to achieve the sustainable development goals and also allow them to thrive and change their societies.

Adolescence signifies a critical phase of biological transition that is characterised by accelerated growth which places extra nutritional demands on the body, making adolescents more vulnerable to nutritional deficiencies (E. Keats et al., 2017; Soliman et al., 2014). Simultaneously, psychosocial and behavioural changes such as increased autonomy, peer influence, self-image concerns and increased mobility occur, affecting their dietary practices and resulting in erratic eating habits (Christian & Smith, 2018; Kotecha et al., 2013). Other factors such as food availability and nutrition knowledge also influence their food habits (Banna et al., 2016; Ochola & Masibo, 2014). As such, adolescence can be a key entry point for interventions targeting establishment and maintenance of healthy dietary habits through adulthood.

This becomes a window of opportunity for correcting earlier nutritional deficiencies and catch up growth so as to break the vicious circle of intergenerational malnutrition and chronic disease (Prentice et al., 2013; WHO, 2014).

The dietary practices established during adolescence coupled with elevated iron needs for build-up of lean body mass and support of menstrual blood losses exposes adolescent girls to a higher risk of anaemia (Mesfin et al., 2015). Long-term negative iron imbalance due to inadequate iron intake, poor absorption, or increased losses such as through menstruation or worm infestation, results in iron deficiency anaemia (Gonete et al., 2018; Srivastava et al., 2016). Further still, the socio-cultural norms of early marriage, adolescence pregnancy and poor health services increases the vulnerability to anaemia (Stang & Stotmeister, 2017; UNICEF, 2011). Consequently, the prevalence of anaemia among adolescent girls and women of reproductive age is high and stands at 27% among adolescent girls globally, 57% among non-pregnant women in Africa, 16% among adolescents 10-14 years and 25% among women of reproductive age in Kenya (National Malaria Control program (NMCP) et al., 2016; WHO, 2015). Anaemia reduces productivity and increases maternal and perinatal mortality risk (Pasricha et al., 2013; WHO, 2015).

Malnutrition is a common cause of morbidity and mortality globally and is rated as having reached epidemic proportions among adolescents in developing countries where Sub-Saharan Africa is one of the two worst hit regions (Ismail et al., 2020; Keino et al., 2014). In Kenya, protein energy malnutrition (PEM) causes 2% of the mortalities in male and female adolescents aged 10-14 years, while iron deficiency anaemia (IDA) causes 3% of morbidities in the same groups, and 2% among female adolescents aged 15-19 years (Wambugu, 2018). In rural settings, adolescents are more ravaged by undernutrition due to reduced social power (National Malaria Control program (NMCP) et al., 2016; M. Sharma, 2015). According to Kenya's adolescent health situation analysis, 16.1% of rural adolescents aged 15-19 years are thin compared to 9.1% of their urban counterparts (Wambugu, 2018).

Malnutrition is aggravated by the emerging nutrition transition and the trend of the triple burden of malnutrition (Keino et al., 2014; UNICEF, 2019). In Africa, stunting remains unchanged while childhood overweight and obesity has been increasing (De Onis et al., 2010). In Kenya, the demographic and health survey (KDHS) of 2014 showed a slight decline in the prevalence of thinness at 9%, but the prevalence of overweight and obesity among women of reproductive age increased to 33% (National Bureau of Statistics-Kenya and ICF International, 2015). This shows a need for careful balance between eradication of undernutrition and prevention of over nutrition.

### 1.2 Statement of the Problem

Despite the increased focus on adolescent health in recent years globally, adolescence is yet to be considered a high priority life stage for fulfilment of nutritional needs and implementation of necessary nutritional interventions (Patton et al., 2016; WHO, 2005). Yet, malnutrition remains a major public health problem among adolescents (Bentham et al., 2017; World Health Organization and others, 2013). A recent scale up nutrition (SUN) report revealed a multiple burden of malnutrition among adolescent girls (15-19 years) in SUN countries where anaemia is prevalent alongside both underweight and overweight and obesity (Fracassi &

Siekmans, 2018). Based on the Kenya Demographic and Health Survey (KDHS) of 2014, 16.6% of adolescents aged 15-19 years were thin, 12.2% were overweight or obese while 1.7% were short. In Machakos County, the same survey established that 6.3%, 29.4% and 0.8% of women (aged 15-49 years) were thin, overweight or obese and short respectively. Furthermore Kenya's adolescent health situational analysis showed that 23.8% of non-pregnant girls and 41.2% of pregnant ones aged 15-19 years had anaemia (Wambugu, 2018). A prevalence of anaemia of 16% among adolescents aged 10-14 years was established by the Kenya malaria indicator survey of 2015. Currently, national data for underweight, overweight and obesity and anaemia for adolescents aged 10-19 years is lacking.

The adverse effects of malnutrition in adolescents are well documented. Underweight exposes adolescents to a higher risk of infectious diseases, and for girls of reproductive age, it is associated with poor pregnancy outcomes (Aregawi & Tadele, 2018; Güngör, 2014; Martins et al., 2011). Overweight and obesity on the other hand is associated with a higher risk and early onset of chronic diseases (Bentham et al., 2017; Food and Agriculture Organisation of the United Nations, 2015). Anaemia causes reduced work capacity, poor academic outcomes and increased risk of unsafe motherhood (Gedefaw et al., 2015; Teji et al., 2016). Nonetheless, these forms of malnutrition among adolescents are scarcely reported in Kenya and the national health surveys which are the key source data explicitly fail to isolate adolescents from children and women of reproductive age. Additionally, local nutrition related studies have repeatedly excluded adolescents and focused on women and young children (Juma et al., 2015; Kisiangani et al., 2015).

Matuu Ward is in Yatta sub-county, an ASAL area prone to droughts and recurrent crop failure hence heavy dependence on food aid (Recha et al., 2012). Absolute poverty affects 67.5% of the population (Sila, 2018). Previous studies have established that large households, restricted food intake over the dry seasons and food taboos characterise of the region (Brownhill et al., 2016; Mburu et al., 2015). Day-schools in such environments cater for a significant proportion of learners' daily food intakes (WFP, 2010). With no control over school diet and other diet determining factors at home, normal anaemia and nutritional status of day-school adolescents in these settings can be highly compromised.

Interventions to lower the burden of malnutrition and anaemia should tackle the contributory factors. Knowledge of their magnitude and causes among school adolescents is therefore important as it will provide an opportunity for school-based interventions targeting improvement of adolescent health. Nevertheless, data on the dietary practices surrounding nutritional and anaemia status among day-school adolescents in the rural Kenyan context is lacking. To fill this gap, this study assessed the dietary practices, prevalence of anaemia and nutritional status among day-school adolescent girls in the tough ecologic background of poverty and food insecurity in Matuu Ward, Yatta sub-county, Machakos County.

### 1.3 Purpose of the Study

The purpose of this study was to establish the dietary practices, prevalence of anaemia and nutritional status among day-secondary school adolescent girls in Matuu Ward, Yatta sub-county, Machakos County, Kenya.

## 1.4 Objectives

The objectives that guided the study were to:

1. Establish the socio-demographic characteristics of adolescent girls attending day secondary schools and their households in Matuu Ward, Yatta sub-county, Machakos County.
2. Determine the dietary practices among adolescent girls attending day secondary schools in Matuu Ward, Yatta sub-county, Machakos County.
3. Establish the menstrual profile and morbidity status of adolescent girls attending day secondary schools in Matuu Ward, Yatta sub-county, Machakos County.
4. Establish the haemoglobin levels of adolescent girls attending day secondary schools in Matuu ward, Yatta sub-county, Machakos County.
5. Assess the nutritional status of adolescent girls attending day secondary schools in Matuu Ward, Yatta sub-county, Machakos County.
6. Establish relationships between dietary practices, nutritional status, menstrual profiles and haemoglobin levels of adolescent girls attending day secondary schools in Matuu ward, Yatta sub-county, Machakos County.

## 1.5 Hypotheses

The study made the following hypotheses:

$H0_1$ There is no relationship between dietary practices and haemoglobin levels of day-secondary school adolescent girls in Matuu Ward.

$H0_2$ There is no relationship between dietary practices and nutritional status of day-secondary school adolescent girls in Matuu Ward.

$H0_3$ There is no relationship between menstrual profiles and haemoglobin levels of day-secondary school adolescent girls in Matuu Ward.

$H0_4$ There is no relationship between nutritional status and haemoglobin levels of day-secondary school adolescent girls in Matuu Ward.

**1.6 Significance of the Study**

This study provides useful information on the dietary practices of adolescent girls and how they relate to anaemia and nutrition status. The study findings will inform stake holders such as the ministries of education and health, the County government of Machakos and the parents on the nature and magnitude of adolescent malnutrition. This will help in formulation of policy and design of intervention programs for improving adolescent girls' nutrition. The study also adds to the existing knowledge on adolescent nutrition.

**1.7 Delimitation**

The study was restricted to day-secondary school adolescent girls in Matuu Ward and hence its findings can only be inferred to day-secondary school students in the area and other regions with similar attributes.

**1.8 Limitations of the Study**

The dietary practices data used in this study was collected during a school term yet these dietary practices may change during school holidays. Additionally, dietary intake data was based on a single 24 hour dietary recall which may not reliably depict usual intake. Also, the big age difference among respondents could be a confounding factor to some of the indices.

## 1.9 Conceptual Framework

The conceptual framework (Figure 1.1) is a perceived link between the independent variables (socio-demographic factors and dietary practices) and dependent variables (haemoglobin levels and nutritional status) of the study. The framework was modified and adapted from the UNICEF's Conceptual-Framework on maternal and child undernutrition (UNICEF, 2013).

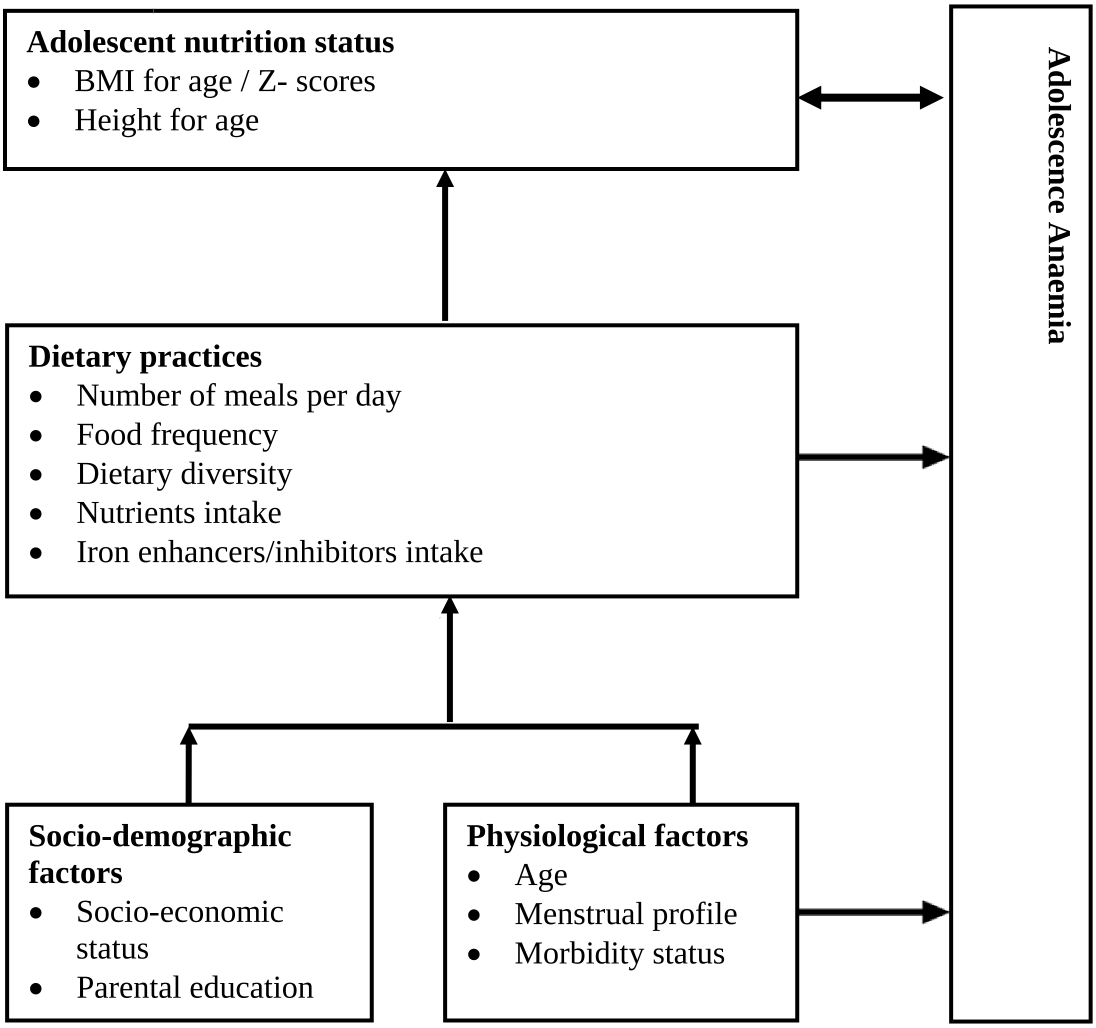


**Figure 1: Conceptual Framework of the main Factors contributing to Anaemia**

*Source: Adapted and modified from UNICEF (2013)*

Socio-demographic factors influence the dietary practices of adolescents. Advancement in age during adolescence is attributed to greater autonomy in food choices. As a result, healthy food habits such as breakfast and fruit and vegetable consumption decrease with increasing age while poor habits such as consumption of soft drinks increases. Dietary practices of adolescents are also influenced by parental socio-economic status (PSES). High SES-individuals have a higher likelihood of consuming healthier foods compared to low SES ones who are associated with poorer diets including the high fat, salt or sugar (HFSS) foods. As parents highly influence the eating habits of children, their education level is linked to understanding and practice of good dietary habits. In addition, parental occupation influences the feeding practices of family members as it is a provider of family income which determines diet quality. However, for mothers especially in developing countries, occupation may conflict with the care giving roles. Low income is a main cause of poor diet quality as healthier foods are believed to have a relatively high cost.

Physiological factors such as morbidity status and menstrual profile also influence anaemia and nutritional status. Infections cause malnutrition due to factors such as loss of appetite, poor absorption of nutrients and increased nutritional demands due to fever and utilisation of nutrients in immune response. This results in inadequate dietary intake which leads to weight loss and growth faltering. Infections such as intestinal parasites, malaria and persistent illness cause anaemia due to blood loss and destruction of red blood cells. In terms of menstruation, heavy menstrual bleeding makes women more susceptible to anaemia if the lost iron is not replenished within the cycle through diet.

Healthy dietary practices in adolescence promote optimal growth as they are associated with better nutrient intake and higher quality of diet hence less instances of anaemia and better nutritional status. Adherence to the recommended number of meals promotes adequate nutrient intake and prevents over/under nutrition. For example, meal skipping is associated with a higher risk for overconsumption of less healthy foods as well as poor nutrient intake that fails to meet developmental requirements of adolescents. Additionally, frequent consumption of some specified foods is a proxy indicator of usual diet patterns, intake of specific nutrients and other food components such as nutrient enhancers and inhibitors. Also, a diverse diet assures adequacy of nutrients, specifically micronutrients, due to intake from different foods. However, inhibitory elements in food bind non-heme iron hindering its absorption, but iron enhancers promote its absorption in to the body.

Nutritional status and anaemia have been found to naturally affect each other. For example, there is evidence that obesity promotes iron deficiency and in turn anaemia by impeding iron uptake from the duodenum (Aigner et al., 2014; Pande et al., 2019). Also, the liver, which is the key iron regulator in the body is affected by obesity through non-alcoholic fatty liver disease and this impedes body’s ability to provide enough iron for red blood cell production hence anaemia (Marmur et al., 2018; Stein et al., 2016). On the other hand, anaemia impairs cellular energy homeostasis thereby increasing inactivity and fatigue, which may aggravate obesity (Aigner et al., 2014).

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Socio-demographic Characteristics affecting Adolescent Girl's Nutrition

Socio-demographic factors determine both anaemia and nutritional status due to their influence on dietary practices (Han & Powell, 2013; Wong et al., 2014). Low mothers' education levels, low socio-economic status (SES) and large households have been associated with stunting among adolescents (Assefa et al., 2015; Melaku et al., 2015). Similarly, studies have identified age, income and low education level of mothers as risk factors of anaemia while high mothers' education levels have been found to cushion against anaemia (Desalegn et al., 2014; Kandala, 2013; Nelima, 2015; Ngesa & Mwambi, 2014). There is paucity of data on socio-demographic factors influencing adolescent girls' nutrition in Kenya. This study aimed to determine these factors and their association with anaemia and nutritional status.

## 2.2 Dietary Habits and Dietary Intakes of School-going Adolescent Girls

Adolescence is a period of transition from complete dependence on parents or guardians for dietary choices and intakes to greater self-responsibility creating room for undesirable change in eating habits (Malibari, 2016; Todd et al., 2015). Common dietary practices observed among adolescent girls such as restricting energy intake, turning to fad diets, eating inconsistently and removing some foods from the diet are developed on the basis of personal preferences, food availability, weight perception and peer influence (Alavi et al., 2013; Mallick et al., 2014). Time restrictions may result to meal skipping and associated snacking (Kelishadi et al., 2017; Teixeira et al., 2012). Low self-esteem, stigma and discrimination because of body weight may expose adolescents to eating disorders such as bulimia, anorexia and binge eating (Brown, 2014; Goldschmidt et al., 2015; Micali et al., 2015). These practices result in a low dietary diversity score and recurrent failure to satisfy dietary recommendations and therefore contribute to anaemia and poor nutritional status (Onyiriuka et al., 2013). Adolescent dietary habits have been overlooked in Kenyan research hence nutrition programmes targeting healthier dietary practices cannot be designed easily. This study determined these practices among rural-school adolescent girls and established how they related to anaemia and nutritional status.

## 2.3 Anaemia in Adolescents

### 2.3.1 Prevalence of anaemia among Adolescents Girls

Numerous studies carried out across the globe have rated anaemia among adolescent girls as a public health problem (Habib et al., 2020; Mengistu et al., 2019; Shaka & Wondimagegne, 2018; Siva et al., 2016). In developing countries, the prevalence of anaemia remains incommensurately high among adolescent girls, ranging from 17% - 90% in the South-East Asia region to approximately 50% in Sub-Saharan Africa (McLean et al., 2009; Srivastava et al., 2016). In Kenya, 27% of adolescents are affected by anaemia (WHO, 2015); and previous studies have reported a high prevalence among adolescent girls including 40.3% in Bondo and 26.5% in Yala (Friis et al., 2003; Nelima, 2015). Anaemia, particularly that resulting from iron deficiency is estimated to be the primary cause of years lived with disability among adolescents (Kyu et al., 2016). Studies on anaemia in Kenya have focused on pregnant women and pre-school age children and data on adolescent girls’ anaemia status is scarce hence there was need to carry out this study.

### 2.3.2 Determinants of Anaemia among Adolescent Girls

Personal, dietary, environmental, health and hereditary factors determine anaemia status (Syed et al., 2016). Micronutrient deficiencies of iron, folic acid, vitamins B12 and A lead to anaemia (Masibo, 2013). Low consumption of iron enhancers, dependency on non-heme iron, and ingestion of iron inhibitors negatively affects iron bioavailability and hemoglobin (Hb) levels (Aspuru et al., 2011; Rodriguez-Ramiro et al., 2017). Physiological characteristics such as age, pregnancy status and menstruation affect the haemoglobin levels of adolescents due to an overlapping rise in iron demands (Sekhar et al., 2015). Helminthic infestation, acquired or inherited disorders and infections cause anaemia (Gitonga et al., 2012; Srivastava et al., 2016; Strunz et al., 2016). Data on adolescent anaemia and associated factors in Matuu Ward is non-existent and baseline data is necessary for formulation of intervention programs.

### 2.3.3 Dietary Practices and Anaemia among Adolescents

Anaemia is more likely in populations that depend on vegetable based diets with limited meat and vitamin C consumption (Aspuru et al., 2011). Heme iron consumption is associated with increased iron status although a simultaneous consumption of inhibitors nullifies this enhancing effect on iron absorption (Beck et al., 2014). Absorption of iron from whole diets is known to be higher when taken with an enhancer (Collings et al., 2013). Micronutrient fortification of condiments and iron fortification of wheat and corn flour have previously been found to reduce the risk and prevalence of anaemia in adolescents, children and adults (Hess et al., 2016; Hirata et al., 2017). Previous research on adolescence anaemia in Kenya related it to helminthic and malarial infections. This study aimed at finding out the relationships between anaemia and dietary practices in this study population.

### 2.3.4 Menstrual profiles and Anaemia

Female adolescents are more vulnerable to iron deficiency and anaemia due to increased iron demands to replace the iron lost through menstruation (Gonete et al., 2018; Moschonis et al., 2013). According to WHO (2011), between 12.5 and 15 milligrams of iron is lost in menstrual blood every month among women throughout their reproductive period. Thus, menstruation has been significantly associated with increased likelihood of iron deficiency and anaemia (Bernardi et al., 2016; Kocaoz et al., 2019). Studies have established that adolescent girls who suffer excessive menstrual bleeding are more at risk of developing anaemia (Gebreyesus et al., 2019; Rati & Jawadagi, 2012; Toheed et al., 2017). Additionally, long menstrual duration has been identified as a predictor of anaemia (Alemu & Gebremedhin, 2020; Mengistu et al., 2019; Siva et al., 2016). Studies have made varying conclusions on the kind of association between menarche age and anaemia. Kavthekar et al. (2016) found an association between early age at menarche and the risk of anaemia while Gupta et al. (2012) found no association between onset of menarche and prevalence of anaemia. On the contrary, another study associated higher age at menarche with higher risk of anaemia (Kakkar et al., 2010). This study tried to find out how anaemia related with menstrual characteristics in this study population.

### 2.3.5 Morbidity Status and Anaemia

A complex relationship exists between anaemia and illness due to the fact that many mechanisms play a part in the onset of anaemia in patients, such as loss of blood, accelerated haemolysis, medication side effects, nutritional deficiencies and elevation in certain immune secretions called cytokines that are associated with anaemia among others (Viana, 2011). Some infections cause poor appetite leading to poor food intake as well as mal-absorption of nutrients which can lead to nutritional anaemia (Chaparro & Suchdev, 2019). Other infections cause inflammation which causes decreased iron absorption and sequestration of iron in to its storage form causing anaemia (Ganz, 2019). Malaria causes anaemia mainly through destruction of red blood cells by the malaria parasite (Shaw & Friedman, 2011; Viana, 2011). Helminthiasis causes anaemia through chronic intestinal blood loss, diarrhoea and reduced micronutrient absorption (Gopalakrishnan et al., 2018). Consequently, periodic deworming has been associated with increased haemoglobin levels and reduced anaemia prevalence (Arinaitwe et al., 2018; Girum & Wasie, 2018). This study determined how morbidity status related with anaemia among these day-school adolescent girls.

### 2.3.6 Diagnosis of Anaemia

Clinical detection of anaemia through signs and symptoms is unreliable unless for very severe cases hence anaemia is confidently diagnosed through laboratory tests when the haemoglobin concentration in blood falls below the normal level for a person's age, sex and physiological status (WHO, 2008, 2011a). Haemoglobin concentration is considered to be the most suitable indicator for measuring anaemia in epidemiological research as it is accurate, easy to measure and internationally accepted (van de Lagemaat et al., 2014). A complete blood count can give clues on nutritional causes of anaemia as its components can reflect the effects of chronic depletion of iron stores on erythropoiesis (Johnson-Wimbley & Graham, 2011). This may be manifested by a combination of decreased red blood cell (RBC) count, high red cell distribution width (RDW), low mean cell volume (MCV) and decreased RBC haemoglobin (Miller, 2013). Macrocytic MCV commonly signals megaloblastic anaemia from vitamin $B_{12}$ or folate deficiencies (WHO & CDC, 2007). Although serum ferritin is considered the best indicator of used up iron stores, its concentration is elevated during inflammation and infection hence care should be taken when using it on sick and menstruating adolescents as both are inflammatory in nature (Gunasekaran et al., 2012; WHO & CDC, 2007).

## 2.4 Nutritional Status of Adolescent Girls

### 2.4.1 Determinants of Nutritional Status

Dietary intake, socio-demographic factors, health status and physical activity levels as some of the factors identified in research as determinants of adolescent nutritional status (Aljaaly, 2012; Singh et al., 2015). Inadequate food intake results in wasting and growth retardation (Maiti et al., 2012). Excess calorie, fat and sugar intake leads to overweight and obesity (Hill et al., 2012). Physical activity levels predict adiposity, therefore their decrease is linked with increased BMI (Reddon et al., 2016). Infections intensify nutrient loss and reduce nutrient intake hence weight loss (Bresnahan & Tanumihardjo, 2014). Socio-economic and psychosocial factors influence dietary intakes and hence nutritional status (Roba & Abdo, 2016). There is dearth of information in Kenya on adolescent nutritional status in relation to dietary intake hence the reason for this study.

### 2.4.2 Consequences of Poor Nutritional Status in Adolescent Girls

The nutritional status of adolescent girls is a key determinant of health outcomes in adulthood (Salam *et al*., 2016). Malnutrition in adolescent girls negatively affects sexual maturation, school achievement, work productivity and future pregnancy outcomes (Branca et al., 2015; Bustillo et al., 2016). Malnourished girls exhibit lower growth velocities and experience late menarche, overweight girls risk infrequent menstrual flows, Stunted ones risk obstructed labour while thin ones deliver low birth weight babies (Ali Abdella et al., 2016; Kader & Perera, 2014; Rode, 2015). Children born to undernourished females have higher odds of cognitive impairments, poor immunity and high mortality (Ransom & Elder, 2003). Data on nutritional status of adolescent girls in Yatta sub-county is lacking hence this study assessed the magnitude of thinness, overweight and obesity and stunting among day-secondary school adolescent girls in Matuu Ward.

### 2.4.3 Measurement of Nutritional Status of Adolescents

A comprehensive assessment of nutritional status of an individual involves undertaking anthropometric, biochemical and dietary intake measurements together with clinical, environmental, socio-economic, functional ability and physical activity assessments (Upadhyay' & Tripathi, 2017). In childhood and adolescence, anthropometry has been termed the most suitable parameter in nutritional status assessment due to its being easy to perform, less costly and harmless, as well as having comparability across age and gender (Lillie et al., 2019; Sampaio et al., 2018). Anthropometric assessment for this age group involves using growth standards and growth references (Nucara et al., 2012). Percentiles and Z- scores are used in assessing undernutrition and over nutrition in young people while normal adult BMI is used for adults (Słowik et al., 2019). WHO, (2006) recommends using growth reference based on anthropometric Z-Scores to assess the nutritional status and growth of children because it's linear and sex independent, and is widely acknowledged. For the purpose of assessing both undernutrition and overweight, the 2007 WHO growth reference for school-age children and adolescents was developed. The recommended cut-off points for obesity, overweight and thinness based on BAZ are > +1, > +2 and < -2 respectively. For HAZ, stunting and severe stunting is <-2 and <-3 respectively (WHO, 2016a).

### 2.4.4 Nutritional Status and Anaemia

The associations previously established between anaemia and nutritional status vary. Some studies have found higher odds of iron deficiency anaemia among overweight and obese persons (Cepeda-Lopez et al., 2011; Sharif et al., 2014). Other studies have inversely associated central obesity with anaemia (Hemamalini, 2013; Qin et al., 2013) while others found no relationship between BMI and haemoglobin concentration (Ghadiri-Anari et al., 2014; Ugwuja et al., 2015). Kandala (2013) found low BMI to be a risk factor for anaemia. The possible reasons given for these mixed results are decreased dietary iron absorption due to adiposity, high iron requirements for obese persons and poor absorption and utilization of iron due to obesity associated inflammation (Kordas, Yanira, et al., 2013; Mawani et al., 2016). This study sought to identify the kind of association between nutritional status and anaemia among adolescent girls in this study population.

## 2.5 The Food Environment for Day-school Students

A day-scholar is exposed to various food environments. Students spend much of their time in school making up to 40% of their dietary intake to occur there (Larson & Story, 2010). Schools in Kenya have feeding programmes funded by parents and sometimes supported by other sectors (MOEST et al., 2016). School menus comprise mostly of boiled maize and beans and though there exists guidelines on school diet, compliance is not ensured hence high risk of malnutrition (MOEST et al., 2016). In resource poor settings, what is eaten at school is a big contributor to diet adequacy (Masibo, 2013). In some instances, learners carry packed meals or money for lunch or snacks allowing food vendors and in-school shops in the food supply chain (Kigaru et al., 2015). What is sold is not regulated hence availability of unhealthy foods and snacks inside schools (Kigaru et al., 2015; Teixeira et al., 2012). Since schools are ideal settings for promotion of good nutrition, initiatives such as micro-nutrient supplementation, food fortification, diet diversification, school feeding programmes and public health interventions are in place to improve nutrition among school children (MOEST et al., 2016; WFP, 2010). However, these interventions are not nationwide and mostly target young children in ASAL and slum areas neglecting vulnerable secondary school children (Masibo, 2013).

## 2.6 Summary of Literature Review

The literature reviewed revealed an incommensurately high prevalence of anaemia and malnutrition in developing countries especially sub-Saharan Africa. It showed that anaemia and nutritional status of adolescents are affected by their socio-demographic and economic characteristics as well as dietary and health practices. It further showed that these status affect adolescent girl's school achievement, work productivity, present and future health and pregnancy outcomes and hence contribute significantly to community nutrition status. Undesirable changes in the eating habits of adolescents as they transition from dependence on parents on dietary choices to some independence were also disclosed by this review. In addition, exposure of day-school adolescents to many food environments that influence their eating habits and in turn nutritional status was shown. This review revealed lack of adequate attention to adolescent girls' nutrition in this country as few studies are available to show their anaemia and nutritional status; and associated dietary practices, especially in rural settings. There was therefore need to carry out this study.

# CHAPTER THREE: METHODOLOGY

## 3.1 Research Design

The study adopted a cross-sectional analytical study design to assess dietary practices, anaemia and nutritional status of day-secondary school adolescent girls aged 10-19 years in Matuu Ward. This design allowed collection of both qualitative and quantitative data from a large number of adolescent girls at a point in time as well as establishment of relationships between variables and testing of hypotheses.

## 3.2 Research Variables

### 3.2.1 Independent Variables

The independent variables were socio-demographic and economic factors, menstrual profiles and health status; and dietary practices. The socio-demographic and economic factors were based on age and household socio-economic status. Menstrual profiles were established with respect to menarche status, menarche age, cycle regularity, menstrual bleeding duration and menstrual cycle length while morbidity status was based on deworming status and incidence of disease within a two week recall period. Dietary practices were analyzed with reference to number of meals, frequency of food consumption, dietary diversity, nutrients intake and ingestion of iron inhibitors or enhancers.

### 3.2.2 Dependent Variables

The dependent variables of the study were haemoglobin levels and nutritional status. Nutritional status of adolescent girls below 18 years was based on BAZ and HAZ according to WHO growth reference data for adolescents and school age children (World Health Organization, 2013); while that for adolescent girls 18-19 years was based on normal adult WHO BMI.

### 3.3 Study Site

The study was conducted in Matuu Ward, Yatta sub-county, Machakos County, Kenya. Yatta Sub-county is one of the ASAL areas in eastern Kenya where hunger and malnutrition is prevalent. The region lies about 140 kilometers east of Nairobi and small scale rain-fed agriculture makes food supply unpredictable due to frequent droughts and crop failure. There is heavy reliance on cereals, pulses and root tubers for food as they are the main crops produced. Absolute poverty affects 66% of the population as stated by the Yatta District Development Plan (2008 – 2012). Matuu ward was chosen as a study area because of food insecurity and high poverty levels.

### 3.4 Target Population

The study population consisted of all adolescent girls 10-19 years attending day public secondary schools in Matuu Ward, Machakos County. These day-schools largely take in students from poor backgrounds who are unable to afford boarding school fees. Consequently, adolescent girls in these schools are prone to malnutrition as they have higher odds of not meeting the recommended dietary intakes.

#### 3.4.1 Inclusion Criteria

The study included all adolescent girls 10-19 years old in day-secondary schools in Matuu ward who assented to participate in the study and whose parents consented by writing if they were below 18 years of age.

#### 3.4.2 Exclusion Criteria

The study excluded students with chronic conditions that could influence haemoglobin levels and nutritional status.

**3.5 Sample Size Determination**

According to the Yatta sub-county education office, there were 6 day-secondary schools in Matuu Ward with a total of 495 girls at the time of data collection. Fisher et al. (1998) formula was used to determine the sample size:

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

n = Desired sample size (if target population is greater than 10,000)

Z = Standard normal deviate (1.96) at the required confidence level

p = Proportion of population estimated to have anaemia

(50% prevalence was used since anaemia data capturing all adolescent girls 10-19 years in a similar set-up was lacking. This prevalence would give a maximum number of respondents for minimum sample size required).

q = Population without the characteristics being measured (1-p)

d = Degree of accuracy (0.05)

$$n = \frac{1.96^2\,[0.5 \times (1-0.5)]}{(0.05^2)} = 384$$

Fisher's finite correction for proportionality was done so as to get a sample size proportionate to the population using the following formula:

$$nf = \frac{n}{\{1+ \frac{(n + 1)}{N}\}} = \frac{384}{1+ (385/495)} = \frac{384}{1.778} = 216$$

An extra 10% (22) was added to the above figure to cater for non-response, giving a final sample size of 238 girls.

**3.6 Sampling Techniques**

Multi-stage random sampling was used to get the sample size. Matuu Ward was purposefully selected due to frequent food supply shocks and high levels of poverty

(Mburu et al., 2015). All the six day-public secondary schools in the Ward were included in the study. Proportionate to size sampling was used to sample 238 girls from the six schools while stratified random sampling was used at the school level to select girls from each year of study (Form 1, 2, 3 & 4) as elaborated in Figure 2.

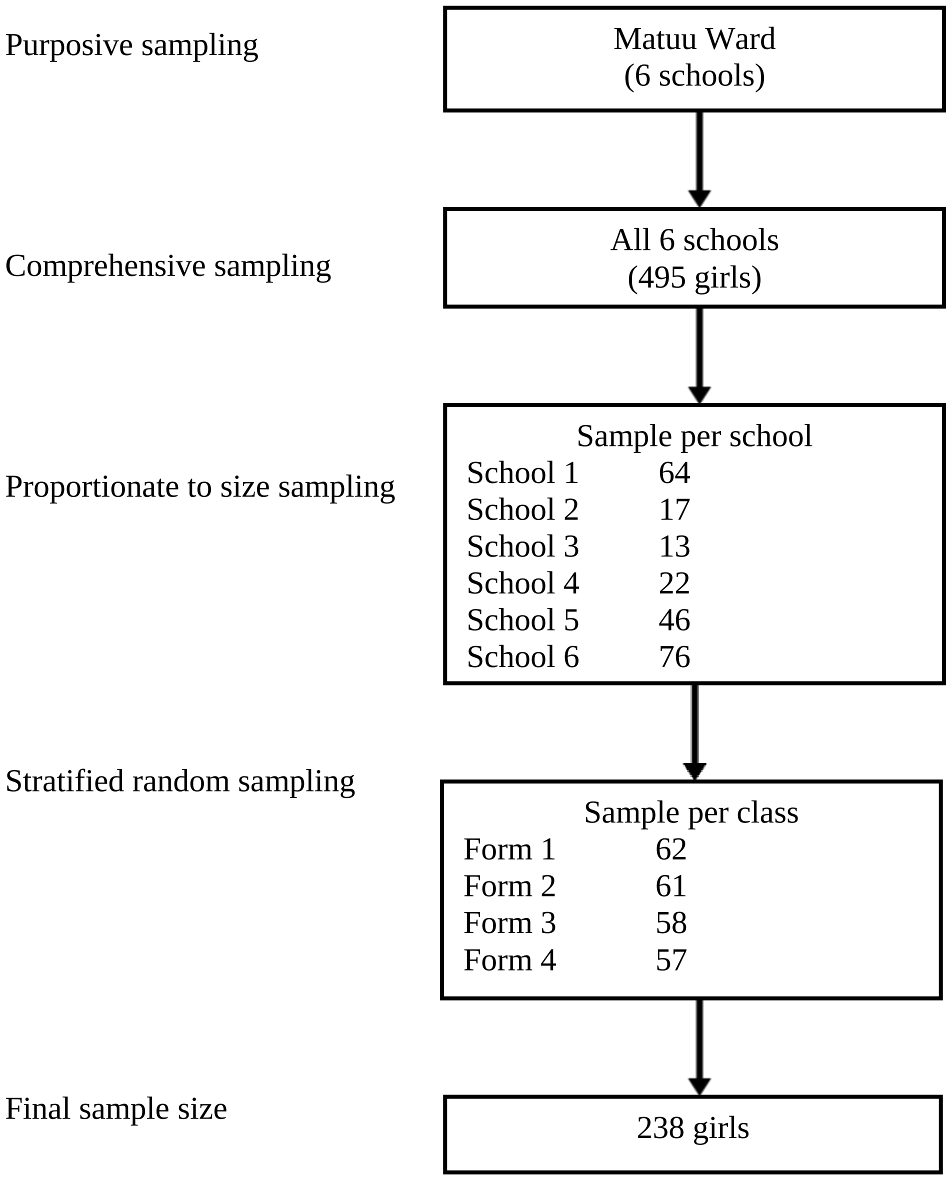


**Figure 2: Sampling Procedure**

### 3.7 Research Instruments

A researcher administered structured questionnaire (Appendix C) was used as the main tool to collect data on socio-demographic and economic characteristics, menstrual profiles, morbidity status and dietary practices. The socio-demographic and economic data collected was on age, SES, family size and parents’ education levels. Menstrual profile data included menarche status and age at menarche, regularity of menstrual cycle, menstrual bleeding duration and length of menstrual cycle. Deworming status based on the past 3 months and presence or absence of an ailment within the previous two weeks gave data for morbidity status. A 24 hour dietary recall questionnaire (Section 2, 2.1) was used to collect quantitative data on nutrient intake, number of meals and consumption of iron enhancers, inhibitors and fortified foods. A 7 day food frequency questionnaire (FFQ) (Section 2, 2.2) with supplementary close-ended questions on specific food habits and practices was used to capture frequencies at which given foods were consumed in the previous 7 days, as well as usual food habits. Dietary diversity data was gathered using a minimum dietary diversity questionnaire for women of reproductive age (MDD-W) adopted from (FAO and FHI 360, 2016) and modified to include local foods. Nutritional status data was generated by analysing anthropometric measurements of height and weight. Data on haemoglobin levels and other red cell parameters was generated by analysing capillary and venous blood samples using a Hemocue photometer and automated haematology analyser respectively and recording the values.

### 3.8 Pretesting of Data Collection Tools

The questionnaire was pre-tested on 24 girls in the neighbouring Kithimani secondary school which has similar conditions. The information from the pre-test was then used to check for content adequacy, clarity and consistency. The necessary adjustments which included removal of unnecessary questions and inclusion of left out foods were then done.

### 3.8.1 Validity

Validated indicators of BAZ, HAZ, BMI and Hb concentrations (WHO, 2007, 2011a) were used. Also, validated questionnaires namely MDD-W (FAO and FHI 360, 2016), FFQ and 24 Hour dietary recall questionnaire (Appendix C Section 2) and calibrated blood analysers and anthropometric scales were used. Research supervisors from Kenyatta University also assessed the questionnaires for relevance.

### 3.8.2 Reliability

Reliability was ensured through running a test-retest administration of the questionnaire on 24 girls (10% of the sample size). The repeat test was done on the same sample after a week. A comparison of the results giving a reliability coefficient of < 0.7 deemed the questionnaire unreliable (Paiva et al., 2014). On calculating the reliability coefficient using Cronbach's alpha test in SPSS, a figure of 0.84 was obtained and the questionnaire was considered acceptable.

## 3.9 Data Collection Procedures and Techniques

### 3.9.1 Recruitment and Training of Research Assistants

The principal investigator recruited and trained a team of four research assistants; three nutritionists with a diploma in nutrition and one was a medical lab technician. The assistants were trained on the study purpose and objectives, ethical issues, administration of the data collection tools, proper collection of blood samples and proper measurement of weight and height. During the training, each questionnaire item was clearly explained and all arising issues were addressed to the satisfaction of all the assistants. Demonstrations were used to ensure thorough understanding of techniques. The training took 3 days and emphasis was laid on self-presentation and respondent instruction.

### 3.9.2 Socio-demographic and Economic Data

A semi-structured questionnaire (Appendix C section 1) was used to collect data on socio-demographic and economic characteristics. The data collected was on age, household characteristics, occupation, education and income levels of parents.

### 3.9.3 Menstrual Profile and Morbidity Status Data

Data on menstrual characteristics and morbidity status in the previous two weeks was collected and recorded in part D of the questionnaire. The menstrual data sought was menarche status, age at menarche, duration of menstrual flow and regularity of menstrual cycle. The respondents were also asked to give information on the nature of ailment if any in the previous two weeks and also their deworming status in the previous three months from the time of data collection.

### 3.9.4 Dietary Practices Data

Data on dietary practices was generated using a 24 hour dietary recall, a one day dietary diversity assessment and a 7 day food frequency assessment with supplementary open-ended questions to capture specific food habits and practices. The 24 hour recall captured all foods and beverages consumed the previous day with details on the cooking method used, amount consumed and place from where the food was eaten. Data was collected using household measures and later converted to standard measures (grams and litres). Visual aids, food models and household utensils such as plates, cups, glasses, bowls and serving spoons were used to assist in approximation of portion sizes. Rigorous probing was done to ensure all consumed foods were recalled.

The food frequency questionnaire was used to capture frequencies at which given foods were eaten in the previous 7 days to data collection. The food items in the questionnaire included locally available foods in the market and commonly consumed foods in the local town, schools and households. Additional questions were included in the questionnaire and captured data on meal skipping, beverage consumption and fortified foods consumption in a typical week.

The MDD-W questionnaire was used to collect data on all foods consumed in the previous 24 hours. The consumed foods were recorded under 16 pre-determined food groups and later merged to 10 food groups which gave a score range of 0-10 points to enable calculation of MDD-W.

### 3.9.5 Anthropometric Measurements

Body weight was taken bare footed in light clothing to the nearest 0.1kg using a digital Seca® 813 scale. Height was taken in standing position bare footed to the nearest 0.1cm using a portable Seca® 213 stadiometer with a sliding head bar. For height measurement, the participants stood upright with feet on a flat ground and back and buttocks straight and touching the wall. All measurements were taken twice and the averages calculated. Age was calculated using date of birth as stated by respondents.

### 3.9.6 Biochemical Assessment of Hb Status

A qualified medical lab technician who was a member of the research team was responsible for blood sample collection. Haemoglobin levels were measured by taking a capillary blood sample through doing a finger prick with a sterile disposable lancet after rubbing the fingertip with a cotton swab immersed in alcohol. The first drop of blood was wiped away and the second drop was drawn into a micro cuvette which was then placed into a portable Hemocue® battery operated photometer (Hemocue® Hb 201$^{+}$) and the value displayed recorded within one minute. Calibration of the photometer was done before every session using provided standard. A complete blood count (CBC) was done on a 25% sub-sample by drawing 2ml of antecubital venous blood with a single use sterile needle and syringe after disinfecting the skin with a cotton swab immersed in alcohol and drying it. The blood was then transferred into Ethylene Diamine Tetra Acetate (EDTA) coated vials which were in turn packed in a cooler box with temperatures of between 2-8$^{o}$ for up to a maximum of 6 hours before analysis.

### 3.10 Data Analyses

The collected data was entered in to Statistical Package for Social Sciences (SPSS) software version 20, cleaned, coded, labelled and then analysed. Descriptive statistics namely frequencies, means and standard deviations were used in description of variables. Microsoft excel was used to draw graphs. Nutri-survey software was used to analyse data from the 24 hour recall in relation to macro and micro-nutrient intakes which were then compared with recommended intakes. Dietary diversity for women of reproductive age was computed on the basis of 10 food groups. Those who consumed at least 5 out of the 10 food groups were categorised as meeting the minimum diversity for women of reproductive age (FAO and FHI 360, 2016).

Analysis of capillary and venous blood samples using a battery operated photometer gave information on haemoglobin levels. Anaemia was termed as haemoglobin concentration less than 120g/L after altitude adjustment according to WHO recommendation since none of the respondents was below 12 years of age (WHO, 2011a). The adjustment was done by subtracting a conversion factor of 0.23 from individual Hb values since the study area lies at an altitude of 1233 meters above sea level. For the complete blood count, analysis of venous blood samples was done using an automated haematology analyser and the cut-offs of 26 Pg. for MCH, 32 g/L for MCHC, 78 for MCV and 3.9 for RBC were used as recommended by WHO & CDC ( 2007).

Nutritional status was determined using WHO AnthroPlus software version 1.0.4 and expressed as BMI-for-age Z scores (BAZ) and Height-for-age Z-scores (HAZ) for adolescent girls below 10-17 years of age. Age was calculated using the same software by entering the date of birth. BMI-for-age Z-score > +2 was termed as obesity, > +1 and < +2 overweight and < -2 thinness while HAZ < -2 was termed as stunting (WHO, 2016a). For adolescent girls 18-19 years, normal adult BMI calculated by dividing the weight (in kilograms) by the square of the height (in meters) was used. The WHO classification was used where BMI <18.5kg/m$^2$ was termed as underweight, between 18.5 kg/m$^2$ and 24.9 kg/m$^2$ normal weight, between 25.0 kg/m$^2$ and 29.9 kg/m$^2$ overweight and >30 kg/m$^2$ obese (WHO, 2016b).

Pearson product moment correlation test was used to establish relationships between variables while Chi-square test was used to determine associations among variables.

Logistical regression was used to predict outcomes and control for confounding variables. Data was analysed at 0.05 significance level. A data analysis summary is presented in Table 3.1.

**Table 3.1: Data analysis**

| Objective | Nature of variable | Statistical analysis |
|---|---|---|
| Socio-demographic and health characteristics | Categorical<br>Continuous | Descriptive statistics (means, percentages and SD) |
| Haemoglobin levels | Continuous | Descriptive statistics (means, percentages and SD) |
| Anaemia status | Categorical | Descriptive statistics (means, percentages and SD) |
| Nutrition status | Categorical | Descriptive statistics (means, percentages and SD) |
| Dietary practices | Continuous | Descriptive statistics (means, percentages and SD) |
| Relationships | Continuous | Pearson correlation coefficient |
| Association | Categorical<br>Continuous | Chi-square tests<br>Logistical regression |

### 3.11 Logistical and Ethical Considerations

Authority to carry out the research was sought from the Kenyatta University (KU) Graduate School (Appendix F). Ethical clearance was obtained from the KU Ethical Review Committee [Ref. No. KU/ERC/APPROVAL/VOL.1 (149)] while research permit was obtained from the National Council for Science, Technology and Innovation (Ref. No. NACOSTI/P/18/56194/24367). Clearance to carry out the study was sought from the County director of education Machakos County (Ref. No. MKS/ED/CDE/U/1/VOL.2/220) and conveyed to respective school principals through the sub-County director of education, Yatta sub-County.

The participants were clearly informed about the study and written consent was sought from parents and informed assent from respondents (Appendix A).

Confidentiality and voluntary participation was ensured throughout the study and names were not used during data collection. Personal information was not disclosed to other persons and data collected was used for study purposes only. Maximum care was taken during sample collection to ensure minimum discomfort and laid down protocol for blood sample collection was strictly followed to ensure total safety (Appendix E). Respondents who were found to be anaemic were given nutrition counselling and the severe cases were referred to Matuu level 4 hospital for management.

# CHAPTER FOUR: RESULTS

## 4.1 Response Rate and Distribution of Respondents by School and Class

Out of the calculated sample size of 238 adolescent girls, 227 were enrolled making the response rate to be 95%. The distribution of those who respondent per school and class is shown in Table 4.1. The remaining 5% declined to either undergo blood testing or give required information and although they had previously given consent to participate, their data was excluded from the analyses.

**Table 4.1: Response Rate and Respondent Distribution by School and Class**

| School | Class | | | | Total |
|---|---|---|---|---|---|
| | Form 1 | Form 2 | Form 3 | Form 4 | |
| School 1 | 15 | 16 | 15 | 16 | 62 |
| School 2 | 5 | 4 | 4 | 3 | 16 |
| School 3 | 3 | 3 | 3 | 3 | 12 |
| School 4 | 7 | 5 | 5 | 5 | 22 |
| School 5 | 11 | 11 | 11 | 10 | 43 |
| School 6 | 18 | 19 | 18 | 17 | 72 |
| Total | 59 | 58 | 56 | 54 | 227 |

## 4.2 Socio-demographic and Economic Characteristics of Respondents and their Households

Table 4.2 and Figure 3 expound on respondent and household characteristics. About two thirds of the respondents were in middle adolescence (15-17 years). The youngest respondent was 13.75 years old and the mean age of the respondents was 16.79 ± 1.38. The household size was 6.1 with number of family members ranging from 2-12 persons. Nearly two thirds (61.7%) of the households were headed by fathers and about half of fathers and mothers had attained secondary education. About two fifths of the households had an income of KES 2,001 - 5,000 per month.

**Table 4.2: Household and Respondent Characteristics**

| Variable | Category | N = 227 n | % |
|---|---|---|---|
| Adolescence stage | Early (10-14) yrs. | 22 | 9.7 |
| | Middle (15-17) yrs. | 148 | 65.2 |
| | Late (18-19) yrs. | 57 | 25.1 |
| Type of family | Nuclear | 163 | 71.8 |
| | Extended | 64 | 28.2 |
| No. of family members | 2 – 4 | 46 | 20.3 |
| | 5 – 7 | 140 | 61.6 |
| | 8 – 10 | 39 | 17.2 |
| | >10 | 2 | 0.9 |
| Household head (n = 227) | Father | 183 | 61.7 |
| | Mother | 30 | 25.1 |
| | Relatives | 14 | 13.2 |
| Father's education level (n=183) | University/college | 40 | 21.9 |
| | Secondary | 93 | 50.8 |
| | Primary | 48 | 26.2 |
| | None | 2 | 1.1 |
| Mother's education level (n=214) | University/college | 26 | 12.2 |
| | Secondary | 118 | 55.1 |
| | Primary | 67 | 31.3 |
| | None | 3 | 1.4 |
| Father's main occupation (n = 183) | Farmer | 70 | 38.3 |
| | Petty trade | 51 | 27.9 |
| | Salaried | 33 | 18.6 |
| | Casual labourer | 28 | 15.3 |
| Mother's main occupation (n = 214) | Farmer | 90 | 42.1 |
| | Petty trade | 80 | 37.4 |
| | Salaried | 33 | 15.4 |
| | Casual labourer | 11 | 5.1 |
| Monthly income (KES) | < 2,000 | 35 | 15.4 |
| | 2,001 – 5,000 | 89 | 39.2 |
| | 5,001 – 10,000 | 54 | 23.8 |
| | 10,001 – 20,000 | 23 | 10.1 |
| | ≥ 20,000 | 26 | 11.5 |

Although farming was the most common form of occupation for both fathers and mothers, petty trade was the highest source of income for the households (Figure 3).

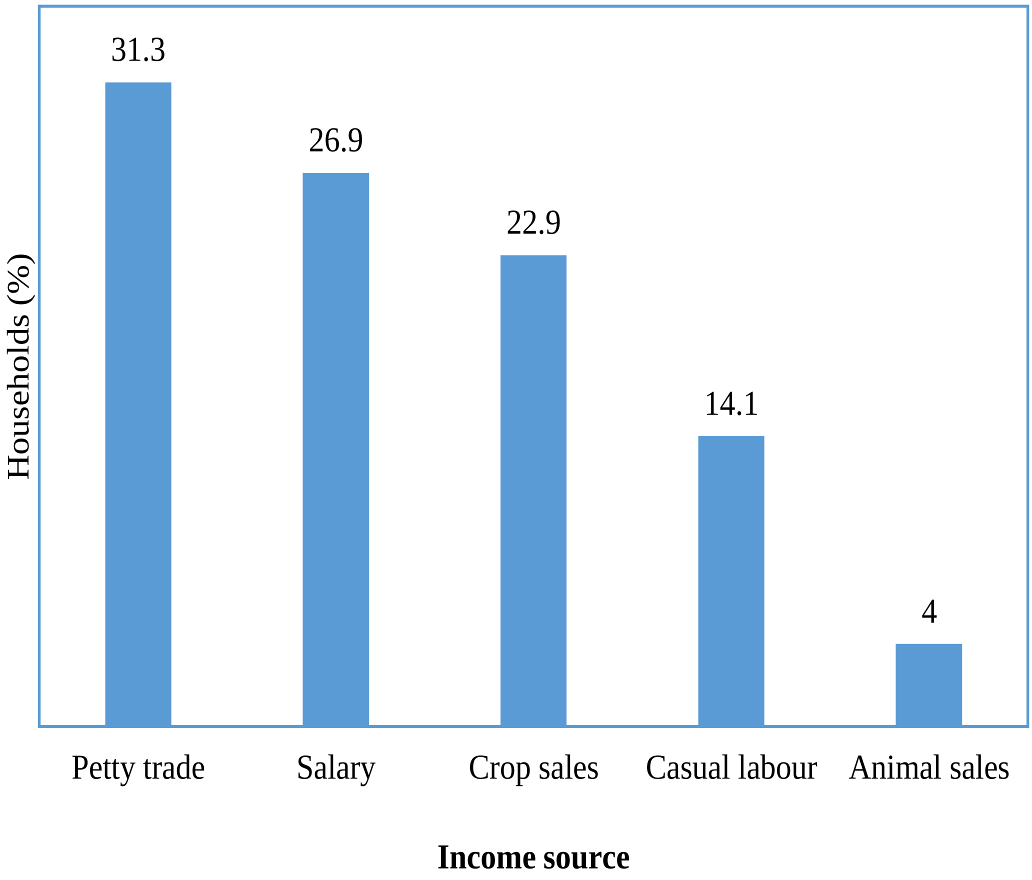


**Figure 3: Main Sources of Respondents' Household Income**

## 4.3 Dietary Practices of the Adolescent Girls

### 4.3.1 Food Consumption Patterns among the Study Respondents

There were two main sources of meals for the respondents, namely home and school, where all the lunches during the week days were provided and taken from school. Majority of the adolescents (83.7%) had 3 or more meals a day both during weekday and weekend and the mean number of meals per day was 3.12 ±0.79. Slightly above a third of the respondents reported skipping one or more main meals within the previous 7 days while 16.7% consumed tea or coffee with meals as elaborated in Table 4.3.

**Table 4.3: Selected Food Consumption patterns adopted by the Respondents**

| **Variable** | **N = 227** | |
|---|---|---|
| **No. of meals per day:** | **n** | **%** |
| Week day | | |
| <3 | 37 | 16.3 |
| 3 | 149 | 65.6 |
| >3 | 41 | 18.1 |
| Weekend | | |
| <3 | 33 | 14.5 |
| 3 | 142 | 62.6 |
| >3 | 52 | 22.9 |
| **No. of girls that skipped breakfast** | | |
| Weekday | 43 | 18.9 |
| Weekend | 15 | 6.6 |
| **No. of girls that skipped lunch** | | |
| Weekday | 12 | 10.6 |
| Weekend | 32 | 8.8 |
| **No. of girls that skipped dinner** | | |
| Weekday | 33 | 14.5 |
| Weekend | 7 | 3.0 |
| No. of girls that had meals regularly at home | 82 | 36.1 |
| No. of girls that drank tea/coffee with meals | 38 | 16.7 |
| No. of girls that ate a fruit(s) with meals | 142 | 62.6 |

### 4.3.2 Nutrient Intake by the Respondents based on 24 hr Dietary Recall

About a fifth (22.6%) of the interviewed respondents reported atypical food consumption the previous day of which 45.1% had more than usual consumption for varied reasons and 54.9% had less than usual consumption due to food shortage and religious activities. The mean daily intakes of energy, calcium, iron and zinc were below the RDA while that of protein was just about adequate (43.71g ± 4.30). However, the mean intakes of carbohydrate and dietary fiber exceeded the RDA. The approximate nutrient intake by the study respondents is summarised in Table 4.4.

**Table 4.4: Comparison of Nutrient Intake by Study Respondents with RDA**

| Nutrient | RDA | Mean intake ± SD | Below/above RDA | % of RDA taken |
|---|---|---|---|---|
| **Energy (Kcal)** | 2200 | 1715.2 ± 402.3 | Below | 78.0 |
| **Protein (g)** | 46 | 43.71 ± 4.30 | Below | 95.0 |
| % Kcal from protein | 12-20 | 10.2 ± 0.67 | Below | |
| **Fat (g)** | ND[a] | 65.6 ± 28.6 | | |
| % Kcal from fat | 25-35 | 34.4± 2.03 | Normal | |
| **Carbohydrate(g)** | 130 | 237.5 ± 41.01 | Above | 182.7 |
| %Kcal from CHO | 45-65 | 55.4 ± 4.63 | Normal | |
| Dietary fiber (g) | 26*(14-18yrs)<br>25*(19yrs) | 45.5 ± 6.21<br>44.63 ± 5.31 | Above<br>Above | 175.0 |
| **Vitamin A (µg)** | 700 | 637.3 ± 20.34 | Below | 91.1 |
| **Folate (µg)** | 400 | 192.8 ± 11.62 | Below | 48.2 |
| Vitamin $B_{12}$ (mg) | 2.4 | 2.8 ± 0.36 | Above | 116.7 |
| Vitamin C (mg) | 65 (14-18yrs)<br>75 (19yrs) | 65.3 ± 21.12<br>71.3 ± 19.34 | Normal<br>Below | 100.5 |
| Calcium (mg) | 1300 (14-18yr)<br>1000 (19yrs) | 435.19 ± 78.87<br>420.89 ± 65.79 | Below<br>Below | 33.5 |
| Magnesium (mg) | 360 (14-18yrs)<br>310 (19yrs) | 462.6 ± 53.4<br>449.52 ± 47.61 | Above<br>Above | 128.5 |
| Phosphorous (mg) | 1250 (14-18yr)<br>700 (19yrs) | 1146.3 ± 422.4<br>1109.7 ± 417.3 | Below<br>Above | 91.7 |
| Iron (mg) | 15 (14-18yrs)<br>18 (19yrs) | 9.77 ± 4.06<br>9.04 ± 2.56 | Below<br>Below | 65.1 |
| Zinc (µg) | 9 (14-18)<br>8 (19yrs) | 5.93 ± 1.04<br>5.08 ± 1.11 | Below<br>Below | 65.9 |

[a] Not determined; * Adequate intake
*Food and Nutrition Board, National Academy of Sciences(2002/2005/2011)*

### 4.3.3 Frequency of Consumption of Foods by Respondents

#### 4.3.3.1 Consumption by Food Groups based on a 7-day Frequency

Table 4.5 shows the frequency with which selected food groups were consumed based on a 7-day recall period. Almost all of the respondents regularly consumed starchy staples (97.4%) and legumes and pulses (90.7%) while four fifths (80.6%) were regular on consumption of dairy products. Nuts and seeds, and eggs were the least regularly consumed food groups at 4% and 11.4% respectively.

**Table 4.5: Frequency of Consumption of Selected Food Groups in 7 Days**

| **Food group** | **N = 227** | | | | | |
|---|---|---|---|---|---|---|
| | **Regular (≥3)** | | **1-2 times** | | **Never ate** | |
| | n | % | n | % | n | % |
| All starchy staples | 221 | 97.4 | 6 | 2.6 | 0 | 0.0 |
| Legumes (beans/peas/lentils) | 206 | 90.7 | 21 | 9.3 | 0 | 0.0 |
| Nuts and Seeds | 9 | 4.0 | 26 | 11.4 | 192 | 84.6 |
| All dairy | 183 | 80.6 | 31 | 13.7 | 13 | 5.7 |
| Flesh foods (meat/poultry/fish) | 142 | 62.6 | 81 | 35.7 | 4 | 1.8 |
| Eggs | 26 | 11.4 | 88 | 38.8 | 113 | 49.8 |
| Vitamin A rich dark green leafy vegs | 133 | 58.6 | 73 | 32.2 | 21 | 9.2 |
| Other vitamin A rich Vegs. & fruits | 34 | 15.0 | 66 | 29.1 | 127 | 55.9 |
| Other vegetables | 174 | 76.7 | 41 | 18.1 | 12 | 5.3 |
| Other fruits | 132 | 58.1 | 95 | 41.9 | 1 | 0.04 |

#### 4.3.3.2 Consumption of Iron Source Foods, Enhancers and Inhibitors by the Respondents

Selected heme iron source foods were isolated from the food groups and their frequency of consumption analysed. Additionally, consumption of selected foods containing iron enhancers and inhibitors was analysed based on whether they were consumed with or within 30 minutes before or post meal. The results as shown in table 4.6 pointed out that some of the iron rich foods were least consumed among respondents. Beef, organ meat, and eggs were poorly consumed where less than a fifth of the respondents had regular consumption at 19.4%, 0.4%, and 11.5% respectively. Similarly, low consumption of fortified flours was observed with only 10% of respondents having consumed in the last 24 hours. A quarter of the respondents consumed citrus fruits with meals 1-2 times a week while 16.7% were regular consumers. Beverages such as tea, coffee and cocoa which contain iron inhibitors were never consumed with food by 21.6%, 80.2% and 89% respectively.

**Table 4.6: 7-day Frequency of Consumption of Iron Source Foods, Enhancers and Inhibitors by the Respondents**

| **Food type** | **Frequency** | | |
|---|---|---|---|
| | **Regular (≥ 3times)** | **1-2 times** | **Never consumed** |
| **Heme iron sources** | | | |
| Beef | 19.4 | 27.8 | 52.9 |
| Chicken | 2.2 | 29.5 | 68.3 |
| Fish | 2.2 | 12.8 | 85.0 |
| Liver/organ meat | 0.4 | 0.4 | 99.1 |
| Eggs | 11.5 | 38.8 | 49.8 |
| **Fortified flours** | | | |
| Fortified maize meal | 2.7 | 7.9 | 89.4 |
| Fortified wheat flour | 9.6 | 53.4 | 37.0 |
| **Vitamin C rich fruits** | | | |
| Citrus fruits | 11.0 | 25.1 | 58.1 |
| Mangoes | 16.8 | 7.5 | 87.2 |
| Pawpaw | 4.9 | 12.8 | 82.4 |
| Pineapple | 3.1 | 10.6 | 86.3 |
| Passion fruit | 1.7 | 7.0 | 91.2 |
| Water melon | 7.4 | 13.2 | 79.3 |
| **Beverages** | | | |
| Milk | 42.2 | 25.1 | 32.6 |
| Tea | 62.9 | 15.4 | 21.6 |
| Coffee | 10.5 | 9.3 | 80.2 |
| Cocoa | 5.7 | 5.3 | 89.0 |

### 4.3.4 Dietary Diversity among the Respondents

#### 4.3.4.1 Individual Dietary Diversity among the Respondents

Table 4.7 represents the individual dietary diversity scores of the respondents which were calculated by tallying the food groups consumed over the previous 24 hours out of a total of 14 food groups as recommended by (FAO, 2011). The mean dietary diversity score was 6.52 ± 2.48. The lowest dietary diversity score was 2 while the highest was 12.

**Table 4.7: Individual Dietary Diversity Scores among the Respondents**

| Dietary diversity score | N = 227 | |
|---|---|---|
| | n | % |
| 2 | 3 | 1.3 |
| 3 | 6 | 2.6 |
| 4 | 11 | 4.8 |
| 5 | 38 | 16.7 |
| 6 | 57 | 25.1 |
| 7 | 53 | 23.3 |
| 8 | 34 | 15.0 |
| 9 | 16 | 7.0 |
| 10 | 7 | 3.1 |
| 11 | 1 | 0.7 |
| 12 | 1 | 0.7 |

### 4.3.4.2 Dietary Diversity Terciles among the Respondents

The dietary diversity scores were categorised in to dietary diversity terciles of low, medium and high dietary diversity if the respondent consumed 1-4, 5-9 and 10-14 food groups respectively. Results showed that majority of the respondents were in the medium dietary diversity tercile as depicted in Figure 4.

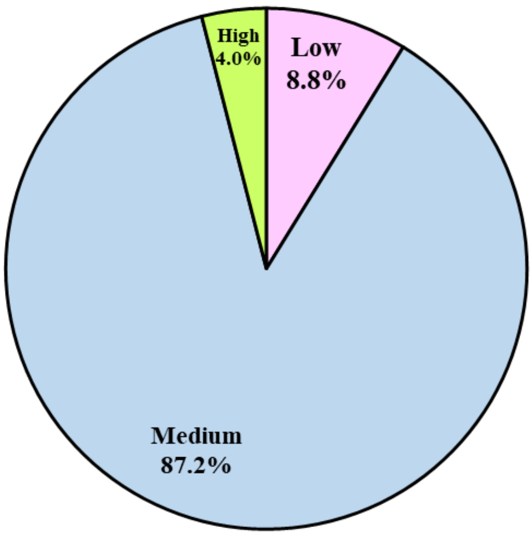


**Figure 4: Dietary Diversity Terciles among the Respondents**

### 4.5.4.3 Respondents' Food Consumption by Food Groups in Previous 24 hours.

**Figure 5 shows respondent's food intakes by food groups in the previous 24 hours where a majority had consumed cereals (98.2%) and oils and fats (93.2%). Dark green leafy vegetables (57.7%) and milk and milk products (56.4%) were averagely consumed while organ meat (7.5%) and fish (1.3%) were the least consumed.**

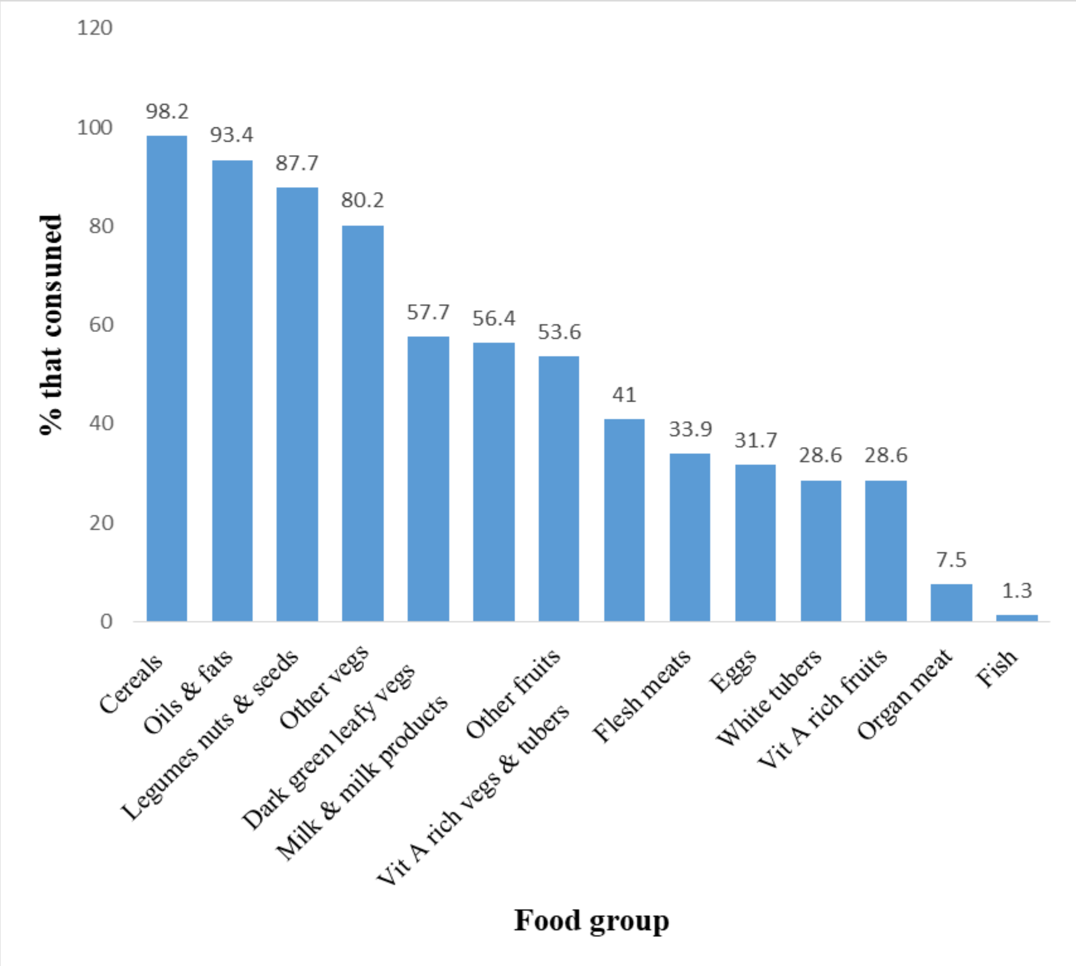


**Figure 5: Food Consumption by Food Groups in Previous 24 hours.**

### 4.3.4.4 Respondent's Achievement of Minimum Dietary Diversity for Women

Out of the 227 respondents, 90.3% (N=205) were aged between 15 and 19 years and were categorised as women of reproductive age. As a result, the minimum dietary diversity for women of reproductive age (MDD-W) indicator was used to measure their dietary diversity for this group as recommended by FAO and FHI 360 (2016). Results showed that 44.4% (n=91) had consumed at least 5 out of the 10 defined food groups the previous day and hence had achieved the minimum dietary diversity for women of reproductive age. About a third (30.7%) of the respondents had consumed four food groups, a quarter (25.4%) had consumed 5 food groups and a fifth (20.0%) had consumed three food groups (Table 4.8). The mean diversity score was 4.46 ± 1.37.

**Table 4.8: Respondents Achievement of Minimum Dietary Diversity for Women**

| No. of food groups consumed out of 10 | N = 205 | % |
|---|---|---|
| 4 | 63 | 30.7 |
| 5 | 52 | 25.4 |
| 3 | 41 | 20.0 |
| 6 | 23 | 11.2 |
| 2 | 10 | 4.9 |
| 7 | 9 | 4.4 |
| 8 | 7 | 3.4 |
| No. of girls who achieved MDD-W | **91** | **44.4** |
| **Mean DDS = 4.46** | | |

### 4.3.5 Consumption of Iron Fortified Foods by the Respondents

Consumption of iron fortified foods the previous day was by 20% (n=46) of the respondents and was mainly through use of fortified wheat flours (59%) in meals. 17% reported consuming foods made from fortified maize flour while 15% had consumed foods from both fortified wheat and maize flours the previous day (Fig 6)

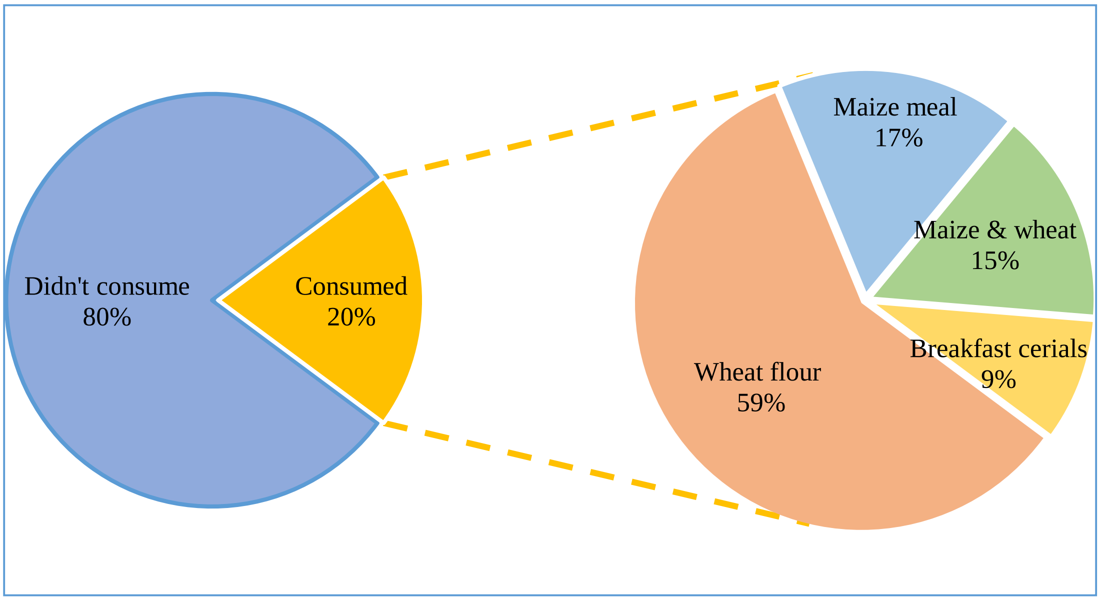


**Figure 6: Consumption of Iron Fortified Foods by the Respondents**

### 4.4 Menstrual Profiles and Morbidity Status of the Respondents

#### 4.4.1 Menstrual Profiles of the Adolescent Girls

The results in Table 4.9 show the menstrual profiles of the respondents based on self-reported menstrual history. Almost all the girls (94.3%) had attained menarche and the mean age at menarche was 14.32 ± 1.06 years. About a tenth of the girls had late menarche and almost half (48.1%) reported an irregular menstrual cycle that could not be predicted.

**Table 4. 9: Menstrual Profiles of the Respondents**

| Variable | Category | n | % |
|---|---|---|---|
| Menarche status (N=227) | Attained | 214 | 94.3 |
| Menarche age (N = 214) | Early (≤ 11yrs) | 1 | 0.5 |
| | Normal (12-15) | 192 | 89.7 |
| | Late (> 15) | 21 | 9.8 |
| Cycle regularity (based on usual ability to predict start of next period) | Regular (predictable) | 111 | 51.9 |
| | Irregular (unpredictable) | 103 | 48.1 |
| Menstrual bleeding duration | Short (< 2 days) | 28 | 13.1 |
| | Normal (2-7 days) | 172 | 80.4 |
| | Long (>7 days) | 14 | 6.5 |
| Menstrual cycle length | Short (≤ 21days) | 9 | 4.2 |
| | Normal (21-35) | 193 | 90.2 |
| | Long (≥ 35 days) | 12 | 5.6 |

### 4.4.2 Morbidity Status of the Respondents

The adolescent girls were asked whether they had experienced any type of sickness in the previous two weeks, and whether they had dewormed within the previous three months. Results showed that close to a third (29.5%) had ailed and majority (85%) had not dewormed as elaborated in Table 4.10

**Table 4. 10: Morbidity Status of the Respondents**

| Variable | Category | N = 227 | |
|---|---|---|---|
| | | n | % |
| Morbidity status in previous 2 weeks | Had ailed | 67 | 29.5 |
| Type of ailment suffered (N = 67) | Malaria | 43 | 64.2 |
| | Amoebiasis | 11 | 16.4 |
| | Typhoid | 8 | 11.9 |
| | Diarrhoea | 5 | 7.5 |
| Deworming status in previous 3 months | Had dewormed | 34 | 15 |
| Previous history of worm infestation | Had suffered | 73 | 32.2 |

## 4.5 Status of Anaemia among the Adolescent Girls

### 4.5.1 Prevalence and Grading of Anaemia among the Adolescent Girls

The data in Table 4.11 describes the anaemia status of the respondents. After adjusting for altitude, slightly above a quarter of the girls were found to be anaemic. The overall prevalence of anaemia among the day-school adolescent girls was 28.6%. The mean haemoglobin concentration was 12.58 g/dl ± 1.54. Anaemia was classified on the basis of severity according to WHO criteria as mild, moderate and severe. Majority (83.1%) of the anaemic respondents had mild anaemia and only two cases (3.1%) of severe anaemia were identified.

**Table 4. 11: Prevalence and Grading of Anaemia among Respondents**

| **Variable** | **Category** | **N = 227** | |
|---|---|---|---|
| | | **n** | **%** |
| Hb status | Anaemic (Hb < 12 g/dl) | 65 | 28.6 |
| | Normal (Hb ≥ 12 g/dl) | 162 | 71.4 |
| Anaemia severity (n=65) | Mild (Hb 10-11.9 g/dl) | 54 | 83.1 |
| | Moderate (Hb 8-9.9 g/dl) | 9 | 13.8 |
| | Severe (Hb < 8g/dl) | 2 | 3.1 |

*Reference: WHO (2011)*

### 4.5.2 Distribution of Anaemia according to Red Blood Cell Parameters

This study adopted 25 % (n = 57) of the study sample as a sub-sample to assess the types and possible causes of anaemia. Out of targeted 57, only 47 (82% response rate) agreed to give venous blood samples for assessment of additional red blood cell parameters of mean cell volume (MCV), red cell distribution width (RDW), mean cell haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). Of those assessed, 57.4% (n=27) were normal while 42.6% (n=20) were anaemic. The blood profiles of the overall sub-sample showed that the mean MCV, RDW and MCHC were within the normal range while MCH was below the normal range as elaborated in Table 4.12

**Table 4. 12: Distribution of Red Blood Cell Parameters by Anaemia Status**

| Parameter | N=47 n / % | Normal n / % | Anaemic n / % | Mean |
|---|---|---|---|---|
| **MCV[1]** | | | | |
| Microcytic(<78) | 20 / 42 | 7 / 35 | 13 / 65 | 79.99 ± 7.48 |
| Normal | 22 / 47 | 15 / 68 | 7 / 32 | |
| Macrocytic (>88) | 5 / 11 | 5 / 100 | 0 / 0 | |
| **RDW[2]** | | | | |
| Low (<11.5%) | 1 / 2 | 0 / 0 | 1 / 100 | 13.60 ± 1.67 |
| Normal | 38 / 81 | 26 / 68 | 12 / 32 | |
| High (>14.5%) | 8 / 17 | 1 / 13 | 7 / 87 | |
| **MCH[3]** | | | | |
| Low (<26pg) | 36 / 77 | 19 / 53 | 17 / 47 | 25.86 ± 4.63 |
| Normal | 10 / 21 | 7 / 70 | 3 / 30 | |
| High (>30pg) | 1 / 2 | 1 / 100 | 0 / 0 | |
| **MCHC[4]** | | | | |
| Hypochromic (<32g/l) | 29 / 62 | 16 / 55 | 13 / 45 | 32.13 ± 4.47 |
| Normal | 17 / 36 | 10 / 59 | 7 / 41 | |
| Hyper chromic (>33.9) | 1 / 2 | 1 / 100 | 0 / 0 | |

[1]Mean Cell Volume, [2]Red Cell Distribution Width, [3]Mean Cell Haemoglobin, [4]Mean Cell Haemoglobin Concentration

### 4.5.3 Comparison of Red Cell Parameters between Normal and Anaemic groups

Comparison of means for mean cell volume (MCV), red cell distribution width (RDW), mean cell haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) between the normal and anaemic groups revealed significant differences where the means were significantly higher for MCV ($p = 0.001$) and MCH ($p = 0.002$) in the normal group. Although the difference was not significant for MCHC, the mean was lower in the anaemic group compared to the normal group as presented in Table 4.13

**Table 4. 13: Comparison of Red Cell Parameters for Normal and Anaemic groups**

| Variable | Normal (mean ± SD) n = 27 | Anaemic (mean ± SD) n = 20 | P-value* |
|---|---|---|---|
| MCV[1] | 83.319 ± 4.68 | 75.485 ± 8.27 | 0.001 |
| RDW[2] | 13.159 ± 1.24 | 14.205 ± 1.99 | 0.047 |
| MCH[3] | 27.507 ± 4.85 | 23.640 ± 3.29 | 0.002 |
| MCHC[4] | 32.744 ± 5.69 | 31.295 ±0.84 | 0.219 |

*Independent-samples t-test, [1]Mean Cell Volume, [2]Red Cell Distribution Width, [3]Mean Cell Haemoglobin, [4]Mean Cell Haemoglobin Concentration

### 4.5.4 Types of Anaemia among the Adolescent Girls

Out of the sub-sample respondents found to be anaemic, 65% exhibited microcytosis while the rest (35%) were normocytic. None of the respondents manifested macrocytosis. Equally, 65% of the same respondents exhibited hypochromasia as portrayed in Table 4.14.

**Table 4. 14: Types of Anaemia among the Adolescent Girls**

| Parameter | | Anaemia type | | | |
|---|---|---|---|---|---|
| | | Microcytic (N=13) | | Normocytic (N=7) | |
| | | n | % | n | % |
| RDW | Low | 1 | 5 | 0 | 0 |
| | Normal | 11 | 55 | 1 | 5 |
| | High | 1 | 5 | 6 | 30 |
| MCH | Low | 11 | 55 | 6 | 30 |
| | Normal | 2 | 10 | 1 | 5 |
| MCHC | Hypochromic | 10 | 50 | 3 | 15 |
| | Normochromic | 3 | 15 | 4 | 20 |

Overall, microcytic hypochromic anaemia was found in half of the anaemic respondents and this is highlighted in Figure 7.

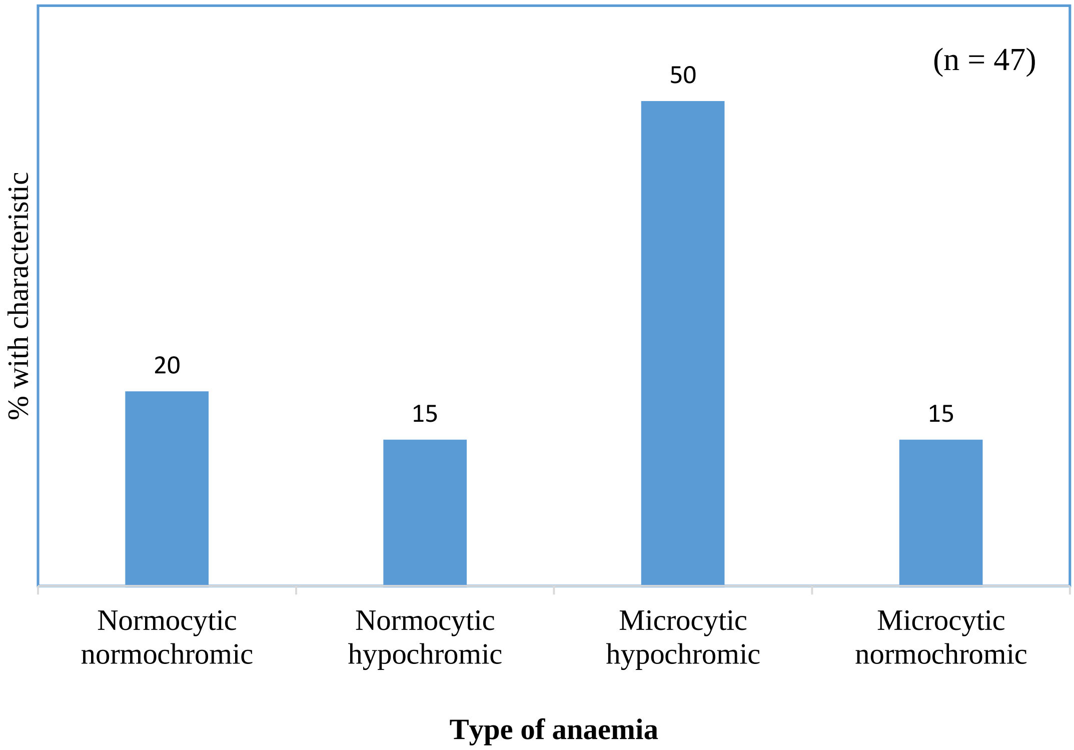


**Figure 7: Types of Anaemia among the Adolescent Girls**

## 4.6 Nutritional Status of the Adolescent Girls

Three quarters (75%) of the studied adolescents (n=170) were aged between 10-17 years while the remaining 57 were adults aged 18-19 years. Nutrition status was analysed using the World Health Organisation (WHO) 2006 BMI-for-age Z-scores (BAZ) and height-for-age Z-scores (HAZ) for those aged 10-17 years; and adult BMI for those aged 18-19 years. The results in Table 4.15 indicate that mean BAZ, HAZ and BMI were within the normal range.

**Table 4. 15: Anthropometric Measurements of the Adolescent Girls**

| Variable | Age (yrs.) | Mean |
|---|---|---|
| Weight (kg) | 10-19 | 51.20 |
| Height (cm) | 10-19 | 158.56 |
| BAZ | 10-17 | -0.35 |
| HAZ | 10-17 | -0.55 |
| BMI ($Kg/m^2$) | 18-19 | 20.92 |

#### 4.6.1 Underweight, Overweight/obesity and Stunting among the Respondents

Table 4.16 provides details on the overall nutrition status of the respondents. About a fifth (21.6%) of the adolescent girls were malnourished with a slightly higher proportion of thinness (12.3%) than overweight/obese (9.3%) adolescents recorded. The overall prevalence of malnutrition was slightly higher among junior adolescents (10-14 years) at 22.7% than in senior adolescents (15-19 years) which stood at 21.5%. In terms of stunting, majority (98.2%) of the adolescents aged 17 years and below had normal height and only 1.8% (n = 2) were stunted.

**Table 4. 16: Nutritional Status of the Respondents**

| **Nutritional status** | **Category** | **N = 227** | **%** |
|---|---|---|---|
| Nutritional Status (BAZ) | Normal | 17 | 77.3 |
| (10-14 years) | Thin | 4 | 18.2 |
| [N = 22] | Overweight | 0 | 0 |
| | Obese | 1 | 4.5 |
| Nutritional Status (BAZ/BMI) | Normal | 161 | 78.5 |
| (15-19 years) | Thin | 24 | 11.7 |
| [N = 205] | Overweight | 19 | 9.3 |
| | Obese | 1 | 0.5 |
| Overall Nutritional Status | Normal | 178 | 78.4 |
| (N = 227) | Underweight | 28 | 12.3 |
| | Overweight | 19 | 8.4 |
| | Obese | 2 | 0.9 |
| HAZ (10-17years) | Normal (> -2) | 167 | 98.2 |
| | Stunted (< -2) | 3 | 1.8 |

**Reference: WHO (2006)*

### 4.7 Proportions of Anaemic Respondents across Nutritional Status Categories

Data on respondents with anaemia among the normal, thin, overweight /obese and stunted adolescents was analysed. Results showed that the proportions of anaemic respondents were higher among the normal (29.8%) and overweight/obese (28.6%) adolescents than among the thin ones. Table 4.17 presents the details.

**Table 4. 17: Proportions of Anaemic Respondents across Nutritional Status Categories**

| **Nutritional status category** | **N** | **Anaemic (n)** | **%** |
|---|---|---|---|
| Normal weight (BAZ -2-+1SD/BMI 18.5-24.9) | 178 | 53 | 29.8 |
| Thin (BAZ < -2SD/BMI <18.5) | 28 | 6 | 21.4 |
| Overweight/obese (BAZ > +1SD/BMI ≥25.0 | 19 | 6 | 28.6 |
| | | | |
| Normal height (HAZ ≥ -2SD) | 167 | 46 | 27.5 |
| Stunted (HAZ < -2SD) | 3 | 1 | 33.3 |

### 4.8 Relationships among Selected Variables of the Study

Table 4.18 expounds on the relationships established among selected variables of the study. There was a significant positive relationship between age and BAZ (r = 0.135, p-value = 0.049), implying that BAZ increased with increase in age. Similarly, haemoglobin levels increased with increase in age at menarche (*r* = 0.164, p-value = 0.014), dietary diversity scores (*r* = 0.175, p-value = 0.012) and amount of iron consumed (*r* = 0.61, p-value = 0.0013). In relation to nutrition status, a highly significant positive relationship was found between BAZ and amount of carbohydrate consumed (*r* = 0.429, p-value = <0.001) denoting that increase in carbohydrate consumption led to an increase in BAZ

**Table 4.18: Relationships between Selected Variables by Pearson Correlation**

| Variables | *r* | p-value |
|---|---|---|
| **Socio-demographic aspects** | | |
| Age and BAZ | 0.135* | 0.049 |
| Age and BMI | -0.015 | 0.913 |
| Age and HAZ | -0.058 | 0.452 |
| Age at menarche and Hb | 0.118* | 0.046 |
| Household size and BAZ | -0.076 | 0.321 |
| **Dietary aspects and Hb** | | |
| Dietary diversity scores | 0.175* | 0.012 |
| Amount of Iron | 0.61** | 0.0013 |
| Organ meats frequency | 0.138* | 0.038 |
| Citrus fruits frequency | 0.130* | 0.049 |
| Number of meals | 0.070 | 0.291 |
| Amount of vitamin C | 0.164* | 0.014 |
| Amount of dietary fibre | 0.106 | 0.269 |
| **Dietary aspects and nutrition status** | | |
| Amount of carbohydrate and BAZ | 0.429* | <0.001 |
| Amount of protein and BAZ | 0.091 | 0.170 |
| Amount of calcium and HAZ | 0.194** | 0.003 |
| **Nutritional status and Hb** | | |
| BAZ | -0.40 | 0.601 |
| BMI | 0.032 | 0.813 |
| HAZ | -0.07 | 0.363 |

**** Correlation is significant at the 0.01 level (2 tailed).**
*** Correlation is significant at the 0.05 level (2 tailed).**

## 4.9 Associations among Selected Variables with Anaemia and Nutritional Status

Significant associations among variables with anaemia and nutritional status were revealed through chi-square tests. House hold size ($\chi^2$ = 8.992, p = 0.011), morbidity in the previous two weeks ($\chi^2$ = 5.349, p = 0.021), dietary diversity tertile ($\chi^2$ = 7.431, p = 0.024) and skipping of supper during weekday ($\chi^2$ = 4.417, p = 0.036) were associated with anaemia. In relation to nutritional status, mother's education level ($\chi^2$ = 16.604, p = 0.005) and father's education level ($\chi^2$ = 11.512, p = 0.042) were associated with overweight while adequacy of carbohydrates ($\chi^2$ = 10.699, p = 0.001) and adequacy of proteins ($\chi^2$ = 6.088, p = 0.014) were associated with thinness. There were no associations established between household sizes or income level and anaemia or nutritional status as elaborated in Table 4.19.

**Table 4.19: Association of Variables with Anaemia and Nutritional Status**

| Variables | $\chi^2$ | p-value |
|---|---|---|
| **Association with anaemia** | | |
| Household size | 8.992 | 0.011* |
| Household income | 1.544 | 0.819 |
| Health status in previous 2 weeks | 5.349 | 0.021* |
| Deworming status (3 months) | 2.822 | 0.244 |
| Nutritional status | 1.536 | 0.674 |
| Dietary diversity tertile | 7.431 | 0.024* |
| Skipping of dinner during weekday | 4.417 | 0.036* |
| Consumption of tea post meal | 0.382 | 0.537 |
| Consumption of fruit with meals | 0.040 | 0.841 |
| **Association with nutritional status** | | |
| Mother's education and overweight | 16.604 | 0.005* |
| Father's education and overweight | 11.512 | 0.042* |
| Protein adequacy and underweight | 6.088 | 0.04* |
| Carbohydrate adequacy and underweight | 10.699 | 0.001* |

***Correlation is significant at the 0.05 level (2 tailed).**

### 4.10 Determinants of Anaemia among Study Subjects

In Table 4.20, factors that emerged as determinants of anaemia in the study population are displayed. After a crude analysis of potential risk factors of anaemia in binary logistic regression, respondent's morbidity status in the previous two weeks, household size, skipping of supper during weekday, dietary diversity tertile and adequacy of iron intake were identified at a p-value of $< 0.05$. After adjusting for other relevant variables, morbidity status in previous two weeks, household size, dietary diversity tertile and adequacy of iron intake were independently associated with anaemia. The odds of anaemia decreased with an increase in household size where those from larger households of ≥4 persons were 3.1 times less likely to be anaemic as compared to those from smaller households <4 persons (AOR 0.31 (95% C.I. 0.062 – 0.713), p = 0.030). Adolescent girls who had ailed within the previous two weeks were 2.7 times more likely to be anaemic as compared to those who never ailed within the same period (AOR 2.703 (95% C.I. 1.238 – 5.902), p = 0.013). The risk of anaemia decreased as one moved from a lower to a higher diversity tertile

(AOR 0.62 (95% C.I. 0.02 – 0.79), p = 0.039) implying that adolescent girls in the higher dietary diversity tertile of 5 or more food groups were 1.6 times less likely to be anaemic as compared to those in the lower diversity tertile of less than 5 food groups. Those who had inadequate iron intake were 10 times more likely to be anaemic as compared to those who had adequate iron intake (AOR 10.447 (95% C.I. 2.123 – 199.082), p = 0.009).

**Table 4.20: Determinants of Anaemia among Respondents**

| **Variable** | **Anaemia** | | **COR** | **AOR** | **P-** |
|---|---|---|---|---|---|
| | **Yes** | **No** | **(95% CI)** | **(95% CI)** | **value** |
| **Household size** | | | | | |
| ≤4 | 11 | 8 | 1 | 1 | 0.030* |
| >4 | 54 | 154 | 0.30 (0.08-0.65) | 0.32 (0.06-0.71) | |
| **Morbidity in previous 2 weeks** | | | | | |
| Never ailed | 53 | 107 | 1 | 1 | 0.013* |
| Ailed | 12 | 55 | 2.27 (1.12-4.60) | 2.70 (1.24-5.90) | |
| **Deworming status** | | | | | |
| Dewormed | 11 | 23 | 1 | 1 | 0.062 |
| Never dewormed | 54 | 139 | 0.52 (0.19 – 0.75) | 0.58 (0.07 – 1.13) | |
| **Dinner intake** | | | | | |
| Skipped | 6 | 34 | 1 | 1 | 0.194 |
| Never skipped | 59 | 128 | 0.38 (0.15-0.96) | 0.58 (0.22-1.54) | |
| **DD scores** | | | | | |
| Lower (≤ 5 ) | 28 | 50 | | 1 | 0.039* |
| Higher (> 5) | 36 | 91 | 0.59 (0.03-0.83) | 0.62 (0.02-0.79) | |
| **Iron intake** | | | | | |
| Adequate | 1 | 30 | 1 | 1 | 0.009* |
| Inadequate | 64 | 132 | 10.06(1.94-109.1) | 10.4 (2.12-199.1) | |

***Statistically significant at α = 0.05, 1 = reference group**

# CHAPTER FIVE: DISCUSSION

## 5.1 Socio-demographic and Economic Characteristics of Respondents and their Households

Age, household size, household income and parental education level are some of the important socio-demographic factors that determine the dietary practices and hence anaemia and nutritional status of adolescents (Ngan et al., 2019). Findings of this study revealed that less than a tenth of the day-school adolescents were in early adolescence (10-14 years) and a quarter were in late adolescence (18-19 years). Based on the defined entry and exit age for secondary education in Kenya which falls in the 14$^{th}$ and 17$^{th}$ years respectively (MOE, 2018), these results revealed either a delayed form one entry or inconsistent school attendance leading to repetition or both. An earlier study in Kalama ward in the county of study made a similar observation and reported that a significant number of the high school students were older for their years of study (Wambua, 2012). An adolescent's age determines nutritional requirements and influences nutritional status due to ongoing physical changes. In this study, age was found to have a positive relationship with BAZ which is similar to findings of a study in Ethiopia (Dinku et al., 2020).

The average household size of 6.1 established in this study was much higher than the national average of 3.9 established in the 2014 Kenya demographic and health survey (KNBS & ICF International, 2015). The reason for the difference could be the high number of extended family households found in this study population. In addition, data from this study indicates that majority of the households live below the updated world bank international poverty line of US $1.90 a day person, which is in line with the situation in sub-Saharan African countries (Anyanwu & Anyanwu, 2017).

Household size and income levels have consistently been found to influence household food security and diet whereby smaller households and higher incomes have been associated with better quality of diet and in turn nutritional status (Arage et al., 2019; Shariff et al., 2015). This study however found no association between household size and nutritional status as opposed to what was found among adolescents in Ethiopia where large households were associated with poor nutritional status (Handiso et al., 2021).

## 5.2 Dietary Practices of the Adolescent Girls

Dietary practices were explored in terms of number of meals consumed, frequency of food consumption, dietary diversity and amount of nutrients taken by the day-secondary school adolescent girls.

### 5.2.1 Food Consumption Patterns among the Study Respondents

This study revealed that majority of the adolescents had an eating frequency of 3 or more times a day which agrees with similar studies in Ethiopia and Indonesia (Agustina et al., 2020; Mengistu et al., 2019). A study in Kenya also showed evidence of a three main meal pattern in a day with limited intake of snacks (Holdsworth et al., 2020). Furthermore, a similar finding was made among Egyptian adolescents although the percentage of those consuming less than 3 meals was higher at 38.2% (El-Gilany & Elkhawaga, 2012). The average number of meals per day in this study was 3.12 which lies below the recommended five to six meals including snacks. The number of meals consumed in a day may influence energy intake alongside other nutrients but does not guarantee adequacy of nutrients as it depends on the quality of the meal taken (Agustina et al., 2020), hence the need for promotion of healthier foods and regular meals to meet the dietary requirements of adolescents.

Meal skipping can have detrimental effect on adolescent health as it affects diet quality. In the current study, meal skipping emerged as a common practice among the adolescent girls where breakfast was the most commonly skipped meal. This is in line with a finding in an urban setting in India where 45% of school going adolescent girls were found to skip meals; and a review on meal skipping where breakfast was identified as the most commonly skipped meal (Kotecha et al., 2013; Pendergast et al., 2016). In a comparative study involving low and middle income countries, the proportion of adolescents skipping breakfast was almost double that found in this study (E. C. Keats et al., 2018). However, this finding differs with that of a study in Poland where supper was more commonly skipped by school adolescents than breakfast (Ostachowska-Gasior et al., 2016).

Meal skipping among adolescents has been attributed to several factors such as increased autonomy, lack of time, weight control, food preferences and food unavailability (Pendergast et al., 2016). A study among university students in Nairobi, Kenya found that 17.6% of males and 13% of females skipped breakfast at least three times a because of too much time spend on television (Catherine et al., 2021). In this study, the cited reason for skipping breakfast were lack of enough time and in the morning. Meal skipping among adolescents has been associated with unhealthy snacking and reduced quality of diet (Kelishadi et al., 2017; Medin et al., 2019). Measures to make consumption of all the three main meals in a day a dietary habit among adolescents is a potential course of action to improve their nutrition.

### 5.2.2 Nutrient Intakes by the Respondents

Food consumption data from this study showed insufficient mean daily energy and protein intake and excess carbohydrate intake, a finding similar to that of a review on dietary intakes of adolescents in low and middle income countries (E. C. Keats et al., 2018). But other similar studies in Tanzania and South Africa found a low mean energy intake and adequate carbohydrates, proteins and fats intake (Napier & Oldewage-Theron, 2015; Nicholaus et al., 2020), a difference that may be attributed to access to food from outside the schools in the latter studies. However among Bangladesh adolescent girls, it was the carbohydrate and fat intakes that were inadequate while protein intake was excessive (Kabir et al., 2010). The difference could be due to the urban setting and the meat and eggs preference observed in the study. There was overdependence on carbohydrates for daily energy in the current study, probably due to the overreliance on maize-based foods. Excessive intake of carbohydrates exerts a high metabolic load on the body which may over time lead to poor metabolic health and a higher risk of heart disease (Kurpad et al., 2005); and this calls for promotion of healthy dietary practices among adolescents.

The micronutrients of concern in relation to nutritional deficiency anaemia are iron, zinc, folic acid and vitamins A, C& B12 (Jamil et al., 2008; Van Den Broek, 2003). Iron plays a major role in heme synthesis while vitamin A is important for haematopoiesis. Vitamin C improves dietary iron absorption and prevents oxidative damage to red blood cells. Folate (B9) and vitamin B12 help in proliferation of erythroblasts during differentiation while zinc acts as a co-factor for many enzymes involved in erythrocyte production (Houghton et al., 2019; Kelkitli et al., 2016). Due to their roles in red blood cell formation, deficiency of any of these micronutrients may contribute to nutritional anaemia. In this study, the mean dietary intakes reflected inadequacies in iron, zinc, vitamin A and folic acid intake which is consistent with the finding of pooled data on women of reproductive age from Kenya, Ethiopia, Nigeria and South Africa (Harika et al., 2017). It also agrees with the 2011 Kenya National Micronutrient Survey where vitamin A, zinc and folate deficiencies among women of reproductive age were reported (KNBS, 2011). Furthermore, Abeywickrama et al. (2018) concurs with the same finding after observing a high prevalence of zinc, iron, folate and vitamin A deficiency; and identifying the coexistence of multiple micronutrient deficiency as a key issue affecting over 50% of Sri-Lanka adolescents. Since the requirements for these micronutrients increase during adolescence, consumption of fortified foods can help in their provision especially in situations where access to nutrient rich diets is a challenge like in this study population.

### 5.2.3 Consumption of Iron Source Foods, Enhancers and Inhibitors by the Respondents.

Cereals, legumes and pulses, particularly maize and beans were the staple food for majority of people in the region, both at the household and school level. These foods are known to be sources of non-heme iron (Cavalcanti et al., 2014; Skolmowska & Głąbska, 2019). Apparently in this study, more than 90% of the adolescents reported daily consumption of maize and beans. More so, the daily lunch for all the schools was a stewed mixture of dried maize and beans commonly referred to as “Githeri”. At the household level, this dish was sometimes improved by addition of vegetables. This finding agrees with other studies among school children where school meals in developing countries are confined from starchy staples (mainly cereals) and legumes

(Evang et al., 2020; Nicholaus et al., 2020; Worku et al., 2017).

Frequent consumption of cereals and pulses increases ingestion of tannins, polyphenols and phytates which act as bio-inhibitors of iron in humans (R. K. Gupta et al., 2013; Hmielowski, 2016; Nissar et al., 2017). This study found that over 90% of the adolescents frequently consumed starchy staples and legumes, foods that are excessively high in dietary fibre. High fibre diets add to the inhibitory quality of a diet and affect the quantity of iron absorbed from its source foods hence the need for removal of the inhibitory factors. De-hulling, soaking, fermentation and germination have been identified as important strategies for improving iron bioavailability in cereals and pulse crops (DellaValle & Glahn, 2014; R. K. Gupta et al., 2013). A study in Egypt found that soaking and germination reduces polyphenols, tannins and phytates by up to 57%, 64% and 65% respectively (Mehanni et al., 2017). In this study, the only reported meal preparation strategy that could improve iron bioavailability from cereals was de-hulling of maize in preparation of a traditional dish (*Muthokoi*). This points to the need for sensitisation on food preparation, cooking and consumption practices that enhance dietary iron absorption while eliminating inhibitors.

Beverages especially tea and coffee contain tannins which bind non-heme iron hindering its absorption especially if taken with meals (Kumera et al., 2018; Sung et al., 2018). In the current study, the number of respondents consuming tea or coffee with meals (16.7%) was lower than that reported in India, North west and South west Ethiopia (Mengistu et al., 2019; Rakesh et al., 2015; Tesfaye et al., 2015). The low tea/coffee consumption with meals was attributed to the fact that beverages were mainly served for breakfast in this study area as opposed to lunch or supper. This low consumption may be an important factor in the prevention of iron deficiency anaemia as it helps in minimising the amount of iron inhibitors in the daily diet and therefore needs to be encouraged.

Research has underscored the importance of fruits and vegetables in anaemia prevention, not only as express sources of iron and folic acid but also as vitamin C rich foods. Vitamin C is known to enhance absorption of non-heme iron when consumed together with the source by forming a more soluble chelate iron ascorbate (Ghose & Yaya, 2018). A study predicting bioavailability of iron in maize and beans among women found iron absorption to triple with vitamin C supplementation (Beiseigel et al., 2007). Fruit and vegetable consumption is presumed to translate to a higher vitamin C intake but in the current study, the adolescents did not meet the WHO recommendation of 400 grams per day. This corroborates results of various other similar studies (Darfour-Oduro et al., 2018; Ndagire et al., 2019; Rathi et al., 2017; Ziaei et al., 2019). However, this finding differs with that of a study in Bangladesh where fruit consumption was higher than recommended, and this was attributed to the fact that the study was done at the climax time for seasonal fruits (Yearul et al., 2010). As this adolescent population is highly dependent on non-heme iron, promoting fruit and vegetable consumption is critical for the achievement of their growth and development potential.

Intake of heme iron is important in prevention of iron deficiency anaemia as it is better absorbed and almost not inhibited by other food components (Nissar et al., 2017). Additionally, some of the amino acids in meats chelate non-heme iron thereby increasing its bioavailability (Cavalcanti *et al*., 2014). The consumption of heme iron was low in this study just like in other studies among adolescent girls in developing countries (Melaku et al., 2015; Nelima, 2015; Rathi et al., 2017). This was so despite the fact that many households kept livestock of varied kinds, which can be explained by the fact that many households used the animal products for sale. In agreement are studies in eastern and western Kenya where animal source foods played a greater role of income generation compared to plant foods, a factor that contributed to their low consumption (Evang et al., 2020). A similar finding of low consumption of flesh foods was observed among adults in the neighbouring Kitui county (Hansen et al., 2011). Food based strategies to improve heme iron consumption by consuming animal products in the households should be encouraged so as to combat iron deficiency anaemia.

### 5.2.4 Dietary Diversity among the Adolescent Girls

It was observed in this study that 44.4% of the adolescent girls aged 15 years and over had consumed 5 or more food groups thereby achieving the minimum dietary diversity for women of reproductive age. This figure is lower than the 75.4% found among adolescent girls in Ethiopia (Birru et al., 2018) but higher than the 11.2% found in Zimbabwe (Reese-Mastorson & Murakwani, 2016) and 41.2% established in Ethiopia (Roba et al., 2016). After taking consumption of 5-7 food groups to represent medium diversity so as to compare with previous studies in the region, the figure of 41.0% obtained is lower than that of 61.6% and 63.3% obtained among women in Machakos and Makueni Counties (Bukania et al., 2014). The difference could be attributed to age difference where the latter study included women aged 15-49 years who may have better access to quality food compared to school adolescents.

The mean dietary diversity score was 4.46, a figure almost the same as that of 4.69 found in Ethiopia but lower than that of 6.81 established among Iranian adolescents (Vakili et al., 2013; Worku et al., 2017). This comparatively lower score could be due to difference in study population where the Iranian adolescents were obtained from both public and private schools which may be in a position to offer better diets. However, this figure is higher than that of 3.91 found in Nigeria (RA & Yusuf, 2018) and this could be due to difference in methodology where the Nigerian study based their diversity scores on 9 food groups as opposed to 10 used in this study. Dietary diversity is a key indicator of both macro and micro-nutrient adequacy of diets and from this study results there is need to promote consumption of foods from varied food groups to ensure adequacy of nutrients among adolescents.

### 5.3 Menstrual Profiles of the Adolescent Girls

The mean age at menarche among the girls was 14.32 ± 1.06 years, which is earlier than that of 15.1 previously reported among adolescent girls in Western Kenya, but later than the global average of 12 years, the 12.5 years reported among urban primary school adolescents in Nairobi and the 13.0 years reported among primary school adolescents in Kajiado, Kenya (Korir et al., 2018; Ogeng'o et al., 2011). Numerous earlier studies also reported earlier age at menarche than reported in this study (Ayele & Berhan, 2013; Irewole-Ojo et al., 2018; Khadgawat et al., 2016). Additionally, this study found negligible cases of early menarche (by 11 years) and as high as 10% cases of late menarche (over 15 years). Research has associated early menarche age with weight gain at childhood, physical inactivity, urban settings and high socio-economic status (Ayele & Berhan, 2013; Engidaw & Gebremariam, 2019; J.-Y. Kim et al., 2010; Malitha et al., 2020). The high incidence of late menarche in this study may therefore indicate the opposite, probably childhood malnutrition, low social economic status and strenuous work; all associated with poor rural settings.

Irregular menstrual cycle was reported by about half of the respondents in this study and this is lower than the 64% recorded among adolescent girls in Nepal (S. Sharma et al., 2016). However, this figure is much higher than that found in Eastern Sudan and India (Aziem et al., 2011; Patil & Angadi, 2013). The comparatively high rate of menstrual irregularity in this study could be attributed to the late age menarche observed among the respondents as irregular menstruation is deemed to be a normal phenomenon within the first two years of menarche after which normal cycle length is obtained (Diaz et al., 2006). There is therefore a possibility that the menstrual cycles for many of the girls were yet to normalise.

This study found that up to four fifths of the adolescents had a normal menstrual duration which is comparable findings in Nepal by (S. Sharma et al., 2016). A small percentage of 6.5 reported longer menstrual bleeding and careful attention should be given to such this has been shown to result in iron deficiency anaemia (Toxqui et al., 2014). The proportion with shorter cycle length of less than 21 days in this study was 4.2% which is comparable to that of Italian adolescents (Rigon et al., 2012); but that with longer cycle length of more than 45 days was 5.6% which is far much lower than that of Nepalese adolescents (S. Sharma et al., 2016). The difference could be attributed to ethnicity which was a strongly associated factor in the Nepalese study.

## 5.4 Anaemia Status of the Day-school Adolescent Girls

### 5.4.1 Prevalence and Grading of Anaemia among the Adolescent Girls

The overall anaemia prevalence as determined by haemoglobin concentration <12g/dL after altitude adjustment was 28.6%. Based on WHO (2008) classification of 20–39.9%, the observed prevalence was a moderate public health problem. This finding agrees with WHO’s 27% anaemia estimate for adolescent girls in developing countries (WHO, 2011b), and also similar studies in western Kenya (26.5%) and Rural Ethiopia (27%) (Nelima, 2015; Regasa, 2019). A lower prevalence than established in this study was found in an earlier study in western Kenya and another study in North West Ethiopia (Leenstra et al., 2004; Mengistu *et al*., 2019). This difference could be attributed to seasonal variation as the data in the current study was collected during the dry season, a factor which could have exposed the adolescents to several months of nutritional challenges and hence iron depletion prior to the anaemia assessment.

The prevalence in this study is significantly lower than the 45% estimated for adolescent girls in Africa (Regasa, 2019) and the 48.18% and 84.6% identified among adolescent girls in schools in India (Goyal & Rawat, 2018; Shedole et al., 2017). This difference could be due to variations of study population as some studies took the 13-16 age bracket. It can also be attributed to cultural issues where the Indian studies had majority of participants being vegetarians. The 2015 Kenya Malaria Indicator Survey reported national anaemia prevalence of 16% among adolescents aged 10-14years. This disparity may be due the larger range of study participants (10-19 years) in the current study.

The World Health Organisation grades anaemia on the basis of haemoglobin (Hb) concentration as mild (Hb 10-11.9 g/dL), moderate (Hb 8-9.9 g/dL) and severe (Hb <8g/dL) (WHO, 2011a). The most common form of anaemia in this study was mild followed by moderate and then severe. This finding concurs with that of Nelima's stud in Yala, Kenya (Nelima, 2015) as well as studies in Southwest Ethiopia and Shimla Hills of north India (A. Gupta et al., 2012; Tesfaye et al., 2015). However, it differs with a finding in Eastern Sudan where moderate anaemia was most common followed by mild anaemia (Abdelrahim et al., 2009). This discrepancy may be due to higher nutritional deficiency among the Sudanese adolescents as multiple micronutrient deficiencies with iron deficiency were reported, which could have increase the severity of anaemia.

### 5.4.2 Distribution of Anaemia according to Red Blood Cell Parameters

According to Anyika et al., (2009), a minimum sample of 10% is adequate for testing on any additional component within a study. This study adopted 25% of the sample to test for additional red blood cell parameters so as to allow for morphological categorization of anaemia. It was observed that half of the anaemic adolescents presented with microcytic hypochromic anaemia and 65% had microcytosis compared to 25.9% of the normal proportion. Additionally, more anaemic adolescents presented with hypochromia compared to the normal ones. These results point to anaemia that is related to iron deficiency.

Microcytic hypochromic anaemia emanates from any factor which disrupts iron supply to the body thereby reducing the body's iron stores (Ozdemir, 2015). Deficiency of iron, a component of haemoglobin results in formation of smaller red blood cells with less haemoglobin concentration making them to appear pale (hypochromia). Research has also shown that advancement in iron deficiency is accompanied by a simultaneous increase in cell microcytosis (Manjula et al., 2014). The high prevalence of microcytic hypochromic anaemia in this study may therefore be attributable to iron deficiency. Furthermore, the significantly lower mean cell volume (p = 0.001) among anaemic girls compared to normal ones is additional evidence that iron deficiency is the main cause of anaemia in the current study. In addition, iron intake, a factor related to iron deficiency was a significant predictor of anaemia in the current study. Similar findings where microcytic hypochromic anaemia was dominant among female adolescents were observed in India and Ethiopia (Biopharma *et al*., 2018; Tesfaye *et al*., 2015). Based in the study findings, there is need for intermittent iron-folic acid supplementation since majority of these adolescents have attained menarche and anaemia prevalence among them is above 20% as recommended (WHO, 2018)

### 5.5 Socio-demographic and Economic Characteristics and Anaemia

Out of the socio-economic factors studied, only household size emerged as a determinant of anaemia in this study where adolescent girls from larger households of more than 4 persons were 3.1 times less likely to be anaemic (AOR = 0.32, P = 0.030) as compared to those from smaller households of 4 or less persons. This finding contradicts many studies which show higher odds of anaemia in larger families (Mengistu et al., 2019; Shaka & Wondimagegne, 2018; Srivastava et al., 2016). It however concurs with the finding of a study in Uganda where children from larger households had a lower risk of anaemia (Legason et al., 2017). This uncommon finding could be a factor of food production rather than household size as larger households have been associated with a higher potential for food production and hence a better food security than smaller households (Ngongi et al., 2014).

This study found no association between household income and anaemia unlike other studies that identified associations (Chalise et al., 2018; J. Y. Kim et al., 2014; Mengistu et al., 2019); but it agrees with Gebreyesus et al., (2019) and Ngan et al., (2019). The reason for this lack of association could be that majority of the households in this study relied on home-grown rather than market sourced produce for their dietary needs making the difference in income level less significant. Similarly, no relationship was found between anaemia and either age or adolescence stage probably due to the small age differences for majority of the respondents (14 – 19 years).

### 5.6 Menstrual Profiles and Health Status; and anaemia among the Respondents

Earlier studies have associated menstrual characteristics and anaemia. Among adolescent girls in Nepal and undergraduate medical students in India, duration of menstrual bleeding was found to be a strong predictor of anaemia (Hamal et al., 2018; Manjula et al., 2014). Another study among rural school adolescents found an association between age at menarche and anaemia (Kavthekar et al., 2016). Also, a negative correlation was found between duration of menstrual flow and haemoglobin levels (Manjula et al., 2014). The results of this study contrasts the above findings but agree with a study in Ethiopia as no association was found between menstrual characteristics and anaemia in this study population (Gonete et al., 2018).

Morbidity in the previous two weeks emerged as a determinant of anaemia where adolescents who had ailed within the period were 2.7 times more at risk of being anaemic compared to their counterparts who had been healthy. This could be explained by the fact that majority of those who had ailed reported to have suffered from malaria. Studies have associated malaria with anaemia due to destruction of red blood cells (Icyishatse et al., 2019; Intiful et al., 2016; Nelima, 2015; White, 2018). Although no studies were found that had reported on anaemia and recent history of illness, significant associations between anaemia and recurrent infection have previously been reported (Kavthekar et al., 2016; Manjula et al., 2014). Anaemia due to iron deficiency affects the body's capacity to initiate adequate immune response due to impaired lymphocyte proliferation which is necessary for specific response to infections (Hassan et al., 2016).

There was no relationships between anaemia and deworming status or history of worm infestation in this study which is in agreement with (Kavthekar et al., 2016) but contrary to (Hamal et al., 2018) who associated failure to deworm in previous 6 months with higher likelihood of anaemia. Other studies have also associated worm infestation with anaemia (Gopalakrishnan et al., 2018; Guan & Han, 2019; Nelima, 2015). Intestinal worms contribute to anaemia by inducing iron deficiency through intestinal blood loss (Osazuwa et al., 2011). The lack of association found in this study may be because the students were only asked for history of worm infestation instead of an actual stool exam which would have been more objective.

### 5.7 Dietary Practices and Anaemia among the Respondents

Findings of the present study identified dietary diversity and iron intake as the dietary risk factors of anaemia. The odds of being anaemic were 1.6 times lower in those with higher diversity scores of >4 (AOR 0.62, $p = 0.039$) as compared to those in the less than 4. This concurs with many other studies where higher dietary diversity reduced the odds of anaemia (Chalise et al., 2018; Gonete et al., 2018; Olumakaiye, 2013). Although studies in Ghana and Indonesia did not find any association between dietary diversity and anaemia, positive correlations were found between dietary diversity scores and haemoglobin levels (Agustina et al., 2020; Saaka et al., 2017). Dietary diversity at the individual level is a reflection of dietary quality especially the adequacy of micronutrients, a factor that is commonly assumed to have positive association with haemoglobin levels and in turn an inverse association with iron deficiency anaemia (Olumakaiye, 2013)

In this study, inadequacy of iron intake resulted in 10 times higher odds of anaemia (AOR 10.447, p = 0.009). This supports a finding by Nelima (2015) who significantly associated inadequacy of daily iron intake among Kenyan adolescent girls with anaemia. Earlier in western Kenya, a third of the anaemia among school adolescent girls was attributed to iron deficiency (Leenstra et al., 2004). A study in rural Ethiopia found that all anaemic adolescents were also iron deficient while another study in Turkey associated 37% of anaemia among adolescents to iron deficiency (Seyoum et al., 2019; Y. et al., 2012). Dissimilar results among Brazilian adolescents showed a lack of association between adequacy of iron intake and anaemia suggesting that other factors could have been responsible for anaemia in that study population (Bagni et al., 2014). Iron is important in the synthesis of heme, an important component of haemoglobin (Miller, 2013).

Results obtained showed a significant association between skipping of dinner during the weekday and anaemia where adolescents who did not skip dinner during weekdays were less likely to be anaemic (COR 0.38 95% CI 0.15-0.96). This concurs with the finding among Indonesian adolescents where no association was found between breakfast and lunch skipping and anaemia but dinner had an inverse association such that those who skipped it were less likely to be anaemic (Agustina et al., 2020). It is also supports other previous studies that significantly associated meal skipping and anaemia (Jalambo et al., 2018; E. C. Keats et al., 2018). The association in this study could be attributed to inadequacy of the school meals and breakfast skipping making dinner critical for compensation of lacking nutrients as it was the only main meal taken from home during the week days.

**5.8 Nutritional Status of the Adolescent Girls**

The assessment of the nutritional status for adolescents aged 17 years and below was done through the adoption of the BMI-for-age and height-for-age Z scores recommend by WHO (2006) as ideal for assessment of nutrition status of adolescents but for those aged 18-19 years, normal adult BMI was used. BMI-for-age and height-for age Z-scores are indicators for long term effect of nutrition on the growth of adolescents. Overall, the proportion of thin girls was higher than that of overweight and obesity combined. This finding agrees with that of Leenstra et al. (2004) in Asembo, but contrasts that of Nguu-gutu et al. (2014) in Nairobi, Kenya where thinnes was lower than overweight and obesity. This variation may be attributed to snacking practices and socio-economic differences since the study was conducted in a rural setting while the Nairobi study was carried out in an urban setting.

A simultaneous existence of undernutrition and over-nutrition was observed in this study population which agrees with the 2014 Kenya Demographic and Health Survey. Similar findings were reported among school going adolescents in Nairobi

Kenya as well as in Ethiopia and South Africa (Githinji et al., 2016; Kt et al., 2016; Silangwe, 2016). This shows the need for unique interventions to address malnutrition in all its forms so as to prevent early death from non-communicable diseases (GOPAC et al., 2017).

Stunting in adolescence is a reflection of poor nutrition, disease and environmental stress accumulated ever since the foetal stage and is a risk factor for poor outcomes if it precedes pregnancy (Christian & Smith, 2018; Inoue et al., 2016; Khanam et al., 2019). The prevalence of stunting in this study was 1.8% which is higher than that of 0.8% established among women of reproductive age in Machakos County by the 2014 KDHS. It is however lower than the 10.8% reported by Leenstra in western Kenya (Leenstra et al., 2004). Furthermore, stunting among adolescent girls aged 15-19 years has previously been estimated at 8% in Kenya, 6% in Brazil, 44% in Bangladesh and 52% in Guatemala (Black et al., 2013). A study among adolescents in rural India reported much higher levels of stunting (48.37%) compared this study (Nair et al., 2017). The comparatively higher prevalence in the current study may be due its rural setting as rural residence has been associated with higher odds of stunting (Al-Mansoob & Masood, 2018; Keino et al., 2014; Melaku et al., 2015).

### 5.9 Socio-demographic Characteristics and Nutritional Status of Respondents

In this study population, BAZ increased with age, reflecting a normal growth pattern for children where after the age of 4-6 years, BAZ gradually increases through adolescence and nearly all of adulthood (CDC, 2000). An earlier study among adolescent girls in western Kenya showed a significantly declining prevalence of underweight with age (Leenstra et al., 2004). This finding also agrees with other existing literature which reported that adolescent girls improved in BAZ as they aged (Assefa et al., 2015; Gebregyorgis et al., 2016; Melaku et al., 2015; Tambalis et al., 2019). It however contradicts a study in Tanzania where BAZ decreased with age among adolescents (Ismail et al., 2020). Increase of BAZ with age may be partly due to body fat gain that occurs at menarche (Cusick & Kuch, 2012).

Both maternal and paternal education levels were associated with overweight among this study respondents. A similar association was observed in low and middle income countries (Vollmer et al., 2017) and elsewhere (Choudhuri & Balaram, 2020; López et al., 2012; Viswambharan et al., 2020). Parental literacy has been identified as a critical determinant of children's wellbeing in developing countries and studies have singled out better mother education as an enhancing factor to nutritional status (Abuya et al., 2012; Fadare O et al., 2019; Feng et al., 2019). Father's education is also a critical determinant of nutritional status in most African settings as fathers are the chief family decision makers and bread winners (Igbokwe et al., 2017).

### 5.10 Dietary Practices and Nutritional Status among Respondents

Pearson's correlation tests in the current study revealed a strong positive relationship between amount of carbohydrate taken with BAZ, as well as an association of carbohydrate adequacy with underweight. The correlation results contrast some existing literature where BMI decreased with carbohydrate intake among healthy adults (Merchant et al., 2009) and another where no relationship was found between daily carbohydrate intake and BMI (Ma et al., 2005). Normally, excess carbohydrates are eventually converted to fats in the body and stored in the adipose tissues hence failure to balance carbohydrate intake with consumption can lead to weight gain

(Kurpad et al., 2005). However existing literature suggests that the type of carbohydrates along other factors rather than the amount determines body weight and this could explain the correlation found in this study (Ma et al., 2005)

Protein adequacy was also associated with thinness in this study. A systematic review on eating practices of adolescent girls in LMICs associated low protein intakes with underweight in Africa and South Asia (E. Keats et al., 2017). In an Indonesian study protein intake was significantly associated with the nutritional status of adolescents (Sari & Dewi Sartika, 2019). The association of protein intake and body weight emanates from its critical role of build-up and maintenance of body tissues, which cannot be performed by other nutrients as well as it's being an energy source. In developing countries, protein rich foods are expensive, a factor that may limit their frequent consumption leading to undernutrition.

### 5.11 Nutritional Status and Anaemia

This study found no association between anaemia and either BAZ or BMI although a negative significant relationship was found between haemoglobin levels and BAZ. It also found no association between anaemia and thinness. This lack of association agrees with a studies on Nigerian and Columbian women (Kordas, Fonseca Centeno, et al., 2013; Ugwuja et al., 2015) but contrasts various other studies where BMI was associated with anaemia. In Ethiopia, adolescents with low BMI were 3.2 times more likely to be anaemic compared to those with high BMI (Mengistu et al., 2019). Among Iranian adolescents, overweight adolescents had a higher prevalence of anaemia (Eftekhari et al., 2009). In another study among medical students, anaemia was positively correlated with BMI (Sunita B & Kallur, 2016).

There was no association found between anaemia and stunting which contradicts the findings of Shaka & Wondimagegne (2018) where stunted adolescents were six times more likely to be anaemic. In another study in Bhutan, the risk of anaemia was 1.2 times greater in stunted children (Campbell et al., 2018). Similarly in China, the odds of anaemia were 30% higher in stunted school children than in non-stunted ones (Wang et al., 2020). The lack of association of nutrition status and anaemia in this study may be attributed to the low prevalence of stunting as well as the fact that this study results pointed to iron deficiency as the main cause of anaemia, a factor that may not directly reflect in nutritional status.

### 5.12 Relationships between Variables

The first hypothesis that stated that there is no significant relationship between dietary practices and haemoglobin levels was rejected since dietary diversity scores, amounts of iron and vitamin C consumed were significantly related to haemoglobin levels. Similarly, significant relationships were found between carbohydrate intake and BAZ as well as between calcium intake and HAZ and hence the second hypothesis stating that there is no significant relationship between dietary practices and nutritional status was rejected. Also, a relationship existed between age at menarche and haemoglobin levels hence the third hypothesis stating that there is no significant relationship between menstrual profiles and haemoglobin levels was rejected. However, statistical analyses of this study did not find any significant relationships between BAZ, BMI or HAZ and haemoglobin levels and therefore the fourth hypothesis stating that there is no significant relationship between nutritional status and haemoglobin levels was accepted.

# CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Summary of the Findings

This study sought to establish the dietary practices, prevalence of anaemia and nutritional status among day-secondary school adolescent girls in Matuu ward, Machakos County.

### 6.1.1 Socio-demographic and Economic Factors

The mean age of the adolescent girls was 16.79 ± 1.38 years and 65.2% were in middle adolescence. Majority of the adolescents were from households of between 5-7 members and the average household size was 6 ± 2. Most of the households had low income and the main sources of income were petty trade, employment and crop sales. A significant positive relationship was found between age and BAZ while house hold size was a determinant of anaemia.

### 6.1.2 Dietary Practices

The adolescent girls mainly relied on home and school for their nourishment and on average consumed three meals in a day. Many of the girls had inadequate energy intake whose source was limited to repetitive intake of a few staples. Micro-nutrient intake of vitamin A, calcium and iron were inadequate but intake of carbohydrates and dietary fiber was higher than recommended. Their girl's diet mainly comprised of starchy staples and legumes with very limited consumption of fortified and heme iron source foods. Less than half (44.4%) achieved minimum dietary diversity for women of reproductive age. Dietary diversity scores, frequencies of consumption of citrus fruits and amounts of iron and vitamin C consumed were significantly related to haemoglobin levels. Skipping dinner during weekday was associated with anaemia while parental education and adequacy of protein and carbohydrate intake were associated with nutritional status. Dietary diversity tertile and adequacy of iron intake were the dietary determinants of anaemia in this study population.

### 6.1.3 Menstrual Profiles and Health Status

Over 90% of the girls had attained menarche with a fifth attaining it later than 15 years of age. Also, about a third of the adolescents had ailed within the previous two weeks with majority ailing from malaria. Age at menarche was significantly related with haemoglobin levels while health status in the previous two weeks was a determinant of anaemia.

### 6.1.4 Prevalence of Anaemia

The prevalence of anaemia was established at 28.6% and therefore rated as a moderate public health problem. The mean haemoglobin concentration was 12.58 ± 1.54. Majority (83.1%) of the adolescents had mild anaemia.

### 6.1.5 Nutritional Status of the Adolescent Girls

A fifth of the respondents were malnourished by being either thin, overweight or obese and only 1.8% of the adolescents aged 17 years and below were stunted. The proportion of thin girls was slightly higher than that of overweight/obese.

### 6.1.6 Hypotheses

The first, second and third hypotheses were rejected as relationships were established among the stated variables. However, the fourth hypothesis was accepted as no relationship was found between nutritional status and anaemia.

**6.2 Conclusions**

This study has shown that majority of adolescent girls in day-secondary schools in Matuu division are in middle adolescence and hail from relatively large poor households that mainly depend on peasant agriculture for subsistence. Interventions that improve and diversify food crop production in these dry areas are highly required in order to make food more accessible.

This study concludes that anaemia is a moderate problem existing in nearly a third of the day secondary school adolescent girls and majority are suffering from mild anaemia. If not addressed, this can easily advance to a higher level of severity hence the need for prevention and control measures to reverse this situation.

A coexistence of undernutrition, over-nutrition and micro-nutrient deficiencies among the adolescents in this study has been found. This calls for interventions to address the unique nutritional needs of adolescents at this critical stage of development and promote healthy growth while at the same time minimising the risk of health problems.

The dietary practices of adolescents in this study are inclined towards unhealthy ones in regard to meal skipping, inadequate nutrient intakes and lack of diversity. This necessitates frequent interaction between parents, school administration, health personnel and the adolescents so as to create a link between healthy dietary practices and overall health of school adolescents.

In this study, anaemia and nutritional status of the adolescents was found to be significantly determined by socio-demographic, health and dietary factors; some of which are beyond their control. There is therefore need for awareness creation to the adolescents, the school staff and the family about nutrition and health of adolescents to avoid the vicious cycle of malnutrition.

### 6.3 Recommendations of the Study

#### 6.3.1 Recommendation for Policy

Findings of this study show that school meals play a major role in the day-school adolescent girl's daily diet. The study has also established that the adolescent girls' dietary intakes are inadequate. School meals can therefore be an effective channel for promoting adequate nutrition and combating anaemia.

1. The Kenya government through the ministry of education should expand the national school meals and nutrition strategy for nutrition sensitive school meals to include day-secondary school learners. This will ensure involvement of all stake holders in provision of a healthy lunch in the schools.
2. The Kenya government through the ministries of health and education should establish and promote a micronutrient supplementation program targeting adolescent girls so as to avert nutrient deficiencies and improve nutritional status.

#### 6.3.2 Recommendation for Practice

Findings of this study associated anaemia and dietary iron intake. Iron demands in adolescent girls increase as they advance in age due to menstrual losses and rapid growth.

1. Special health and nutrition education sessions targeting school adolescents, school heads, cooks and parents / guardians; and addressing behaviour changes in

dietary practices to increase iron intake and improve nutritional status should be implemented by ministry of health, ministry of education and ministry of agriculture, livestock and fisheries personnel in the county.

2. Regular anaemia screening among adolescent girls is recommended and those found to be anaemic given the necessary treatment in order to curb the negative effects of anaemia.

### 6.3.3 Recommendation for Further Research

1. The current study focused on prevalence of anaemia and associated dietary practices. Another study on knowledge, attitude and practices of anaemic and non-anaemic day school adolescent girls is encouraged in order to pinpoint gaps in this area so as to inform policy on health and nutrition education.
2. All of the day-secondary schools were mixed and as such, a comparative study on anaemia and dietary practices among adolescent boys and girls in these schools is highly encouraged. This will help highlight gender related aspects of anaemia in this study population.
3. Since there is scarcity of data on anaemia, nutritional status and dietary practices of Kenyan adolescents, similar research in other counties is recommended so as to help highlight possible contributory factors to adolescent malnutrition.

**REFERENCES**


Abeywickrama, H. M., Koyama, Y., Uchiyama, M., Shimizu, U., Iwasa, Y., Yamada, E., … Mitobe, Y. (2018). Micronutrient Status in Sri Lanka: A Review. *Nutrients*, *10*(11), 1–20. https://doi.org/10.3390/nu10111583

Abuya, B. A., Ciera, J., & Kimani-Murage, E. (2012). Effect of mother’s education on child’s nutritional status in the slums of Nairobi. *BMC Pediatrics*, *12*(1998). https://doi.org/10.1186/1471-2431-12-80

Adams, S., Sello, C. T., Qin, G. X., Che, D., & Han, R. (2018). Does dietary fiber affect the levels of nutritional components after feed formulation? *Fibers*, *6*(2), 1–15. https://doi.org/10.3390/fib6020029

Agustina, R., Nadiya, K., El Andini, A., Setianingsih, A. A., Sadariskar, A. (2020). Associations of meal patterning, dietary quality and diversity with anemia and overweight-obesity among Indonesian schoolgoing adolescent girls in West Java. *PLoS ONE*, *15*(4), 1–19. https://doi.org/10.1371/journal.pone.0231519

Aigner, E., Feldman, A., & Datz, C. (2014). Obesity as an emerging risk factor for iron deficiency. *Nutrients*, *6*(9), 3587–3600. https://doi.org/10.3390/nu6093587

Al-Mansoob, M. A. K., & Masood, M. S. A. (2018). The Relationship between Stunting and Some Demographic and Socioeconomic Factors among Yemeni Children and Adolescents. *Advances in Public Health*, *2018*, 1–6. https://doi.org/10.1155/2018/5619178

Alavi, M., Eftekhari, M., Noot, R., Rafinejad, J., & Chinekesh, A. (2013). Dietary habits among adolescent girls and their association with parental educational levels. *Global Journal of Health Science*, *5*(5), 202–206. https://doi.org/10.5539/gjhs.v5n5p202

Alemu, T., & Gebremedhin, S. (2020). Prevalence and Predictors of Anaemia Among Adolescent Girls in Rural Hadero Tunto District, Southern Ethiopia. *International Journal of Nutrition and Food Sciences*, *9*(1), 16. https://doi.org/10.11648/j.ijnfs.20200901.14

Ali Abdella, D. N. H., Nasr Abd-Elhalim, D. E. H., & Fathy Attia, D. A. M. (2016). The Body Mass Index and Menstrual Problems among Adolescent Students. *IOSR Journal of Nursing and Health Science*, *05*(04), 13–21. https://doi.org/10.9790/1959-0504021321

Anyanwu, J. C., & Anyanwu, J. C. (2017). The Key Drivers of Poverty in Sub-Saharan Africa and What Can Be Done About it to Achieve the Poverty Sustainable Development Goal. *Asian Journal of Economic Modelling*, *5*(3), 297–317. https://doi.org/10.18488/journal.8.2017.53.297.317

Anyika, J. U., Uwaegbute, A. C., Olojede, A. O., & Nwamarah, J. U. (2009). Nutrient intakes of adolescent girls in secondary schools and universities in Abia State of Nigeria. *Pakistan Journal of Nutrition*, *8*(10), 1596–1602. https://doi.org/10.3923/pjn.2009.1596.1602

Arage, G., Assefa, M., & Worku, T. (2019). Socio-demographic and economic factors are associated with nutritional status of adolescent school girls in Lay Guyint Woreda, Northwest Ethiopia. *SAGE Open Medicine*, *7*, 205031211984467. https://doi.org/10.1177/2050312119844679

Aregawi, A., & Tadele, G. (2018). Prevalence and Associated Factors of Thinness among Adolescent Girls Attending Governmental Schools in Aksum Town, Northern Ethiopia. *Medical Journal*, 582–585. https://doi.org/10.4103

Arinaitwe, M., Nanyunja, M., M. Tukahebwa, E., Adriko, M., Kabatereine, N. B., & Tinkitina, B. (2018). Impact of a national deworming campaign on the prevalence of soil-transmitted helminthiasis in Uganda (2004-2016). *PLOS Neglected Tropical Diseases*, *12*(7), 1–15.

Aspuru, K., Villa, C., Bermejo, F., Herrero, P., & López, S. G. (2011). Optimal management of iron deficiency anemia due to poor dietary intake. *International Journal of General Medicine*, *4*, 741. https://doi.org/10.2147/IJGM.S17788

Asefa, H., Belachew, T., & Negash, L. (2015). Socio-demographic factors associated with underweight and stunting among adolescents in Ethiopia. *Pan African Medical Journal*, *20*, 252. https://doi.org/10.11604/pamj.2015.20.252.3588

Ayele, E., & Berhan, Y. (2013). Age at menarche among in-school adolescents in Sawla Town, South Ethiopia. *Ethiopian Journal of Health Sciences*, *23*(3), 189–200. https://doi.org/10.4314/ejhs.v23i3.1

Aziem, A., Ali, A., Rayis, D. A., Mamoun, M., & Adam, I. (2011). Age at menarche and menstrual cycle pattern among schoolgirls in Kassala in eastern Sudan. *Journal of Public Health and Epidemiology*, *3*(3), 111–114. Retrieved from http://www.academicjournals.org/jphe

Bagni, U. V., Yokoo, E. M., & Da Veiga, G. V. (2014). Association between nutrient intake and anemia in Brazilian adolescents. *Annals of Nutrition and Metabolism*, *63*(4), 323–330. https://doi.org/10.1159/000357955

Banna, J., Buchthal, O., Delormier, T., Creed-Kanashiro, H., & Penny, M. (2016). Influences on eating: a qualitative study of adolescents in a periurban area in Lima, Peru. *BMC Public Health*, *16*. https://doi.org/10.1186/s12889-016-2724

Beck, K., Conlon, C., Kruger, R., & Coad, J. (2014). Dietary determinants of and possible solutions to iron deficiency for young women living in industrialized countries. *Nutrients*, *6*(9), 3747–3776. https://doi.org/10.3390/nu6093747

Beiseigel, J., Hunt, J., Glahn, R., Welch, R., Menkir, A., & Maziya-Dixon, B. (2007). Iron bioavailability from maize and beans. *American Journal of Clinical Nutrition*, *86*(2), 388–396. https://doi.org/10.1093/ajcn/86.2.388

Bernardi, L., Ghant, M., Andrade, C., Recht, H., & Marsh, E. (2016). The association between subjective assessment of menstrual bleeding and measures of iron deficiency anemia in premenopausal African-American women. *BMC Women's Health*, *16*(1), 1–7. https://doi.org/10.1186/s12905-016-0329-z

Biopharma, S., Vijayasimha, M., Jayaswal, R., & Jha, R. K. (2018). Prevalence of microcytic and hypochromic anemia in rural areas of Mysore district ( India ). *Retrieved from*: https://www.researchgate.net/publication/327622033

Birru, S. M., Tariku, A., & Belew, A. K. (2018). Improved dietary diversity of school adolescent girls in the context of urban Northwest Ethiopia: 2017. *Italian Journal of Pediatrics*, *44*(1), 48. https://doi.org/10.1186/s13052-018-0490-0

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., … Uauy, R. (2013). Maternal and child undernutrition and overweight in low and middle-income countries. *The Lancet*, *382*(9890), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Branca, F., Piwoz, E., Schultink, W., & Sullivan, L. M. (2015). Nutrition and health in women, children, and adolescent girls. *BMJ (Clinical Research Ed.)*, *351*(November), h4173. https://doi.org/10.1136/bmj.h4173

Bresnahan, K., & Tanumihardjo, S. (2014). Undernutrition, the acute phase response to infection, and its effects on micronutrient status indicators. *Advances in Nutrition*, *5*(6), 702–711. https://doi.org/10.3945/an.114.006361

Brownhill, L. ., Njuguna, E. M. ., Bothi, K. L. ., Pelletier, B. ., Muhammad, L. W. ., & Hickey, G. M. . (2016). *Food security, gender and resilience: Improving smallholder and subsistence farming*. *Food Security, Gender and Resilience:* Routledge. https://doi.org/10.4324/9781315745855

Bukania, Z., Mwangi, M., Karanja, R., Mutisya, R., Kombe, Y., … & Johns, T. (2014). Food Insecurity and Not Dietary Diversity Is a Predictor of Nutrition Status in Eastern Kenya. *Journal of Nutrition and Metabolism, 2014,* e907153. https://doi.org/10.1155/2014/907153

Campbell, R., Aguayo, V., Kang, Y., Dzed, L., … West, K. (2018). Epidemiology of anaemia in children, adolescent girls, and women in Bhutan. *Maternal and Child Nutrition*, *14*(April), 1–9. https://doi.org/10.1111/mcn.12740

Chalise, B., Aryal, K. K., Mehta, R. K., Dhimal, M., Sapkota, F., Mehata, S., … Sawyer, S. (2018). Prevalence and correlates of anemia among adolescents in Nepal. *PLoS ONE*, *13*(12), 1–11. https://doi.org/10.1371/journal.pone.0208878

Chaparro, C. M., & Suchdev, P. S. (2019). Anemia epidemiology, pathophysiology, and etiology in low- and middle- income countries. *Annals of the New York Academy of Sciences*, *36*(1), nyas.14092. https://doi.org/10.1111/nyas.14092

Choudhuri, D., & Balaram, S. (2020). Factors Associated with Nutritional Status of Adolescent Schoolchildren in Tripura. *Indian Pediatrics*, *57*(2), 177–178. https://doi.org/10.1007/s13312-020-1740-y

Christian, P., & Smith, E. R. (2018). Adolescent Undernutrition: Global Burden, Physiology, and Nutritional Risks. *Annals of Nutrition and Metabolism*, *72*(4), 316–328. https://doi.org/10.1159/000488865

Collings, R., Harvey, L, Hooper, L., Hurst, R., Brown, T., Ansett, J., … Fairweather-Tait, S. J. (2013). The absorption of iron from whole diets. *American Journal of Clinical Nutrition*, *98*(1), 65–81. https://doi.org/10.3945/ajcn.112.050609

De Onis, M., Blössner, M., & Borghi, E. (2010). Global prevalence and trends of overweight and obesity among preschool children. *American Journal of Clinical Nutrition*, *92*(5), 1257–1264. https://doi.org/10.3945/ajcn.2010.29786

DellaValle, D. M., & Glahn, R. P. (2014). Differences in relative iron bioavailability in traditional Bangladeshi meal plans. *Food and Nutrition Bulletin*, *35*(4), 431–439. https://doi.org/10.1177/156482651403500405

Desalegn, A., Mossie, A., & Gedefaw, L. (2014). Nutritional iron deficiency anemia: Magnitude and its predictors among school age children, southwest ethiopia. *PLoS ONE*, *9*(12). https://doi.org/10.1371/journal.pone.0114059

Eftekhari, M., Mozaffari, H., & Shidfar, F. (2009). The relationship between BMI and iron status in iron-deficient adolescent Iranian girls. *Public Health Nutrition*, *12*(12), 2377–2381. https://doi.org/10.1017/S1368980009005187

El-Gilany, A. H., & Elkhawaga, G. (2012). Socioeconomic determinants of eating pattern of adolescent students in Mansoura, Egypt. *Pan African Medical Journal*, *13*, 1–12. https://doi.org/10.11604/pamj.2012.13.22.1390

Engidaw, M. T., & Gebremariam, A. D. (2019). Prevalence and associated factors of stunting and thinness among adolescent Somalian refugee girls living in eastern Somali refugee camps, Somali regional state, Southeast Ethiopia. *Conflict and Health*, *13*(1), 1–8. https://doi.org/10.1186/s13031-019-0203-3

Evang, E., Habte, T., Owino, W., & Krawinkel, M. (2020). The nutritional and micronutrient status of urban schoolchildren with moderate anemia is better than in rural Kenya. *Nutrients*, *12*(1). https://doi.org/10.3390/nu12010207

Fadare O, Amare M, Mavrotas G, Akerele D, & Ogunniyi A. (2019). Mother's nutrition-related knowledge and child nutrition outcomes: Empirical evidence from Nigeria. PLoS ONE, 14(2). https://doi.org/10.1371/journal.pone.0212775

FAO and FHI 360. (2016). Minimum Dietary Diversity for Women- A Guide to Measurement. *Food And Nutrition Technical Assistance III, 82.* Retrieved from http://www.fao.org/3/a-i5486e.pdf

Food and Agriculture Organisation of the United Nations. (2015). Range of Malnutrition. *Food and Nutrition Division*. Retrieved from http://www.fao.org/worldfoodsummit/english/fsheets/malnutrition.pdf

Friis, H., Mwaniki, D., Omondi, B., Muniu, E., Thiong'o, F., Ouma, J., … Fleischer Michaelsen, K. (2003). Effects on haemoglobin of multi-micronutrient supplementation and multi-helminth chemotherapy. *European Journal of Clinical Nutrition*, *57*(4), 573–579. https://doi.org/10.1038/sj.ejcn.1601568

Ganz, T. (2019). Anemia of inflammation. *New England Journal of Medicine, 381*(12), 1148–1157. https://doi.org/10.1056/NEJMra1804281

Gebregyorgis, T., Tadesse, T., & Atenafu, A. (2016). Prevalence of thinness and stunting and associated factors among adolescent school girls in Adwa Town, North Ethiopia. *International Journal of Food Science*, *2016*. https://doi.org/10.1155/2016/8323982

Gebreyesus, S. H., Endris, B. S., Beyene, G. T., Farah, A. M., Elias, F., & Bekele, H. N. (2019). Anaemia among adolescent girls in three districts in Ethiopia. *BMC Public Health*, *19*(1), 92. https://doi.org/10.1186/s12889-019-6422-0

Ghadiri-Anari, A., Nazemian, N., & Vahedian-Ardakani, H. (2014). Association of body mass index with hemoglobin concentration and iron parameters in Iranian population. *ISRN Hematol*, *2014*, 525312. https://doi.org/10.1155/2014/525312

Ghose, B., & Yaya, S. (2018). Fruit and vegetable consumption and anemia among adult non-pregnant women: Ghana Demographic and Health Survey. *PeerJ*, *2018*(2), 1–16. https://doi.org/10.7717/peerj.4414

Girum, T., & Wasie, A. (2018). The Effect of Deworming School Children on Anemia Prevalence. *The Open Nursing Journal*, *12*(1), 155–161. https://doi.org/10.2174/1874434601812010155

Githinji, P., Chege, P., & Githinji, S. (2016). Nutritional Status and School Performance among Upper Primary Children in Selected Public Schools in Nairobi County, Kenya. *International Journal of Health Science and Research*, *6*(12), 227–234.

Gitonga, C., Edwards, T., Karanja, P., Noor, A., Snow, R., & Brooker, S. J. (2012). Plasmodium infection, anaemia and mosquito net use among school children across different settings in Kenya. *Tropical Medicine and International Health*, *17*(7), 858–870. https://doi.org/10.1111/j.1365-3156.2012.03001.x

GOPAC, UNDP, & IDB. (2017). Parliament's Role in Implementing the Sustainable Development Goals. *Retrieved from* http://www.undp.org/undp/democratic-governance

Gopalakrishnan, S., Eashwar, V. A., Muthulakshmi, M., & Geetha, A. (2018). Intestinal parasitic infestations and anemia among urban female school children in Kancheepuram district, Tamil Nadu. *Journal of Family Medicine and Primary Care*, *7*(6), 1395. https://doi.org/10.4103/jfmpc.jfmpc_89_18

Guan, M., & Han, B. (2019). Association between intestinal worm infection and malnutrition among rural children in Guizhou Province, China. *BMC Public Health*, *19*(1), 1–11. https://doi.org/10.1186/s12889-019-7538-y

Gunasekaran, D., Swapna, K., Venkatesh, C., & Soundararajan, P. (2012). Iron stores and menstruation in healthy adolescent girls - Pilot study. *Current Pediatric Research*, *16*(2), 153–155.

Güngör, N. K. (2014). Overweight and obesity in children and adolescents. *JCRPE Journal of Clinical Research in Pediatric Endocrinology*, *6*(3), 129–143. https://doi.org/10.4274/jcrpe.1471

Gupta, A., Parashar, A., Thakur, A., & Sharma, D. (2012). Anemia among adolescent girls in Shimla hills of north India: *Indian Journal of Medical Sciences*, *66*(5–6), 126–130. https://doi.org/10.4103/0019-5359.114198

Gupta, R., Gangoliya, S., & Singh, N. (2013). Reduction of phytic acid and enhancement of bioavailable micronutrients in grains. *Journal of Food Science and Technology*, *52*(2), 676–684. https://doi.org/10.1007/s13197-013-0978-y

Habib, N., Abbasi, S., & Aziz, W. (2020). An Analysis of Societal Determinant of Anemia among Adolescent Girls in Azad Jammu and Kashmir, Pakistan. *Anemia*, *2020*. https://doi.org/10.1155/2020/1628357

Han, E., & Powell, L. M. (2013). Consumption Patterns of Sugar-Sweetened Beverages in the United States. *Journal of the Academy of Nutrition and Dietetics*, *113*(1), 43–53. https://doi.org/10.1016/j.jand.2012.09.016

Hansen, A. W., Christensen, D. L., Larsson, M. W., Eis, J., Christensen, T., Friis, H., … Tetens, I. (2011). Dietary patterns, food and macronutrient intakes among adults in three ethnic groups in rural Kenya. *Public Health Nutrition*, *14*(9), 1671–1679. https://doi.org/10.1017/S1368980010003782

Harika, R., Faber, M., Samuel, F., Kimiywe, J., Mulugeta, A., & Eilander, A. (2017). Micronutrient status and dietary intake of iron, Vitamin A, iodine, folate and zinc in women of reproductive age and pregnant women in Ethiopia, Kenya, Nigeria and South Africa. *Nutrients*, *9*(10). https://doi.org/10.3390/nu9101096

Hassan, H., Badr, A., Karam, A., Zkaria, M., El Saadany, F., … Selim, A. M. (2016). Impact of iron deficiency anemia on the function of immune system in children. *Medicine*, *95*(47), 1–5. https://doi.org/10.1097/MD.0000000000005395

Hemamalini, J. (2013). Anemia in Relation to Body Mass Index and Waist Circumference among Andhra Pradesh Women. *Journal of Obesity & Weight Loss Therapy*, *3*(3), 3–5. https://doi.org/10.4172/2165-7904.1000173

Hess, S., Tecklenburg, L., & Eichler, K. (2016, February). Micronutrient fortified condiments and noodles to reduce anemia in children and adults—a literature review and meta-analysis. *Nutrients*. https://doi.org/10.3390/nu8020088

Hirata, A. M., Aparecida, J., Braga, P., Sylvia, M., Vitalle, D. S., Maria, O., & Amancio, S. (2017). Effect of the Brazilian iron fortification of wheat and corn flour on nutritional iron status in adolescents. *Nutrire*, *42*, 1–6. https://doi.org/10.1186/s41110-017-0035-0

Holdsworth, Michelle et al. "Unhealthy eating practices of city-dwelling Africans in deprived neighbourhoods: Evidence for policy action from Ghana and Kenya." *Global food security* vol. 26 (2020): 100452. doi:10.1016/j.gfs.2020.100452

Houghton, A., Trilok, G., McIntosh, D., … Gibson, R. S. (2019). Multiple micronutrient status and predictors of anemia in young children in New Delhi, India. *PLoS ONE*, *14*(2), 1–16. https://doi.org/10.1371/journal.pone.0209564

Intiful, F. D., Wiredu, E. K., Asare, A., Asante, M., & Adjei, D. N. (2016). Anaemia in pregnant adolescent girls with malaria and practicing pica. *Pan African Medical Journal*, *24*, 1–7. https://doi.org/10.11604/pamj.2016.24.96.9282

Irewole-Ojo, O., Senbanjo, O., Oduwole, O., & Njokanma, F. (2018). Age of pubertal events among school girls in Lagos, Nigeria. *Journal of Pediatric Endocrinology & Metabolism , 31*(3), 313–321. https://doi.org/10.1515/jpem-2017-0344

Ismail, A., Darling, A. M., Mosha, D., Fawzi, W., Sudfeld, C., Sando, M. M., … Vuai, S. (2020). Prevalence and risk factors associated with malnutrition among adolescents in rural Tanzania. *Tropical Medicine and International Health*, *25*(1), 89–100. https://doi.org/10.1111/tmi.13331

Jalambo, M. O., Karim, N. A., Naser, I. A., & Sharif, R. (2018). Prevalence and risk factor analysis of iron deficiency and iron-deficiency anaemia among female adolescents in the Gaza Strip, Palestine. *Public Health Nutrition*, *21*(15), 2793–2802. https://doi.org/10.1017/S1368980018001568

Jamil, M., Rahman, S., Bardhan, K., Khan, A. I., Chowdhury, F., Sarker, S. A., … Ahmed, T. (2008). Micronutrients and anaemia. *Journal of Health, Population and Nutrition*, *26*(3), 340–355. https://doi.org/10.3329/jhpn.v26i3.1900

Johnson-Wimbley, T. D., & Graham, D. Y. (2011). Diagnosis and management of iron deficiency anemia in the 21st century. *Therapeutic Advances in Gastroenterology*, *4*(3), 177–184. https://doi.org/10.1177/1756283X11398736

Juma, M., O, Oiye. S., & O, Konyole. S. (2015). Predictors of optimum antenatal iron-folate supplementation in a low resource rural set-up in Eastern Kenya. *Journal of Public Health and Epidemiology*, *7*(November), 337–345. https://doi.org/10.5897/JPHE2015.0770

Kabir, Y., Shahjalal, M., Saleh, F., & Obaid, W. (2010). Dietary pattern, nutritional status and anaemia-related knowledge in urban adolescent college girls of Bangladesh. *Journal of the Pakistan Medical Association*, *60*(8), 633–638.

Kader, M., & Perera, N. K. P. (2014). Socio-economic and nutritional determinants of low birth weight in India. *North American Journal of Medical Sciences*, *6*(7), 302–308. https://doi.org/10.4103/1947-2714.136902

Kandala, N. (2013). *Socio-demographic determinants of anaemia and nutritional status in the Democratic Republic of Congo, Uganda and Malawi*. Retrieved from http://eprints.soton.ac.uk/354347/

Kavthekar, D. S., Kulkarni, D. D., Kurane, D. A., & Chougule, D. A. (2016). Association of BMI, socioeconomic status and menarche age with anemia in rural school going adolescent girls. *Pediatric Review: International Journal of Pediatric Research*, *3*(7), 486–492. https://doi.org/10.17511/ijpr.2016.i07.04

Keats, C., Rappaport, I., Shah, S., Oh, C., Jain, R., & Bhutta, A. (2018). The dietary intake and practices of adolescent girls in low-and middle-income countries: A systematic review. *Nutrients*, *10*(12). https://doi.org/10.3390/nu1012197

Keino, S., Plasqui, G., Ettyang, G., & Van Den Borne, B. (2014). Determinants of stunting and overweight among young children and adolescents in sub-Saharan Africa. *Food and Nutrition Bulletin*, *35*(2), 167–178. https://doi.org/10.1177/156482651403500203

Kelkitli, E., Ozturk, N., Aslan, N. A., … Bakan, E. (2016). Serum zinc levels in patients with iron deficiency anemia and its association with symptoms. *Annals of Hematology*, *95*(5), 751–756. https://doi.org/10.1007/s00277-016-2628-8

Kenya National Bureau of Statistics (KNBS) - Ministry of Planning, National Development and Vision 2030 (2009). *2009 Kenya population and housing census*. Retrieved from https://www.knbs.or.ke

Khadgawat, R., Marwaha, R. K., Mehan, N., Surana, V., … Gupta, N. (2016). Age of Onset of Puberty in Apparently Healthy School Girls from Northern India. *Indian Pediatrics*, *53*(5), 383–387. https://doi.org/10.1007/s13312-016-0857-5

Kigaru, D., Loechl, C., Moleah, T., Macharia, C., & Ndungu, Z. (2015). Nutrition knowledge, attitude and practices among urban primary school children in Nairobi City, Kenya: a KAP study. *BMC Nutrition*, *1*, 44. https://doi.org/10.1186/s40795-015-0040-8

Kim, J., Oh, I., Lee, E., Oh, C., … Choi, J.-M. (2010). The relation of menarcheal age to anthropometric profiles in Korean girls. *Journal of Korean Medical Science*, *25*(10), 1405–1410. https://doi.org/10.3346/jkms.2010.25.10.1405

Kisiangani, I., Mbakaya, C., Makokha, A., & Magu, D. (2015). Assessment of iron status among preschool children (6 to 59 months) with and without malaria in Western Province, Kenya. *Pan African Medical Journal*, *21*(62). https://doi.org/10.11604/pamj.2015.21.62.4560

KNBS. (2011). The Kenya National Micronutrient Survey, 1–150. Retrieved from http://www.nutritionhealth.or.ke/wp-content/uploads/Downloads/The Kenya National Micronutrient Survey 2011.pdf

Kocaoz, S., Cirpan, R., & Degirmencioglu, A. Z. (2019). The prevalence and impacts heavy menstrual bleeding on anemia, fatigue and quality of life in women of reproductive age. *Pakistan Journal of Medical Sciences*, *35*(2), 365–370. https://doi.org/10.12669/pjms.35.2.644

Kordas, K., Fonseca Centeno, Z. Y., Pachón, H., & Jimenez Soto, A. Z. (2013). Being overweight or obese is associated with lower prevalence of anemia among Colombian women of reproductive age. *The Journal of Nutrition*, *143*(2), 175–181. https://doi.org/10.3945/jn.112.167767

Korir, E., Okwara, F. N., & Okumbe, G. (2018). Menstrual hygiene management practices among primary school girls from a pastoralist community in Kenya: A cross sectional survey. *Pan African Medical Journal*, *31*, 1–11. https://doi.org/10.11604/pamj.2018.31.222.13521

Kotecha, P. V., Patel, S. V., Baxi, R. K., Mazumdar, V. S., Shobha, M., Mehta, K. G., … Ekta, M. (2013). Dietary Pattern of Schoolgoing Adolescents in Urban Baroda, India. *Journal of Health, Population, and Nutrition*, *31*(4), 490–496.

Kurpad, A., Muthayya, S., & Vaz, M. (2005). Consequences of inadequate food energy and negative energy balance in humans. *Public Health Nutrition*, *8*(7a), 1053–1076. https://doi.org/10.1079/phn2005796

Larson, N., & Story, M. (2010). Are 'Competitive Foods' Sold At School Making Our Children Fat? *Health Affairs*, *29*(3), 430–435. https://doi.org/10.1377/hlthaff.2009.0716

Leenstra, T., Kariuki, S. K., Kurtis, J. D., Oloo, A. J., Kager, P. A., & ter Kuile, F. O. (2004). Prevalence and severity of anemia and iron deficiency: cross-sectional studies in adolescent schoolgirls in western Kenya. *European Journal of Clinical Nutrition*, *58*(4), 681–691. https://doi.org/10.1038/sj.ejcn.1601865

Legason, I., Atiku, A., Ssenyonga, R., … & Barugahare, J. (2017). Prevalence of Anaemia and Associated Factors among Children in North-western Uganda. *BMC Hematology*, *17*(1), 1–9. https://doi.org/10.1186/s12878-017-0081-0

Lillie, M., Lema, I., Kaaya, S., Steinberg, D., & Baumgartner, J. (2019). Nutritional status among young adolescents attending primary school in Tanzania. *BMC Public Health*, *19*(1), 1–12. https://doi.org/10.1186/s12889-019-7897-4

Malitha, J., Islam, M., Islam, S., & Hossain, M. (2020). Early age at menarche and its associated factors in school girls in Bangladesh. *Journal of Physiological Anthropology*, *39*(1), 1–9. https://doi.org/10.1186/s40101-020-00218-w

Mallick, N., Ray, S., & Mukhopadhyay, S. (2014). Eating Behaviours and Body Weight Concerns among Adolescent Girls. *Advances in Public Health*, *2014*, 1–8. https://doi.org/10.1155/2014/257396

Manjula, V., Parameshwari, P., Pothen, L., & Sobha, A. (2014). Prevalence of Anemia Among Female Undergraduate Students of Government Medical College Kerala. *International Journal Of Medical And Health Sciences*, *3*(2), 133–138. Retrieved from https://www.ijmhs.net/journals-aid-157.html

Masibo, P. K. (2013). Effects of Initial Nutritional Status on the Responses to a School Feeding Programme among School Children Aged 6 to 13 Years in the Millennium Villages Project , Siaya , Kenya. *Retrieved from* http://scholar.sun.ac.za/handle/10019.1/85693

Mawani, M., Aziz Ali, S., Bano, G., & Ali, S. A. (2016). Iron Deficiency Anemia among Women of Reproductive Age, an Important Public Health Problem: Situation Analysis. *Reproductive System & Sexual Disorders*, *5*(3), 1–6. https://doi.org/10.4172/2161-038X.1000187

Mburu, B. K., Kung'u, J. B., & Muriuki, J. N. (2015). Climate change adaptation strategies by small-scale farmers in Yatta District, Kenya. *African Journal of Environmental Science and Technology*, *9*(9), 712–722. https://doi.org/10.5897/AJEST2015.1926

Mehanni, A., Mehanni, A. E., Sorour, M. A., El-galel, H. A., & Ahmed, W. K. (2017). BAOJ Food sciences & Technology Polyphenols , Tannins and Phytate Contents in Some Egyptian Legumes as Affected by, (March 2019), 1–7.

Melaku, Y., Zello, G., Gill, T., ... & Shi, Z. (2015). Prevalence and factors associated with stunting and thinness among adolescent students in Northern Ethiopia. *Archives of Public Health*, *73*, 1–11. https://doi.org/10.1186/s13690-015-0093

Mengistu, G., Azage, M., & Gutema, H. (2019). Iron Deficiency Anemia among In-School Adolescent Girls in Rural Area of Bahir Dar City Adminstration, North West Ethiopia. *Anemia*, *2019*, 1–9. https://doi.org/10.1155/2019/1097547

Miller, J. L. (2013). Iron deficiency anemia: A common and curable disease. *Cold Spring Perspectives in Medicine*, *3*(7). https://doi.org/10.1101/cshperspect.a011866

MOEST, MOH, & MOALF. (2016). School Nutrition and Meals Strategy For Kenya. *Retrieved from* https://extranet.who.int/nutrition/.../KEN_school nutrition .

National Bureau of Statistics-Kenya and ICF International. (2015). Kenya 2014 Demographic and Health Survey Key Findings, *6*, 24. https://doi.org/10.5261/2013.GEN1.04

National Malaria Control program (NMCP), Kenya National Bureau of Statistics (KNBS), & ICF International. (2016). Kenya Malaria Indicator Survey 2015. *Ministry of Health Kenya*, 165.

Ndagire, C. T., Muyonga, J. H., & Nakimbugwe, D. (2019). Fruit and vegetable consumption, leisure-time physical activity, and sedentary behavior among children and adolescent students in Uganda. *Food Science and Nutrition*, *7*(2), 599–607. https://doi.org/10.1002/fsn3.883

Nelima, D. (2015). Prevalence and Determinants of Anaemia among Adolescent Girls in Secondary Schools in Yala Division Siaya District, Kenya. *Universal Journal of Food and Nutrition Science*, *3*(1), 1–9. https://doi.org/10.13189/ujfns.2015.030101

Ngesa, O., & Mwambi, H. (2014). Prevalence and risk factors of anaemia among children aged between 6 months and 14 years in Kenya. *PLoS ONE*, *9*(11), e113756. https://doi.org/10.1371/journal.pone.0113756

Ngongi, A. M., Urassa, J. K., & Lecturer, S. (2014). Farm Households Food Production and Households' Food Security Status: A Case of Kahama District, Tanzania. *Tanzania Journal of Agricultural Sciences*, *13*(2), 40–58

Nicholaus, C., Martin, H. D., Kassim, N., Matemu, A. O., & Kimiywe, J. (2020). Dietary Practices, Nutrient Adequacy, and Nutrition Status among Adolescents in Boarding High Schools in the Kilimanjaro Region, Tanzania. *Journal of Nutrition and Metabolism*, *2020*. https://doi.org/10.1155/2020/3592813

Ogeng'o, D. N., Obimbo, M. M., & Ogeng'o, J. A. (2011). Menarcheal age among urban Kenyan primary school girls. *Acta Paediatrica (Oslo, Norway : 1992)*, *100*(5), 758–761. https://doi.org/10.1111/j.1651-2227.2011.02152.x

Olumakaiye, M. F. (2013). Adolescent Girls With Low Dietary Diversity Score Are Predisposed to Iron Deficiency in Southwestern Nigeria. *Infant, Child, and Adolescent Nutrition*, *5*(2), 85–91. https://doi.org/10.1177/1941406413475661

Pasricha, S.-R., Drakesmith, H., Black, J., Hipgrave, D., & Biggs, B.-A. (2013). Control of iron deficiency anemia in low- and middle-income countries. *Blood*, *121*(14), 2607–2617. https://doi.org/10.1182/blood-2012-09-453522

Pendergast, F., Livingstone, K., Worsley, A., & McNaughton, S. (2016). Correlates of meal skipping in young adults. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1). https://doi.org/10.1186/s12966-016-0451-1

Prentice, A., Ward, K., Goldberg, G., Jarjou, L. M., .. & Prentice, A. (2013). Critical windows for nutritional interventions against stunting. *American Journal of Clinical Nutrition*. https://doi.org/10.3945/ajcn.112.052332

Qin, Y., Melse-Boonstra, A., Pan, X., Yuan, B., Dai, Y., Zhao, J., … Shi, Z. (2013). Anemia in relation to body mass index and waist circumference among Chinese women. *Nutr J*, *12*(1), 10. https://doi.org/10.1186/1475-2891-12-10

Rakesh, P., Rajeswaran, T., Ramachandran, R., Mathew, G., Sheeja, A., Subhagan, S., & Salila, K. (2015). Anaemia among schoolchildren from southern Kerala, India. *National Medical Journal of India*, *28*(5), 225–227.

Rathi, N., Riddell, L., & Worsley, A. (2017). Food consumption patterns of adolescents aged 14-16 years in Kolkata, India. *Nutrition Journal*, *16*(1), 1–12. https://doi.org/10.1186/s12937-017-0272-3

Rati, S. A., & Jawadagi, S. (2012). Prevalence of Anemia among Adolescent Girls Studying in Selected Schools. *International Journal of Science and Research*, *3*(8), 2319–7064. Retrieved from www.ijsr.net

Recha, J., Kinyangi, J., & Omondi, H. (2012). Climate Related Risk and Opportunities for Agricultural Adaption and Mitigation in Semi-arid Eastern Kenya. *Climate Change, Agriculture and Food Security*, 1–43.

Reese-Mastorson, A., & Murakwani, P. (2016). Assessment of adolescent girl nutrition, dietary practices and roles in Zimbabwe. Retrieved from www.ennonline.net/fex/52/adolescentgirlnutrition

Roba, K., & Abdo, M. (2016). Nutritional Status and Its Associated Factors among School Adolescent Girls in Adama City, Central Ethiopia. *Journal of Nutrition & Food Sciences*, *06*(03), 4–11. https://doi.org/10.4172/2155-9600.1000493

Rodriguez, I., Brearley, C., Bruggraber, S., Perfecto, A., …& Fairweather-Tait, S. (2017). Assessment of iron bioavailability from different bread making processes using an in vitro intestinal cell model. *Food Chemistry, 228,* 91–98. https://doi.org/10.1016/j.foodchem.2017.01.130

Shaka, M. F., & Wondimagegne, Y. A. (2018). Anemia, a moderate public health concern among adolescents in South Ethiopia. *PLoS ONE, 13*(7), 1–14. https://doi.org/10.1371/journal.pone.0191467

Sharma, M. (2015). Eating Pattern , Nutritional Status and Anaemia-Related Knowledge in Rural Adolescent Girls of Panipat ( Haryana ), *3*(2), 52–58.

Sharma, S., Deuja, S., & Saha, C. G. (2016). Menstrual pattern among adolescent girls of Pokhara Valley: A cross sectional study. *BMC Women's Health*, *16*(1), 1–6. https://doi.org/10.1186/s12905-016-0354-y

Silangwe, B. N. (2016). Nutritional Status and Dietary Intake of Adolscent Girls in Mandlenkosi High School Lindelani. *South African Journal of Clinical Nutrition*, *34*(5), 245–253. Retrieved from https://ir.dut.ac.za/handle/10321/875

Siva, P. M., Sobha, A., & Manjula, V. D. (2016). Prevalence of anaemia and its associated risk factors among adolescent girls of central Kerala. *Journal of Clinical and Diagnostic Research*, *10*(11), LC19–LC23. https://doi.org/10.7860/JCDR/2016/20939.8938

Skolmowska, D., & Głąbska, D. (2019). Analysis of heme and non-heme iron intake and iron dietary sources in adolescent menstruating females in a national Polish sample. *Nutrients*, *11*(5). https://doi.org/10.3390/nu11051049

Soliman, A., De Sanctis, V., & Elalaily, R. (2014). Nutrition and pubertal development. *Indian Journal of Endocrinology and Metabolism*, *18*(Suppl 1), S39-47. https://doi.org/10.4103/2230-8210.145073

Srivastava, A., Kumar, R., & Sharma, M. (2016). Nutritional anaemia in adolescent girls. *International Journal of Community Medicine and Public Health*, *3*(4), 808–812. https://doi.org/10.18203/2394-6040.ijcmph20160687

Stang, J. S., & Stotmeister, B. (2017). Nutrition in Adolescence. *Nutrition Guide for Physicians and Related Healthcare Professionals* (pp. 29–39). Springer International Publishing.

Strunz, E. C., Suchdev, P. S., & Addiss, D. G. (2016, January). Soil-Transmitted Helminthiasis and Vitamin A Deficiency: Two Problems, One Policy. *Trends in Parasitology*. https://doi.org/10.1016/j.pt.2015.11.007

Sung, E. S., Choi, C. K., Kim, N. R., Kim, S. A., & Shin, M.-H. (2018). Association of Coffee and Tea with Ferritin. *Chonnam Medical Journal*, *54*(3), 178. https://doi.org/10.4068/cmj.2018.54.3.178

Sunita B, K., & Kallur, R. (2016). Association of Anemia with BMI in Medical Students, a Cross-Sectional Study. *Indian Journal of Basic and Applied Medical Research;*, *6*(1), 371–377. Retrieved from www.ijbamr.com

Teji, K., Dessie, Y., Assebe, T., & Abdo, M. (2016). Anaemia and nutritional status of adolescent girls in Babile District, Eastern Ethiopia. *The Pan African Medical Journal*, *24*. https://doi.org/10.11604/pamj.2016.24.62.6949

Tesfaye, M., Yemane, T., Adisu, W., Asres, Y., & Gedefaw, L. (2015). Anemia and iron deficiency among school adolescents : burden , severity , and determinant factors in southwest Ethiopia. *Adolescent Health, Medicine and Therapeutics*, 189–196. https://doi.org/10.2147/AHMT.S94865

Toheed, R., Ayub, T. Bin, Ali, H. S., & Ali, F. (2017). Prevalence of Menstrual Dysfunction and its Comparative Correlation with Anaemia. *Journal Of Rawalpindi Medical College*, *21*(2), 157–160.

UNICEF. (2011). UNICEF State of the World's Children 2011–Adolescence. *Australian Policy Online*. Retrieved from https://www.unicef.org/sowc2011

UNICEF. (2013). Improving child nutrition. *NCSL Legisbrief*, *18*(8), 1–2. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20196250

Vakili, M., Abedi, P., Sharifi, M., & Hosseini, M. (2013). Dietary diversity and its related factors among adolescents: a survey in Ahvaz-Iran. *Global Journal of Health Science*, *5*(2), 181–186. https://doi.org/10.5539/gjhs.v5n2p181

Viana, M. B. (2011). Anemia and infection: A complex relationship. *Revista Brasileira de Hematologia e Hemoterapia*, *33*(2), 90–91. https://doi.org/10.5581/1516-8484.20110024

Vollmer, S., Bommer, C., Krishna, A., Harttgen, K., & Subramanian, S. V. (2017). The association of parental education with childhood undernutrition in low- and middle-income countries. *International Journal of Epidemiology*, *46*(1), 312–323. https://doi.org/10.1093/ije/dyw133

Wambua, P. M. (2012). *Parents' socio-economic characteristics and students' academic performance. The case of Kalama Division, Machakos District.* https://doi.org/10.7328/jurpcb20122711180

Wambugu, C. (2018). Kenya ' s Adolescent Health situational analysis. *Pediatric Association Conference*. Retrieved from http://kenyapaediatric.org/wp-content/uploads/2018/05/

White, N. J. (2018). Anaemia and malaria. *Malaria Journal*, *17*(1), 1–17. https://doi.org/10.1186/s12936-018-2509-9

WHO. (2006). WHO | WHO Child Growth Standards: Methods and development. Retrieved from http://www.who.int/childgrowth/standards/technical_report/en/

WHO. (2007). WHO | Growth reference data for 5-19 years. Retrieved from http://www.who.int/growthref/en/

WHO. (2011). Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity, 1–6. https://doi.org/2011

WHO. (2013). WHO: Growth reference data for 5-19 years. Retrieved May 19, 2017, from http://www.who.int/growthref/en/

WHO. (2013). Global action plan for the prevention and control of noncommunicable diseases 2013-2020. *World Health Organization*. Retrieved from www.who.int%0Awww.who.int%

WHO. (2014). Adolescence: a period needing special attention - adolescence-physical-changes. *Who*. Retrieved from http://apps.who.int/adolescent/second-decade/section2/page1/recognizing-adolescence.html

WHO. (2015). WHO | The global prevalence of anaemia in 2011. *Retrieve from* http://www.who.int/entity/nutrition/publications/micronutrients/global_prevalence_anaemia_2011/en/index.html

WHO. (2016). WHO | Childhood overweight and obesity. *Retrieved from* http://www.who.int/dietphysicalactivity/childhood/en/

WHO. (2017). Transformative Accountability for Adolescents. *Retrieved from* http://iapreport.org/files/IAP

WHO, & CDC. (2007). Assessing the iron status of populations: Red blood cell parameters. *World Health Organization*. https://doi.org/10.1007/s00277-011-1164-9

WHO, & UNICEF. (2019). Adolescent Health: The missing population in Universal Health Coverage. *Adolescent Health*, 1–32.

Wong, J., Skidmore, P., & Parnell, W. (2014). Healthy Dietary Habits Score as an Indicator of Diet Quality in New Zealand Adolescents 1 – 3. *Journal of Nutrition*, *144*(6), 937–942. https://doi.org/10.3945/jn.113.188375.937

WFP. (2010). Impact Evaluation of WFP School Feeding Programmes in Kenya (1999-2008): A Mixed-Methods Approach. *Evaluation*, *1*. Retrieved from http://www.wfp.org/evaluation Rome,

Yasemin, B., Aysun, K., & Ibrahim, Ç. (2012). Prevalence and risk factors of anemia among adolescents in Denizli, Turkey. *Iranian Journal of Pediatrics*, *22*(1), 77–81. Retrieved from http://ijp.tums.ac.ir/index.php/ijp/article/view/1289/pdf

Ziaei, R., Shahi, H., Dastgiri, S., Mohammadi, R., & Viitasara, E. (2019). Fruit and vegetable intake and its correlates among high-school adolescents in Iran. *Journal of Public Health (Germany)*. https://doi.org/10.1007/s10389-019-01084-2

# APPENDICES

## APPENDIX A: INTRODUCTION AND CONSENT LETTER

**Dear respondent,**

My name is Dorcas Nduku Mulei, a Kenyatta University Postgraduate student pursuing a Master of Science degree in Food, Nutrition and Dietetics. I am conducting a study on Dietary practices, anaemia and nutritional status of day-secondary school adolescent girls in Machakos County. This study will help inform the government and relevant stakeholders on possible ways of enhancing adolescent nutrition in Matuu and Kenya in general.

**Procedures to be followed**

With your own consent and that of your parent / guardian, we (principal investigator and research assistants) intent to ask you some questions about you and your household through a questionnaire. The questions will be about dietary practices socio-economic status and demographic attributes and will take between 30-40 minutes to complete. In addition, and with your permission, we will take your weight and height measurements and a small sample of blood will be drawn from your finger by a qualified lab technician to check your haemoglobin status. Please note that participation is voluntary and you can decline to answer any question(s). Our research team will try to make the sessions as short and confidential as possible and your cooperation will be highly appreciated.

**Confidentiality**

Any information provided will be strictly confidential and will not be used for any other purposes other than for the study and will not be revealed to other person.

**Possible Benefits.**

There may be no direct benefits but the findings may be useful in formulating policies that are geared towards improving adolescent nutrition. The participant may also benefit from knowing and understanding their nutrition and anaemia status.

**Possible Risks/Discomfort**

There are no anticipated risks associated with the study however, the process of drawing blood will involve pricking your finger which may cause some little pain and discomfort at the prick site. Maximum care will be taken to ensure minimum discomfort and immediate stoppage of bleeding. You may be uncomfortable with some questions and in case this happens, you are free not to answer the questions.

**Compensation**

Participation in this study is on voluntary basis and therefore you are not entitled to any form of payment.

**Community Consideration**

Appropriate advice may be given and on completion of the study, result findings will be dispersed to relevant stakeholders for appropriate interventions.

**Care and Protection of Study Participants**

To ensure that there are no associated risks to the study, the procedures will be clearly and satisfactorily explained to the participants together with their right to withdraw from the study any time they choose without any punishment.

**Person to Contact**

You are free to ask questions that you may have before consenting and at any other time during the data collection. The principal investigator (Dorcas Nduku Mulei) and all the other members of the research team will be ready to answer your questions. For any further enquiries regarding the study, you may contact;

Dorcas N. Mulei OR Kenyatta University Ethical Committee
Principal Investigator P.O Box 43844-00100, Nairobi
Kenyatta University Tel: 8710901/12
Tel: +254-721801104

**Your participation will be highly appreciated.**

**Respondent's Assent**

I have fully understood the above information concerning my participation in the study as explained by the principal investigator, and I voluntarily agree to participate.

Name of participant ___________________________

Signature _____________________

Date _____________________

**Investigator's Statement**

I, the undersigned, certify that I have explained to the volunteer participant in the most understandable way and language, the purpose and procedures to be followed as well as the risks and benefits involved in this study.

Name of investigator _____________________

Investigator's signature _____________________ Date _____________________

## APPENDIX B: PARENTAL PERMISSION/CONSENT FORM

Dorcas Nduku Mulei,
Kenyatta University,
P.O Box 43844-00100,
Nairobi.

Thro,

The Principal,
………….............. Secondary School,
P.O. Box ………………,
Matuu.

**Dear Parent/guardian,**

I am a Masters student in Foods Nutrition and Dietetics, Kenyatta University. I am undertaking a study on, "Dietary practices, anaemia and nutritional status of day-secondary school adolescent girls in Machakos County." Findings of the study may be helpful in identifying priority areas and creating awareness on adolescent nutrition. The KU Ethical Review Committee, the National Commission for Science, Technology and Innovation (NACOSTI) and the school administration have allowed me to conduct the research. Upon your approval, I will explain the study to the girls and ask for their agreement to participate. I would appreciate it if you would sign below for approval.

**Signature of Parent or Guardian _______________**

**Date ______________________**

## APPENDIX C: RESEARCHER ADMINISTERED QUESTIONNAIRE

**Dietary practices, anaemia and nutritional status of day-secondary school adolescent girls in Machakos County, Kenya.**

**Administrative Details**
Questionnaire No.________________ Interviewer's name _______________
School name _____________________ Date of interview _________________
Respondent Code ___________________

**SECTION 1: DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS**

**Part A: Respondent Details**
*Please fill in the spaces with the requested information or tick where applicable.*

| NO | 1.1 | 1.2 | 1.3 | 1.4 |
|---|---|---|---|---|
| | **Responded code** | **Date of birth** | **Class** | **Religion (tick)** |
| | | Day___________<br>Month_________<br>Year __________ | F1 __<br>F2 __<br>F3 __<br>F4 __ | 1 Catholic<br>2 Protestant<br>3 SDA<br>4 Muslim<br>5 Traditional Religion<br>6 Other (specify) |
| | | | | |

**Part B: Household Composition and Characteristics**
*Please tick ( √ ) the one that describes your most appropriate answer to the questions.*

| **NO** | **Question** | **Code** | **Skip** |
|---|---|---|---|
| 1.5 | Type of family | 1 Nuclear<br>2 Extended | |
| 1.6 | No. of family members (those who feed from the same pot) | __________ | |
| 1.7 | No. of siblings (brothers and sisters) | ------------- | |
| 1.8 | Household head is? | 1 Father<br>2 Mother<br>3 Other (Specify) | |
| 1.9 | Your relationship to household head | 1 Daughter<br>2 Grandchild<br>3 Sister<br>4 Niece<br>5 Other (specify) | |
| 1.10 | Highest level of father's education | 1 Primary<br>2 Secondary | *If N/A skip to* |

| | | | |
|---|---|---|---|
| | | 3 college<br>4 University<br>5 Never went to school<br>6 N/A | *1.12* |
| 1.11 | Main father's Occupation | 1 Salaried employee<br>2 Farmer<br>3 Self employed<br>4 Casual labourer<br>5 Unemployed<br>6 Retired<br>7 Other (specify) | |
| 1.12 | Highest level of mother's education | 1 Primary<br>2 Secondary<br>3 college<br>4 University<br>5 Never went to school<br>6 N/A | *If N/A skip to 1.14* |
| 1.13 | Main mother's occupation | 1 Salaried employee<br>2 Farmer<br>3 Self employed<br>4 Casual labourer<br>5 Unemployed<br>6 Retired<br>7 Housewife<br>8. Other (specify) | |

**Part C: Socio-economic Characteristics**

| NO | Question | Code | |
|---|---|---|---|
| **1.14** | What type of house do you live in? | 1 Own<br>2 Rented<br>3 Other (specify) | *If own skip to 1.16* |
| **1.15** | What is the size of the main house you live in? | 1 1 Room<br>2 2 Rooms<br>3 3 Rooms<br>4 4 Rooms and above | |
| **1.16** | What is the household's main source of income? | 1 Salary/employment<br>2 Trade/business<br>3 Crop sales<br>4 Animal & animal product sales<br>5 Casual labour<br>6 Food aid/gifts/donations<br>7 Other (specify) ___________ | |

<table>
<tr><td>1.17</td><td>What is the total household income per month?</td><td>1. Less than 2,000<br>2. 2,001-5000<br>3. 5,001-10,000<br>4. 10,001-20,000<br>5. 20,001 and above</td><td></td></tr>
<tr><td>1.18</td><td>Does your household own any of the following items</td><td>1 = Yes 2 = No
<table>
<tr><td>Item</td><td>Yes</td><td>No</td><td>Item</td><td>Yes</td><td>No</td></tr>
<tr><td>Car</td><td>1</td><td>0</td><td>Computer</td><td>1</td><td>0</td></tr>
<tr><td>Motorcycle</td><td>1</td><td>0</td><td>Radio</td><td>1</td><td>0</td></tr>
<tr><td>Bicycle</td><td>1</td><td>0</td><td>Television</td><td>1</td><td>0</td></tr>
<tr><td>Wheelbarrow</td><td>1</td><td>0</td><td>Refrigerator</td><td>1</td><td>0</td></tr>
<tr><td>Tractor</td><td>1</td><td>0</td><td>Sofa set</td><td>1</td><td>0</td></tr>
<tr><td>Mobile phone</td><td>1</td><td>0</td><td>Other ____</td><td></td><td></td></tr>
</table></td><td></td></tr>
<tr><td>1.19</td><td>Does your household own any livestock?</td><td>1 = Yes<br>2 = No</td><td></td></tr>
<tr><td>1.20</td><td>Does your household have any land for farming?</td><td>1 Yes<br>2 No</td><td>If no skip to 1.25</td></tr>
<tr><td>1.21</td><td>If yes which crops are grown in the farm?</td><td>1 Cereals<br>2 Legumes<br>3 Vegetables<br>4 Fruits<br>Others (specify)</td><td></td></tr>
<tr><td>1.22</td><td>15. What do you do with your farm produce?</td><td>1 Home consumption<br>2 Sale<br>3 Home consumption and sale<br>4Other (Specify)___________________</td><td></td></tr>
<tr><td>1.23</td><td>What is the main source of cooking fuel?</td><td>1 Wood 5 Electricity<br>2 Charcoal 6 Solar<br>3 Kerosene 7 Other (specify) _________<br>4 Gas</td><td></td></tr>
<tr><td>1.24</td><td>What is the main source of lighting?</td><td>1 Tin lamp 5 Electricity<br>2 Hurricane lamp 6 Solar<br>3 Pressure lamp 7 Other (specify)<br>4 Gas lamp</td><td></td></tr>
<tr><td>1.25</td><td>What is the main material of the floor of the main</td><td>1 Cement<br>2 Earthen<br>3 Tiles</td><td></td></tr>
</table>

| | | | |
|---|---|---|---|
| | house? | 4 Wood<br>5 Other (Specify) ____________ | |
| **1.26** | What is the main material of the roof of the main house? | 1 Iron sheets<br>2 Grass thatched<br>3 Tiles<br>4 Other (Specify) ___________ | |
| **1.27** | What is the main material of the exterior walls of the main house? | 1 Plaster<br>2 Brick/block/stone<br>3 Wood/timber<br>4 mud<br>5 Iron sheets<br>6 Other (specify) __________ | |

**Part D: Health Status and Menstrual Profile**

| | | | |
|---|---|---|---|
| **1.28** | Have you suffered any sickness in the last two weeks? | 1 Yes<br>2 No | *If no skip to 34* |
| **1.29** | If yes which type of disease? | 1 Malaria<br>2 Diarrhoea<br>3 Typhoid<br>4 Other (specify)___________ | |
| **1.30** | What were the disease symptoms? | 1 Fever<br>2 Diarrhoea<br>3 Vomiting<br>4 Other (specify)___________ | |
| **1.31** | Where was treatment sought? | 1 Health centre / Hospital<br>3 Pharmacy/ Chemist<br>4 Traditional healer/ religious leader<br>4 Other (specify)___________ | |
| **1.32** | Have you dewormed in the last three months? | 1 Yes<br>2 No | |
| **1.33** | Have you ever been diagnosed with worm infestation at any time in your life? | 1 Yes<br>2 No | |
| **1.34** | Have you attained menarche (Menstruation)? | 1 Yes<br>2 No | *If no skip the next 4 questions* |
| **1.35** | At what age was it attained? | _________ yrs. | |
| **1.36** | How long does your menstrual bleeding last? | 1= < 3 days<br>2= 3-7 days<br>3= > 7 days | |
| **1.37** | According to your own perception, how would you describe the amount of menstrual flow? | 1= Little<br>3= Moderate<br>4= Much<br>5=Too much | |

| | | | |
|---|---|---|---|
| **1.38** | How would you describe your menstrual cycle? | 1=Regular (usually able to predict start of next cycle)<br>2=Irregular (usually unable to predict start of next cycle) | |
| **1.39** | How would you describe your cycle length? | 1=Short (after 25 days or less<br>2= Normal (after 26-34 days)<br>3=Long(After 35 or more days) | |

## SECTION 2: DIETARY PRACTICES AND DIETARY INTAKE

### 2.1 24 HOURS DIETARY RECALL QUESTIONNAIRE

Questionnaire No ____________________ Interviewer name _______________
Respondent code ____________________ Date _____ / ______ / 20 _____
School name ________________________

**2.1.1 Tick the day of the week that yesterday was.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |

**2.1.2 Please tell me whether you ate (or drank) any of the following foods yesterday**

| Food item | Remembered | Amount taken (pieces, slices, cups, packets, tsps., tbsps. |
|---|---|---|
| Sweets / chocolate | | |
| Mandazi/ / Samosa | | |
| Any fruit | | |
| Cakes / cookies | | |
| Bread / scones | | |
| Cold drinks / Soda | | |

**2.1.3 What you ate/drank yesterday; was it same as, more than or less than usual? (Tick where appropriate)**

| | | | | | |
|---|---|---|---|---|---|
| 1 Same as usual | | 2 More than usual | | 3 Less than usual | |

**2.1.4 If not same as usual, state why?**

| | | | |
|---|---|---|---|
| 1 Celebration | 2 Religious activity | 3 Lack of enough Food | 4 Other (specify) |

**2.1.5 Please think back to when you woke up yesterday morning to the time you went to sleep in the evening**.

Now, I want you to try to remember what you ate or drank yesterday from the moment you got up until you went to sleep again last night. Run through the whole day in your mind and try to remember everything that you ate or drank. Now I would like you to tell me what, when where and how much you ate/drank yesterday.

| Type/ Meal | Place | Food item and preparation method | Ingredients | Amount in HH measure | Amount in grams (official use only) | Code (official use only) |
|---|---|---|---|---|---|---|
| **Break fast** | | | | | | |
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| **Snack 1** | | | | | | |
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| **Lunch** | | | | | | |
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| **Snack 2** | | | | | | |
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| **Supper** | | | | | | |
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| **Snack 3** | | | | | | |
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## 2.2 7-DAY FOOD FREQUENCY

### 2.2.1 7-Day FFQ

Please think carefully about the food and drink you have consumed during the last 7 days. I will go through a list of foods and drinks and I would like you to tell me if you ate the food and how many times a day you ate it and if not every day how many times a week you ate it.

| **Food Item** | **No. of times eaten per day** | **No. of times eaten per week** |
|---|---|---|
| **Cereals, Carbohydrates, Starch** | | |
| Bread | | |
| Ugali | | |
| Rice | | |
| Chapatti | | |
| Githeri | | |
| Porridge | | |
| Spaghetti/Pasta | | |
| Roasted/Boiled Maize | | |
| Mandazi | | |
| Breakfast cereals e.g. Weetabix, cornflakes | | |
| Chips | | |
| Others (Specify) | | |
| **Roots and Tubers** | | |
| Green Bananas | | |
| Potatoes (Maluu) | | |
| Sweet potatoes (Makwasi) | | |
| Yams (Kikwa) | | |
| Arrow roots (Nduma) | | |
| Others (Specify) | | |
| **Dairy** | | |
| Whole milk | | |
| Yogurt | | |
| Ice cream | | |
| Butter | | |

| | | |
|---|---|---|
| Ghee | | |
| Margarine | | |
| Cheese | | |
| Others (specify) | | |
| **Meats, Meat Products and Eggs** | | |
| Beef | | |
| Mutton | | |
| Chicken | | |
| Fish | | |
| Pork | | |
| Matumbo | | |
| Sausages/smokies | | |
| Bacon | | |
| Eggs | | |
| Others (specify) | | |
| **Legumes Pulses and Nuts** | | |
| Peas (Mbiinzi) | | |
| Beans | | |
| Green grams (Ndengu) | | |
| Lentils (kamande) | | |
| Black eye peas (Nzavi) | | |
| Cowpeas (Nthooko) | | |
| Pigeon peas (Nzuu) | | |
| Chickpeas (……….) | | |
| Simsim | | |
| Groundnuts | | |
| Coconut | | |
| Others (specify) | | |
| **Vegetables** | | |
| Kales (Sukuma wiki) | | |
| Cabbage | | |
| Tomatoes | | |
| Carrots | | |
| Spinach | | |
| Cucumber | | |
| French Beans (Mishiri) | | |
| African vegetables e.g. Kunde, Managu, Terere | | |
| Others (Specify) | | |
| **Fruits** | | |
| Banana | | |
| Mangoes | | |
| Citrus fruits (Oranges, lemons, Tangerines) | | |
| Pawpaw | | |
| Melon | | |

| | | |
|---|---|---|
| Avocado | | |
| Pineapple | | |
| Passion | | |
| Apples | | |
| Others (specify) | | |
| **Sugar Alternatives and Sweets** | | |
| Sugar | | |
| Honey | | |
| Cakes | | |
| Biscuits<br>Sweets | | |
| **Beverages and Spreads** | | |
| Soda | | |
| Tea | | |
| Cocoa | | |
| Coffee | | |
| Jam | | |
| Juice | | |
| Margarine/ Blue band/ prestige/ Gold band | | |
| Peanut butter | | |

**2.2.2 Eating habits (7-day recall)**

| NO | Question | Code | Skip |
|---|---|---|---|
| 2.2.2.1 | How many meals do you usually eat in a typical day? | ___________ | |
| 2.2.2.2 | Were there any eating occasions that you skipped a main meal in the last 7-days (week) | 1 Yes<br>2 No | |
| 2.2.2.3 | If yes, name the occasion(s) | During week day (tick where appropriate)<br>□ Breakfast<br>□ Lunch<br>□ Supper<br><br>During the weekend<br>□ Breakfast<br>□ Lunch<br>□ Supper | |
| 2.2.2.4 | Specify how many times you missed the meals | During week day (insert the right number in the box)<br>□ Breakfast<br>□ Lunch<br>□ Supper | |

| | | | |
|---|---|---|---|
| | | During the weekend<br>□ Breakfast<br>□ Lunch<br>□ Supper | |
| 2.2.2.5 | Did you eat your meals at about the same time every day? | 1 Yes<br>2 No | |
| 2.2.2.6 | 2.3.3 When is your usual time for taking tea/coffee/cocoa? | 1=Breakfast time<br>2=With snacks<br>3=With/immediately after meals<br>4=Others (specify) | |
| 2.2.2.7 | How much tea/coffee/cocoa do you take in a day? | □ None<br>□ 1-2 cups<br>□ 3-4 cups | |
| 2.2.2.8 | When is your usual time for taking fruits? | 1=Breakfast time<br>2=With snacks<br>3=With/immediately after meals<br>4=Others (specify) | |

**2.3 MDD-W Questionnaire**

Now I'd like to ask you to describe everything that you ate or drank yesterday during the day or night, whether you ate it at home or anywhere else. Did you consume any of the following foods?

| **Food group No.** | **Food categories** | **Description/examples of foods** | **Consumed Yes = 1 No= 0** |
|---|---|---|---|
| 1 | Foods made from grains | Porridge, bread, rice, pasta/noodles, ugali, chapatti, pancakes roasted / boiled maize, mandazi | ___ yes (1)<br>___ no (0) |
| 2 | White roots and tubers and plantains | White potatoes, white yams, cassava, sweet potatoes, plantains (matoke) | ___ yes (1)<br>___ no (0) |
| 3 | Pulses (beans, peas and lentils) | Beans, peas (mbiinzi), cowpeas, pigeon peas, black eyed peas (nzavi), lentils (kamande), soya bean, chickpeas | ___ yes (1)<br>___ no (0) |
| 4 | Nuts and seeds | Cashew nut, macadamia, pea/ground nut, chestnut, hazelnut, walnut, sesame seeds pumpkin / squash / gourd | ___ yes (1)<br>___ no (0) |
| 5 | Milk and milk products | Milk, cheese, yoghurt or other milk products but NOT including butter, ice cream, cream or sour cream | ___ yes (1)<br>___ no (0) |
| 6 | Organ meat | Liver, kidney, heart or other organ meats or blood-based foods, including from wild game | ___ yes (1)<br>___ no (0) |
| 7 | Meat and poultry | Beef, pork, lamb, goat, rabbit, wild | ___ yes (1) |

| | | | |
|---|---|---|---|
| | | game meat, chicken, duck or other bird | ___ no (0) |
| 8 | Fish and seafood | Fresh or dried fish, shellfish or seafood | ___ yes (1)<br>___ no (0) |
| 9 | Eggs | Eggs from poultry or any other bird | ___ yes (1)<br>___ no (0) |
| 10 | Dark green leafy vegetables | List examples of any medium-to-dark green leafy vegetables, including wild/foraged leaves, cassava, bean, pumpkin, and amaranth leaves | ___ yes (1)<br>___ no (0) |
| 11 | Vitamin A-rich vegetables, roots and tubers | Pumpkin, carrots, squash or sweet potatoes that are yellow or orange Inside | ___ yes (1)<br>___ no (0) |
| 12 | Vitamin A-rich fruits | Ripe mango, pawpaw, plums, loquat, melon, passion | ___ yes (1)<br>___ no (0) |
| 13 | Other vegetables | Stems, fruits and flowers of plants generally considered as vegetables in culinary systems: cucumber, tomato, French beans, fresh peas, green beans, cabbage, spinach, eggplant, onion, lettuce, hoho | ___ yes (1)<br>___ no (0) |
| 14 | Other fruits | Most fruits except vitamin A-rich and starchy fruits, such as apple, avocado, banana, baobab, coconut, guava, oranges, mulberry, pears, tamarind, tangerine, pineapple, watermelon | ___ yes (1)<br>___ no (0) |
| 15 | Condiments and seasonings | Ingredients used in small quantities for flavour, such as chilies, spices, herbs, fish powder, tomato paste, flavour cubes, Royco, masala, curry powder or seeds | ___ yes (1)<br>___ no (0) |
| 16 | Other beverages and foods | Tea, coffee, malts, yoghurt, juices, sweet pastries, cakes and biscuits, candy, chocolates, fried snacks, chips, crisps, animal fat, butter, oils and insects | ___ yes (1)<br>___ no (0) |

**2.4 FOOD FORTIFICATION QUESTIONNAIRE**

| **NO** | **Question** | **Code** (tick (√) as appropriate) | **Skip** |
|---|---|---|---|
| 2.4.1 | Have you heard about food fortification? | 1 Yes<br>2 No | |
| 2.4.2 | Do you know this sign? | 1 Yes<br>2 No | |

| | | | |
|---|---|---|---|
| 2.4.3 | What is the main source of maize flour for the household currently? | □ Maize taken for milling in a nearby posho mill<br>□ Flour bought from nearby shops/supermarket<br>□ Flour bought from a nearby posho mill<br>□ Other (specify) | *If milled in /bought from posho mill skip to 2.4.5* |
| 2.4.4 | If bought from the shop what brand(s) of the maize flour your household consume? | ____________________<br>____________________ | |
| 2.4.5 | If bought from the shop, does the above sign appear on the packaging of the flour? | 1 Yes<br>2 No<br>3 Don't know<br>4 N/A | |
| 2.4.5 | What brand(s) of wheat flour does your household consume? | ____________________<br>____________________ | |
| 2.5.6 | Does the above sign appear on the packaging of the flour? | 1 Yes<br>2 No<br>3 Don't know<br>4 N/A | |

**SECTION 3: ANTHROPOMETRY**

Respondent code __________ School ______________

Date of birth _____________

| **Anthropometry** | **First reading** | **Second reading** | **Average** |
|---|---|---|---|
| Height<br>(to the nearest 0.1cm) | | | |
| Weight<br>(to the nearest 0.1kg) | | | |

**SECTION 4: BIOCHEMICAL ASSESSMENT**

| **Haemoglobin level (g/dL)** | | | | |
|---|---|---|---|---|
| **Full blood count ( if done)** | | | | |
| RBC | MCV | MCH | MCHC | RDW |
| | | | | |

*(RBC = Red blood cell count, MCV = Mean corpuscular volume, MCH = Mean corpuscular haemoglobin, MCHC = Mean corpuscular haemoglobin concentration, RDW = Red cell distribution width.*

## APPENDIX D: NORMAL RED CELL INDICES FOR CHILDREN

| FEMALES | | | | | MALES | | | |
|---|---|---|---|---|---|---|---|---|
| AGE (years) | 8 - 11.9 | 12 - 14.9 | 15 - 17.9 | >18 | 8 - 11.9 | 12- 14.9 | 15- 17.9 | >18 |
| RBC count | 3.8 - 4.52 | 3.9 - 4.47 | 3.9 - 4.48 | 3.8 - 4.42 | 3.8 - 4.52 | 4.1 - 4.71 | 4.2 - 4.92 | 4.3 - 4.99 |
| MCV (fI) | 76 - 84 | 77 - 86 | 78 – 88 | 81 - 90 | 76 - 84 | 77 - 85 | 79 – 87 | 80 - 89 |
| MCH (PG) | 26 - 28.7 | 26 - 29.4 | 26 – 30 | 26 – 30.6 | 26 - 28.5 | 26 - 29.1 | 27 - 29.9 | 27 - 30.5 |
| MCHC (g/l) | 32 - 34.5 | 32 - 34.1 | 32 - 33.9 | 32 – 33.9 | 32 - 34.5 | 32 - 34.4 | 32 - 34.4 | 32 - 34.5 |

**NB**: Indices based on WHO, (2001) cut-offs.

## APPENDIX E: PROTOCOL FOR COLLECT OF BLOOD SAMPLES

### 1.1: Data collection and labelling.

A unique coded number will be assigned to each respondent consenting to sample collection. At the time of the sample collection, the coded label with each respondent‘s ID will be affixed to the questionnaires and Microtainer.

### 1.2: Blood collection

1. Place all collection materials on top of a disposable pad. Once the respondent is present, open the lancet, alcohol swabs, gauze, bandage, and other items. Have all items ready for blood collection.
2. Put on powder-free gloves. Turn subject’s hand upward. Massage patient‘s hand and lower part of the finger to increase blood flow.
3. Scrub the subject‘s middle / finger with an alcohol swab. Dry with gauze.
4. Hold the finger in an upward position and lance the palm side surface of the finger with the proper-size lancet. Press firmly on the finger when making the puncture. Doing so will help you to obtain the amount of blood you need.
5. Apply slight pressure to start blood flow. Wipe away the first drop of blood on a gauze pad and discard pad in appropriate biohazard container.
6. Keep the finger in a downward position and gently massage it to maintain blood flow.
7. Cap the Microtainer® and gently invert it 10 times to prevent clots from forming.
8. Apply a sterile adhesive bandage over the puncture site.
9. Label the Microtainer® with the pre-printed label provided, and use a permanent marker to add the blood collection date to the label.
10. Properly discard all used materials according to the biological waste disposal laws of the country in which the survey is taking place.

# APPENDIX F: RESEARCH APPROVAL

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke

Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext.4150

Internal Memo

FROM: Dean, Graduate School

DATE: 31st January, 2018

TO: Mulei Dorcas Nduku
C/o Food, Nutrition and Dietetics Dept.

REF: H60/33330/2015

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

We acknowledge receipt of your revised Research Proposal as per our recommendations raised by the Graduate School Board of 10/1/2018.

You may now proceed with your Data Collection, subject to clearance with Director General, National Commission for Science, Technology and Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking Forms per semester. The form has been developed to replace the Progress Report Forms. The Supervision Tracking Forms are available at the University's Website under Graduate School webpage downloads.

Thank you.

HARRIET ISABOKE
FOR: DEAN, GRADUATE SCHOOL

C.c. Chairman, Department of Food, Nutrition and Dietetics

Supervisor:

1. Dr. Peter Chege
   C/o Department of Food, Nutrition and Dietetics
   Kenyatta University
2. Dr. Dorcus Mbithe Kigaru
   C/o Department of Food, Nutrition and Dietetics
   Kenyatta University

# APPENDIX G: ETHICAL APPROVAL

**KENYATTA UNIVERSITY**
**ETHICS REVIEW COMMITTEE**
**Moi Library 1st Floor, Office No. 25**

**Fax: 8711242/8711575**
Email: kuerc.chairman@ku.ac.ke
kuerc.secretary@ku.ac.ke
secretariat.kuerc@ku.ac.ke
Website: www.ku.ac.ke

**P. O. Box 43844,**
**Nairobi, 00100**

Tel: 8710901/12

Our Ref: **KU/ERC/APPROVAL/VOL.1 (149)**

Date: 14th June, 2018

**Mulei Dorcas Nduku**
**P.O. Box 7233-01000**
**Thika, KENYA**

Dear Ms. Mulei,

**APPLICATION NUMBER PKU/815/I881 "PREVALENCE OF ANAEMIA AND NUTRITIONAL STATUS AMONG DAY-SECONDARY SCHOOL ADOLESCENT GIRLS IN MACHAKOS COUNTY, KENYA"**

1. **IDENTIFICATION OF PROTOCOL**

The application before the Committee is with a research topic "**Prevalence of Anaemia and Nutritional Status Among Day-Secondary School Adolescent Girls in Machakos County, Kenya**" was received on 12th February, 2018 and discussed on 12th June, 2018.

2. **APPLICANT**

**Mulei Dorcas Nduku**

3. **SITE**

**Machakos County, Kenya**

4. **DECISION**

The Committee has considered the research protocol in accordance with the Kenyatta University Research Policy (Section 7.2.1.3) and the Kenyatta University Review Committee Guidelines **AND APPROVED that the research may proceed for a period of ONE year from 12th June, 2018**

5. **ADVICE/CONDITIONS**

i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this committee immediately they occur.
iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
iv. Submit an electronic copy of the protocol to KUERC.

**When replying, kindly quote the application number above.**
**If you accept the decision reached and advice and conditions given please sign in the space Provided below and return to KU-ERC a copy of the letter.**

KENYATTA UNIVERSITY OFFICE OF THE CHAIRMAN 05 JUL 2018 ETHICS REVIEW COMMITTEE P.O. BOX ... NAIROBI

**DR. TITUS KAHIGA**
**CHAIRMAN ETHICS REVIEW COMMITTEE**

I ..Dorcas N. Mulei..........accept the advice given and will fulfill the conditions therein.

Signature.......................... Dated this day of....05/07/2018....... 2018.

cc. DVC-Research Innovation and Outreach

## APPENDIX H: RESEARCH PERMIT FROM NACOSTI

**CONDITIONS**

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 19897

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
*MS. DORCAS NDUKU MULEI*
of KENYATTA UNIVERSITY, 0-1000
THIKA,has been permitted to conduct research in *Machakos County*

on the topic: *PREVALENCE OF ANAEMIA AND NUTRITIONAL STATUS AMONG DAY-SECONDARY SCHOOL ADOLESCENT GIRLS IN MACHAKOS COUNTY, KENYA*

for the period ending:
*6th August,2019*

Permit No : NACOSTI/P/18/56194/24367
Date Of Issue : 7th August,2018
Fee Recieved :Ksh 1000

*Applicant's Signature*

*Director General*
*National Commission for Science, Technology & Innovation*

# APPENDIX I: COUNTY APPROVAL

**MINISTRY OF EDUCATION**
STATE DEPARTMENT OF EDUCATION

Telegrams: "**SCHOOLING**" Machakos
Telephone: Machakos (
Fax: Machakos
Email cdemachakos@yahoo.com
**When replying please quote**

OFFICE OF THE
COUNTY DIRECTOR OF
EDUCATION
P.O. BOX 2666-90100,
**MACHAKOS**

MKS/ED/CDE/U/1/VOL.2/220

20/8/2018

Dorcas Nduku Mulei
Kenyatta University
**P.O Box 43844-00100**
**NAIROBI**

**RE: RESEARCH AUTHORIZATION.**

Reference is made to the letter from National Commission for Science, Technology and Innovation Ref: **NACOSTI/P/18/56194/24367** dated **7th August, 2018.**

You are hereby authorized to carry out your research on, "***Prevalence of anaemia and nutritional status among day-secondary school adolescent girls in Machakos County, Kenya"*** for a period ending **6th August, 2019.**

COUNTY DIRECTOR OF EDUCATION
MACHAKOS
20 AUG 2018

**SAMWEL BOTO**
**COUNTY DIRECTOR OF EDUCATION**
**MACHAKOS**

## APPENDIX J: SUB-COUNTY APPROVAL

THE PRESIDENCY
MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Telegrams "DISTRICTER"
FAX NO. 020 241 4792 email: dccyatta2010@gmail.com
Telephone: 020 241 4791
When replying please quote

YTA/DCC/COR. 3/1 VOL 4/134

DEPUTY COUNTY COMMISSIONER
YATTA SUBCOUNTY
P.O. BOX 1 – 90124
KITHIMANI.

23rd August 2018

**RE: TO WHOM IT MAY CONCERN - DORCAS NDUKU MULEI**

The above named has been authorized by the National Commission for Science, Technology and Innovation to carry out a research on "***Prevalence of anaemia and nutritional status among day-secondary school adolescent girls in Yatta sub county, Machakos County, Kenya***" for the period ending **6th August 2019**.

Please accord her the necessary assistance.

DEPUTY COUNTY COMMISSIONER
YATTA

Emmah Kibaara
Deputy County Commissioner
**YATTA**

CC:

Sub County Director of Education
**YATTA**

Scanned with Fast Scan

## APPENDIX K: MAP OF MACHAKOS COUNTY


*Source*: *Kenya National Bureau of Statistics*