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Prevalence of anemia and its association with body mass index and dietary diversity score among healthy adolescent girls in Akakikality sub-city, Addis Ababa Ethiopia. A School based study.

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Prevalence of anemia and its association with body mass index and dietary diversity score among adolescent girls in Akakikality sub-city, Addis Ababa, Ethiopia.

A School based study.

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Acronyms and Abbreviations

AOR……Adjusted Odds Ratio

BAZ…… BMI for age Z-score

BMI……Body Mass Index

CDC……Center of Disease Control and Prevention

CI…… Confidence Interval

CHS……. College of Health Science

DDM……dietary diversity modification

DDS……. Dietary Diversity Score

EDHS……Ethiopian Demographic and Health Survey

FFQ……..... Food Frequency Questioner

G/dL……..Gram per deciliter

Hb……..Hemoglobin

IDA……. Iron Deficiency Anemia

MOH……Ministry of Health

SD……. Standard Deviation

UNICEF……United Nation Children's Fund

WHO……...World Health Organization

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Abstract

Background: Anemia is significantly wide spread public health threat especially among adolescent girls who are more vulnerable to low level of hemoglobin (Hb). Adolescence is a period of accelerated growth and development and therefore demand of dietary nutrient intake during this period is higher than the period preceding it. In addition to this females may start their menstrual period during this time, which may add to the loss of nutrients via menstrual blood lost monthly. Addressing both the increased requirement and added loss are covered nutritionally ensures that adolescents growth and development continues unaffected to get them to healthier adulthood.

The objective of this study was to assess the prevalence of anaemia and its association with Body Mass Index and Dietary Diversity scores, in adolescent school girls between the age of 10-19yrs in AkakiKalitySubcity, in Addis Ababa, Ethiopia.

Methodology: A cross-sectional study design using multi-stage sampling technique was employed. A total of 417 sample size was estimated and the sampled, students were proportionally allocated to each selected schools based on their total adolescent girls population. Structured questionnaire was used to collect socio-economic and demographic characteristics of participants. Data were entered and analysedusing spss version 19. Anthropometric data was computed by WHO Anthro- plus 2007 software. Dietary diversity score was collected by using 24-hour recall technique. Bivariate and multivariate logistic regressions were used to test the association between dependent and independent variables. For all statistical tests, significance level was set at p-value of <0.05.

Result: Among the 417 study participants the finding shows a mean hemoglobin level of 12.9±1.07 g/dl with the range from 9.9 to 16.9 g/dl. The prevalence mild anemia among school girls age between 15 to 19 was found to be 54(12.9 %) and 2(0.5%) moderately anemic the rest 361(86.6%) had normal Hb level and there was no case of severe anemia indentified in the study.

Those study participants who have a meal skipping habit and underweight were 2.1 and 3.2 times respectively, more likely to be anemic than with those who did not skip meals or had with normal BMI.

Conclusion: The present study revealed anemia to be mild public health problem (13.4%) in the school going adolescent girls. In this population, anemia was significantly correlated with BMI and dietary pattern.

Key words:- Adolescent girls BMI, DDS, dietary pattern , anemia

1. Introduction

1.1 Background

Anemia is a condition characterized by reduction in the number of red blood cells and/or hemoglobin(Hb) (a protein found in red blood cells) concentration, that is required by the body to transport oxygen and carbondioxideto and from all tissues for their metabolic needs(WHO, 2011). The amount of haemoglobin required to fulfil physiological functional requirement varies with a person's age, gender, altitude, and pregnancy. A reduction in hemoglobin beyond a critical level (which may vary based on age/ gender and physiological variations) causes a reduced amount of oxygen to be delivered to the body tissues, causing tiredness, fatigue, reduced work/functional capacity and may further have deleterious effect on health.

Anemia is a global public health problem affecting both developing and developed countries and has major consequences for human health as well as social and economic development. It affects 27% of the world population.(Kassebaum, 2016)

The worldwide prevalence of anemia among adolescents is 15% (27% in developing countries and 6% in developed countries) (Balcı YI, 2012). In Ethiopia, the prevalence of Anaemia among women of reproductive age (15 – 49yr) was estimated to be 23.4% in 2016 (WHO, 2017a)and according to Ethiopian Central Statistical Agency(ICF, 2016) the prevalence of anemia among the age group 15–19-year-old males and females was reported to be18.2% and 19.9%, respectively.

The three mechanisms involved in the development of anaemiaare;a reduction in the production of haemoglobin/ or red blood cells, increased destruction of red blood cells, or blood loss. Reduced production ofhaemoglobin or red blood cells may occur as a result of inadequate nutrient availability for production of haemoglobin, of which iron deficiency is reported to be the most common cause (iron is essential to synthesize hemoglobin), although general malnutrition, and deficiency of Vitamin A, B6,B12 and folate deficiency are alsoother nutrients implicated. (WHO, 2017b)Malaria and inherited blood disorder of abnormal hemoglobin production (thalassemias, Sickle cell anaemia) are also causes which may occur as single or in conjunction with other causes. Infection and infestations by parasitic worms also contribute to anaemia through the mechanism of increased blood loss/and reduced production.(WHO, 2017b) Inadequate and unsafe water sources and sanitary practices are one of the most important underlying environmental conditions contributing to this mechanism.

Classificationof anaemia is frequently based causal factors e.g. hemolytic anaemia, Iron deficiency anaemia (IDA) or anaemia of inflammation etc.(Chaparro, 2019)

In the first phases of iron deficiency the iron stores in the body are progressively depleted however, hemoglobin levels may not drop below the cutoff point for diagnosis of anaemia. Once the body stores of iron are used up, an individual begins to produce less hemoglobin. This is the

second phase of iron deficiency. As iron deficiency develops further, it progressively leads to anemia. In the third phase, anemia is diagnosed when an individual's hemoglobin concentration falls below a specific cutoff value. Iron deficiency anemia is a reduction in the amount of red blood cells, which is caused by a lack of iron and which decreases the amount of oxygen transported to the cells of the body (Janz et al,. 2013).

Our body gets its iron and other nutrients from our diet and it is necessary to keep a balanced diet for proper function. The nutrients required for health and sufficient to maintain adequate haemoglobin production in health are multiple and therefore are sourced from the different food groups, so no one food source can provide adequate minerals and vitamins to meet the fluctuating demands of erythropoiesis (red blood cell production) at different stages of growth, varied physiological demands and even to cover basic requirement. Maintaining a sufficient amount of nutritional intake and ensuring an adequate dietary diversity is necessary to ensure the maintenance of optimal nutrient intake for health.The Institute of Medicine of the National Academy of Sciences , recommends a daily allowance of 8 - 15 mg of iron intake per day for adolescent girls.The requirement set for pregnant women is higher at 27mg/day (Institute of Medicine of the National Academy of Sciences2015).

Adolescent girls (15-19 years of age) are more vulnerable to become anemic because of their higher requirement for iron and other dietary nutrients due to higher demand for growth and physical development, with added demand imposed by menstrual cycle blood loss(Halterman JS, 2001)

1.2 Statement of the problem

Adolescents are one of the major risk groups for anemia (Halterman JS, 2001). The prevalence of anemia among adolescents is 27% in developing countries and 6% in developed countries (Dugdale 2001). In Ethiopia this is around 19.9%. The prevalence of underweight in the same age group is 29%, which is higher than that of underweight women (22.4%). (ICF, 2016) Nutritional anemia is the most common type of anemia worldwide and is the easiest type of anaemia to prevent/treat in the public setting provided economic and social conditions are conducive.

Adolescent girls are the future mothers, and the occurrence of pregnancy at this age puts a greater metabolic demand on the growing body of young girls. Concurrent iron deficiency anaemia at this age increases the chances of intrauterine growth retardation on the developing fetus, postpartum complication on the mother, which are significant causes of morbidity and mortality of the mother as well as the infant(Rahman MM, 2016)In low- and middle-income countries, 12% of low birth weight, 19% of preterm births, and 18% of perinatal mortality were attributable to maternal anemia.(Rahman MM, 2016) In Ethiopia the perinatal mortality rate was reported to be 33/1000 pregnancies and this was higher in mothers under the age of 18yr as well as those over 34 years of age. (ICF, 2016)

Iron is an essential element for the function of various organs including brain, therefore its deficiency may lead to impaired perception and learning difficulties ending up with declined school success (soemantri, et al.1985) in infants children and even adolescents affecting their future economic and social standing and predisposing them to health risks associated with poverty.

The period of adolescence gives us a chance to address the burden of intergenerational impact of malnutrition. This study aims to investigate the prevalence of anemia and the risk factors easily amenable to education and lifestyle adjustment in relation to DDS and BMI among adolescent's high school girls in Addis Ababa region.

1.3 Significance of the study

This will help to determine the prevalence of anemia based on dietary diversity score and body mass index of adolescence school girls in Addis Ababa region and may help to some degree to show and shade light on the prevalence of this problem. Identifying general dietary factors may help to design suitableinterventions for the specific population and address the problem. Policy makers and stakeholders could focus on factors that are more amenable to change locally and redistribute funds and come up with suitable alternative programs. .Providing awareness on how to prevent or minimize the risks of anemia at home level by dietary diversity modification, home fortification with micronutrient mixtures with appropriate amounts of absorbable Fe compounds can be formulated to improve or maintain the Fe status of young adolescent girls before anemia develops.

2. Objective

2.1 General objective

To assess prevalence of anemia and its association with body mass index and dietary diversity score among adolescent girls in Akakikality sub city.

2.2 Specific objectives

To assess the prevalence of anemia in selected high school.

To assess the BMI of the study population

To assess the DDS of the study population

To assess the dietary pattern of the study population

To assess the relationship between BMI, DDS, dietary pattern and its relation to anemia in the selected study area.

3. Literature Review

3.1 Anemia

WHO defines anemia as a condition in which hemoglobin (Hb) content of blood is lower than normal as a result of deficiency of one or more essential nutrients. Anemia is established if the Hb is below the cutoff point recommended by WHO as mild if Hb is (10-11.9g\dl), moderate (7.0-9.9 g/dl,) or sever (<7g\dl) .

Anemia is a major public health problem affecting around 1.62 billion people globally (McLean et al., 2009). It is defined as a common blood disorders in which number of red blood cells, orhemoglobin(Hb) concentration, falls below an established cut-off value, consequently impairing the capacity of the blood to transport oxygen around the body (WHO, Global nutrition targets 2025: anemia policy brief 2014). Anemia may develop at any stage of the life cycle (McLean et al., 2009) but children, adolescent girls and women of reproductive age are high risk groups for developing anemia (Balarajan Y, 2011).

Anemia is a particular concern for adolescent girls i.e., aged 10–19 years (Anthony D, 2011) as this is a period of intense growth with higher iron requirement. This compounded with frequent menstrual blood losses and inadequate dietary iron intake in this period results in anemia (Tolentino K, Friedman JF 2007).

The physical and physiological changes that occur in adolescence place a great demand on their nutritional requirements and make them more vulnerable to nutritional deficiencies. The rapid pubertal growth during this period, with sharp increase in lean body mass, blood volume, and red cell mass, increases iron requirements for myoglobin in muscles and Hb in the blood. Iron requirement increases two- to three-folds from a preadolescent level of ~0.7–0.9 mg iron/day to as much as 1.37–1.88 mg iron/day in adolescent boys and 1.40–3.27 mg iron/day in adolescent girls (Usha R, 2001).

Anemia in adolescence has serious implications for a wide range of outcomes, and nearly all of the functional consequences of iron deficiency are strongly related to the severity of anemia. It causes reduced resistance to infection, impaired physical growth and mental development, and reduced physical fitness, work capacity, and school performance (Jain M, 2011).

Though anemia has multifaceted etiology, it primarily results from iron deficiency (Merrill RD, et al., 2012). Worldwide, about 50% cases of anemia is caused by iron deficiency (Stevens GA, et al., 2013), but based on local conditions, this proportion may vary among population groups and areas (ML SRJ, Black RE, 2004). Some other haemopoietic micronutrient deficiencies like folate, riboflavin, Vitamins A, B12, riboflavin, folic acid, and copper may increase risk for anemia (Tolentino K, Friedman JF, 2007). Infectious diseases such as malaria, tuberculosis and HIV/AIDS can also contribute to anemia, particularly prevalent in Africa and sub- Saharan Africa (Tolentino K, Friedman JF, 2007).

Signs and symptoms of anemia

Anemia goes undetected in many people and symptoms can be minor initially. The symptoms, when they occur, can be related to an underlying cause or the anemia itself. Most commonly, people with anemia report feelings of weakness or tiredness, and sometimes poor concentration. They may also report shortness of breath on exertion (Marx, 2010).

In very severe anemia, the body may compensate for the lack of oxygen-carrying capability of the blood by increasing blood circulation and consequently increasing heart rate. The patient may have symptoms related to this, such as palpitations (rapid, strong, or irregular heartbeat), (if pre-existing heart disease is present), intermittent claudication (cramping pain in the legs) and this may progress to heart failure (Comer et al, 2009).

Major Causes of anemia

The three a mechanism by which anemia develops are; blood loss, decreased red blood cell production, and increased red blood cell breakdown (Janz, et al, 2013). Blood loss can occur as a result of trauma or surgery, gastrointestinal bleeding which can be caused by parasitic infestation among others and bleeding during and after delivery in women. Decreased production of red blood cells could be caused due to nutrient deficiency including iron deficiency, a lack of vitamin A, Pyridoxine B12, and protein energy malnutrition (PEM).Malaria, genetic conditions like Thalassemia, Sickle cell and a number of neoplasms of the bone marrow (Janz, et al, 2013) cause increased breakdown of red blood cells.

Chronic infections and inflamations and certain autoimmune diseases can cause anemia through more than one of the mechanisms mentioned above(WHO, 2017b). Certain gastrointestinal disorders can cause anemia. The mechanisms involved are multi-factorial and not limited to mal-absorption but mainly related to chronic intestinal inflammation, which causes deregulation of hepcidin (regulator of iron homeostasis in humans and other mammals) that leads to decreased access of iron to the circulation (Verma R, 2013).

Menstrual cycle

Menstruation is the cyclic, orderly sloughing of the uterine lining, in response to the interactions of hormones produced by the hypothalamus, pituitary, and ovaries. The length of a menstrual cycle is the number of days between the first day of menstrual bleeding of one cycle to the onset of menses of the next cycle, The median duration of a menstrual cycle is 28 days with most cycle lengths between 25 to 30 days(Beverly G Reed, 2018).

The amount of iron lost (in the form of hemoglobin) ranged from 5 to 26 mg., with an average of 12 mg./period. A healthy diet should compensate for this iron loss(RM, PJ, & JA, 2004).

Iron Deficiency Anemia

Iron deficiency anemia (IDA) is the most common nutritional deficiency worldwide. It can cause reduced work capacity in adults and impact motor and mental development in children and

adolescents (Algarin C, 2003). There is some evidence that iron deficiency without anemia affects cognition in adolescent girls and causes fatigue in adult women. IDA may affect visual and auditory functioning and is weakly associated with poor cognitive development in children and adolescents (Verdon F, 2003).

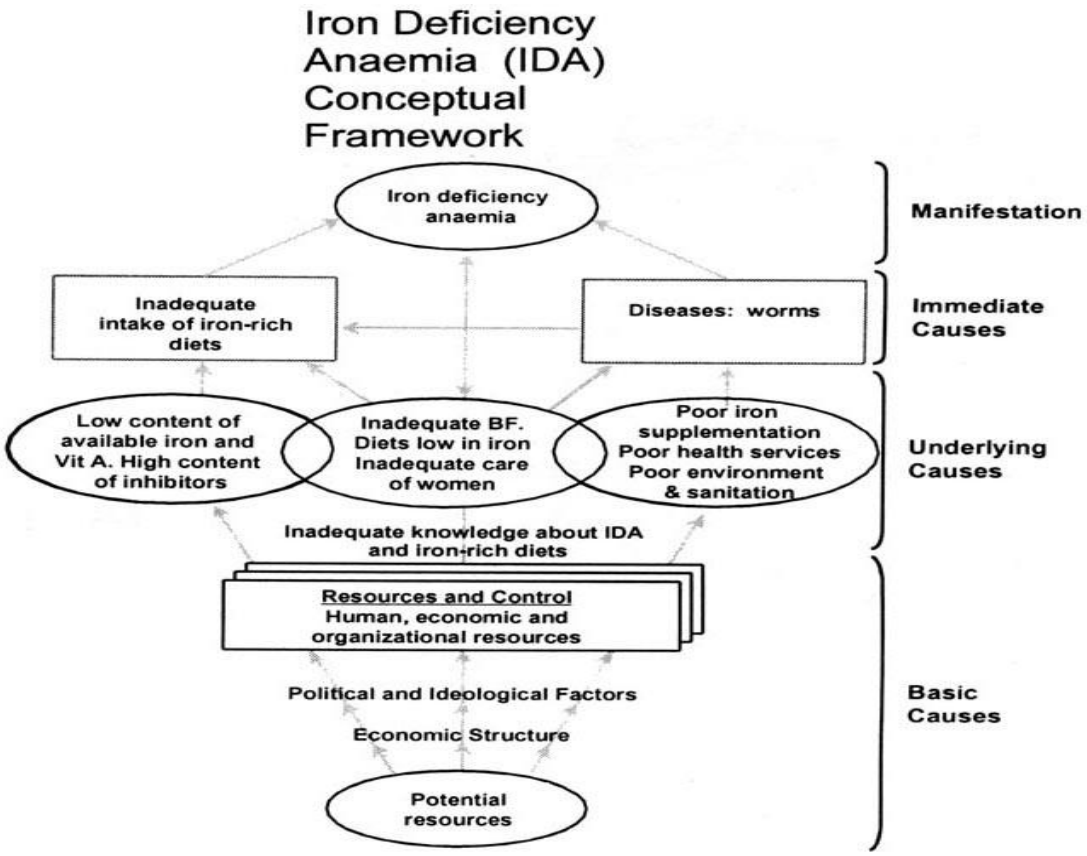

Figure 1 iron deficiency anemia conceptual frame work

Iron is an essential part of hemoglobin we get our daily recommended iron from our food we consume every day. Iron status is highly affected by our dietary pattern, it is the quantities, proportions, variety or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed(Krebs-Smith, 2014).

Identifying the optimal diet (or diets) for chronic disease prevention is a public health priority. Traditionally, nutrition research has focused on single nutrients or specific foods, although individuals do not consume nutrients or foods in isolation(Hu, 2015).

3.2 Classification

The classification of the different types of anaemia may depend on the underlying cause or by the type of red blood cell morphology used to distinguish one type from another. Classification

of anaemia caused by blood loss may be further classified as acute (occurring within a short period of time) like postpartum hamemorhage, or chronic (occurring over a long period of time) like gastrointestinal bleeding due to gastritis or due to parasitic infestation. (Chaparro, 2019)

Anaemias caused by red blood cell distruction my further be classified into hereditary (Sickle cell/ thalasemias) or acquired (due to malaria). Anaemia due to defective red cell production can be further classified based on the red blood cell size of small normal or large, into microcytic (iron deficiency, thalassemia), normocytic (anaemia of inflammation) and macrocytic (Vit B12/folic acid deficiency). (Chaparro, 2019)

3.3 Diagnosis

Diagnosis of anaemia is made through a full history, biochemical, clinical and depending on the individual/population targeted, dietary and environmental assessment. In population screening, evaluation of biochemical tests including haemoglobin level determination, and Red cell morphology determination may be done depending on the availability of resources and the purpose of screening. The indices of red cell morphology, size and haemoglobin levels are then compared against a reference values set for the different age/gender and adjusted for the normal variations seen in the different ethnic groups and environmental factors to determine if anaemia is present or not. Anaemiain men is diagnosed if the hemoglobin level falls below 130 to 140 g/L (13 to 14 g/dL), while in women it is below 120 to 130 g/L (12 to 13 g/dL).(WHO, 2011)

Hemoglobin

Hemoglobin is Conjugate of a protein and 4 molecules of heme. and iron-containing oxygen transport metallo-protein in the red blood cells of all vertebrates (Maton et al,. 1993) (with the exception of the fish family Channichthyidae) as well as the tissues of some invertebrates. It has the formula $C_{2952}H_{4664}O_{832}N_{812}S_8Fe_4$. Hemoglobin in the blood carries oxygen from the respiratory organs (lungs or gills) to the rest of the body (i.e. the tissues). There it releases the oxygen to permit aerobic respiration to provide energy to power the functions of the organism in the process of metabolism.

In this study hemoglobin level is used to as a diagnostic marker for anemia as it is directly relate to a person's diet history, living environment, health condition and can determine prevalence of anemia with short period of time.

There are different cut off points for hemoglobin level depending on the person's age, sex, race, and pregnancy, living area altitude, cigarette smoking, certain diseases and micronutrient deficiencies.

Table. 1: Hb concentrations below which the diagnosis of anaemia can be made at sea level (WHO, 2011)

Age or sex group	Hemoglobinbelow (g/L)
Children6 months to 5 years	110
5 to 11 years	115
12 to 14 years	120
Non pregnant females >15 years	120
Men >15 years	130

Ethnicity

A persons Hemoglobin level is also affected by ethnicity. Data from the United States show that healthy people of African extraction of all age groups at all times, except during the prenatal period, have hemoglobin concentrations 5 to 10 g/L below those of whites and this difference is independent of iron deficiency and in some cases hemoglobinopathies and socio-economic factors (Johnson-Spear et al, 1994). Other US-based races including East Asians, Hispanics, Japanese, and American Indians have hemoglobin values similar to that for white Americans (Looker et al, 1989).

Table 2.Hb adjustment for healthy people of African extraction living at sea level(WHO, 2011)

	Hemoglobin (g/L)
Everyone	-10

Smoking

Hemoglobin concentration increases in smokers because the inhaled carbon monoxide results in increased carboxyhemoglobin, which has no oxygen-carrying capacity. To compensate, hemoglobin levels increase. To take into account the resulting elevated hemoglobin concentration, the U.S. Centers for Disease Control and Prevention developed a smoking-specific hemoglobin adjustment to define anemia in smokers (CDC, 1989).

Table 3. Hemoglobin adjustment for smokers (WHO, 2011)

Amount smoked	Hemoglobin (g/L)
1/2–1 pack/day	**+3**
1–2 packs/day	**+5**
>2 packs/day	**+7**
All smokers	**+3**

Altitude

At elevations above 1000 m, hemoglobin concentrations increase as an adaptive response to the lower partial pressure of oxygen and reduced oxygen saturation of blood (Hurtado, et al, 1947). The compensatory increase in red cell production ensures that sufficient oxygen is supplied to **tissues.(Table 4)**

Table 4.Hemoglobin adjustments (g/L) for altitude (WHO, 2011)

Altitude (m)	Hemoglobin (g/L)
<1000	0
1000	1
1500	4
2000	7
2500	12
3000	18
3500	26
4000	34
4500	44
5000	55
5500	67

3.4 Nutritional Status and Dietary diversity

General malnutrition as seen in many food insecure areas of the world exhibit a higher proportion of the population suffering from anaemia as well as general malnutrition. Anaemia can be caused by nutritional deficiency characterized by low energy intake and limited dietary diversity even in the presence of adequate to marginal iron stores as evidenced by studies done in rural regions of Ethiopia predominantly relying on plant based food sources. (Yohannes Seyoum, 2019)The majority of nutritional anaemia globally is attributed to iron deficiency(WHO, 2017a), however other nutritional factors are also implicated either in conjunction or as sole causes, notably deficiency of Vitamin A, C, B12 and Zinc deficiency to name a few.

Vitamin A deficiency is moderate public health problem in school age children (5-14y), and women of reproductive age with prevalence of (10.9% and 3.4% respectively). (EPHI, 2016)

Undernutrition is cited among the factors associated with anaemiaand Vitamin A deficiency in Adolescent girls and women of reproductive health in several studies.(Regasa, 2019)(Yohannes Seyoum, 2019)Undernutrition/thinness can be reliably assessed by simple anthropometric measurements of Height and Weight, from which the body mass index can be derived. Undernutrition can be classified as a body mass index of < 18.5kg/m^2 in adults, and a

propotional BMI standard chart for age is used to assess adolescents under the age of 18 years of age. (WHO, 2006)

Assessment of nutritional intake, and dietary diversity using Dietary Diversity score (Women) can also indicate possible nutritional factors that may contribute to nutritional anaemia and undernutrition. (Yves Martin-Prévela, 2015) The minimum Dietary Diversity for Women of Reproductive age (MDD-W) is a food group diversity indicator that reflects the micronutrient adequacy across 11 micronutrients including iron, and Vitamin A among others.(FAO F. 3., 2016)

3.5 Socioeconomic impact of anemia

Anemia has a great socioeconomic effect on the world. Almost 50% of the world anemia can be attributed to iron deficiency; in Ethiopia 50% of preschool children 42% of pregnant women and 30% of non-pregnant women are vulnerable to anemia (WHO/CDC, 2008).

There are many health risks attributed to anaemia like increasing the odds of maternal mortality, prenatal mortality, low birth weight, neonatal mortality, post neonatal mortality and child mortality, decreased mental and behavioural cognitive development in children and low productivity in adults. (Rahman MM, 2016) These issues contribute to human and capital cost across the globe.

In addition to incurring high cost of health, the consequences and complications of anaemia on the capacity of learning and attaining a level of education that is associated with healthier population is easy to surmise.(Horton, 2003)

According to Horton S the Economics of Iron Deficiency,(2003)an estimated of 4.2 billion USD loss, $2.32 per capita physical loss, $16.8 per capital including cognitive losses around 4% of GDP occurs around the world.

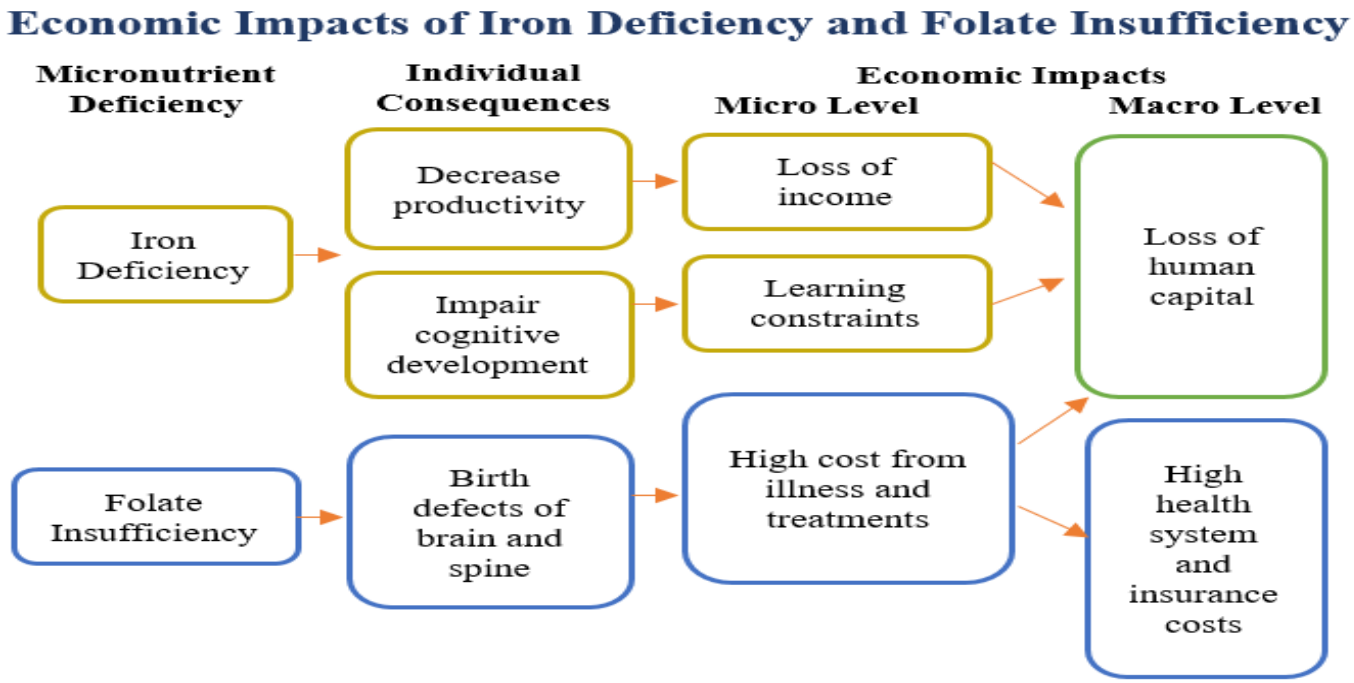

Figure 2 Economic impacts of iron and folate deficiency (Balarajan Y, 2011)

4. Methodology

4.1 Study area and Period

The study was conducted in the capital city of Ethiopia Addis AbabaAkakikality districtbetween the months of September 2018 to November 2018, located at an altitude of 2400m a.s.l

4.2 Study Design

A cross-sectional study design was used in conducting this study

4.3 Study Population

All adolescent girls found in randomly selected from AkakiBeseqahigh school aged between 15-19 years have been included in the survey.

4.4 Inclusion and exclusion criteria

4.4.1 Inclusion criteria

Adolescent girls aged 15-19years who were willing for blood testing

4.4.2 Exclusion criteria

Adolescent girls who were under treatment for anemia, Infectious diseases such as malaria, tuberculosis and HIV/AIDS.

4.5 Sample Size Determination

The sample size was determined using Single population proportion and the following single proportion sample calculation formula was used.

$$n = \frac{Z_{\frac{\alpha}{2}}^{2} P(1-P)}{d^{2}}$$

Where;

n The minimum sample size required for very large source population
Z The critical value for a given confidence interval
P Expected proportion of the event to be studied (to be estimated based on previous studies)
d Margin of error

And the population size was considered to be less than 10,000 it was corrected using the formula below.

$$\text{sample size} = \frac{n \times N}{n + N}$$

Where:

n- is the non-corrected sample size

N -is the size of the source population

As the expected proportion of the event was not known P was taken as 0.5 because it yields the highest sample size for the specified confidence level (CL) and margin of error.

$$\left[n = \frac{1.96^{2} * 0.5 * (1-0.5)}{0.05^{2}} \right] = \mathbf{384}$$

Considering 10% non-response rate (384*10/100) the final sample size was taken as 423

4.6. Sampling technique

A stratified sampling technique was used to ensure each population group has a non-zero equal chance of being selected and has good external validity and to improve the representativeness of the sample among age groups by choosing either proportional or non-proportional stratified sampling**.** Samples were taken from Akakibeseqa governmental high school from 15 to 19 years of age.

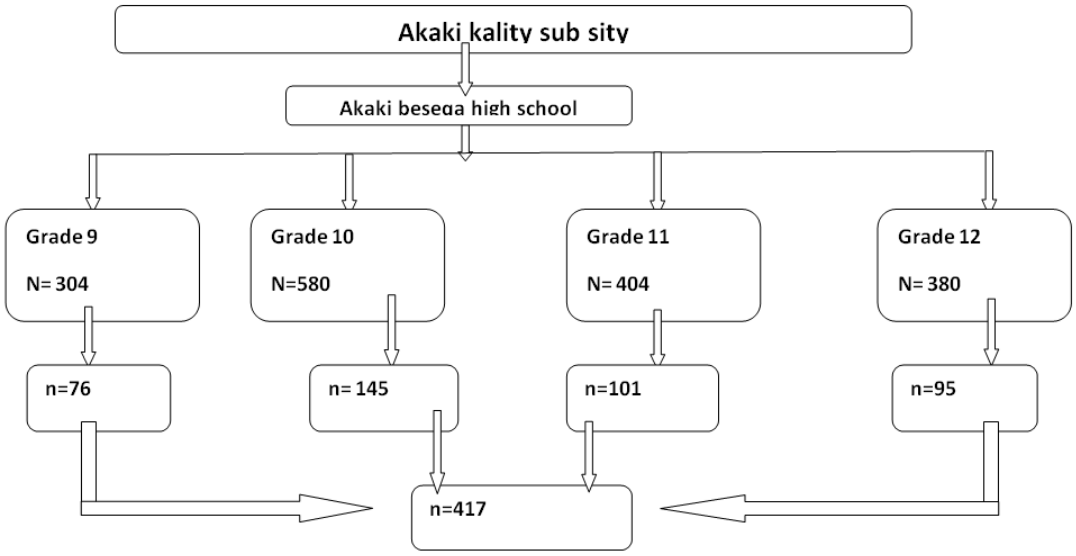

Figure 3 Sampling technique conceptual framework

4.7 Training

Data were collected by two diploma nurses. Two days training was provided by principal investigator focusing on objective of the study, interviewing approach, safety of participants and on maintaining confidentiality and data collection was performed in the school ground.

4.8 Dependent and independent variables

Dependent variable
Anemia

Independent variable
DDS and BMI

4.9 Data collection

A structured interviewer-administered questionnaire was used to collect data from the students about socio-demographic health status, food intake with twenty-four-hour recall in terms of dietary diversity score(DDS) which was translated in to the local language that is Amharic and clinical data was collected by trained clinical nurses.

4.10 Anthropometry

4.10.1 Height**:**
Measurements were carried out using (GMM-H03) an aluminum height measuring board with a sliding head bar. The subjects were asked to stand straight on leveled surface with heels together and their heads positioned and eyes looking straight ahead (frankfort plane) without shoes. The moving head piece of the stadio-meter was lowered to rest flat on the top of the head and reading was noted to the nearest 0.1cm.

4.10.2 Weight**:**
Weight was measured using (GMM-H03) a battery powered a digital personal weighing scale to the nearest 0.1kg. It was calibrated against known 2kg standardized weight regularly and the zero error of the weighing scale was checked before taking the weight and corrected when required before each session. Weight was measured without shoes and in light clothing. The same measurer was employed for a given anthropometric measurement to avoid variability. All measurements were taken twice and the average was computed.

4.11 Blood collection and analysis

Blood sample collection was done by a qualified nurse; capillary blood was taken from each study from the tip of the ring finger. About two drops of blood was taken by using disposable sterile lancets from the finger tips after wiping the first two drops with sterile cotton and alcohol to stimulate blood flow and then the sample is collected in to a micro-cuvette to be analyzed. Precautions was taken to avoid air bubbles getting in to the micro-cuvettes if air is found the blood sample is taken by a different micro-cuvette all over again. The lancet and the micro-cuvette were used once for each study participant and were disposed in to biohazard container.

4.11.1 Blood analysis

The blood sample was analyzed for hemoglobin level by using a battery operated portable haemoglobinometer (hemo-cue 301) used for hemoglobin analysis. After blood sample collection the microcuvatte is placed inside the hemocue and the value is interpreted as normal (hb>12 g\dl, mild (10-11.9g\dl), moderate (7.0-9.9 g/dl,) or sever (<7g\dl) based on the WHO recommended cut off points after adjusting to 2400meter altitude was made.

4.12 Data quality management and processing

4.12.1 Data quality management

To ensure full understanding of the questions on the questionnaire the English version of questionnaire was translated into the local language (Amharic). A pilot survey was conducted among 5% of adolescents of the same age group who were selected and then problems highlighted during the pilot survey were resolved before the start of the actual survey along with two days training for data collectors. The interviewers were trained to standardize the questionnaire administration and anthropometric measurements.

4.12.2 Data processing management

Each questionnaire was checked for error and completeness manually and each were given a code and entered into spss version 19 for analysis. Descriptive summary using frequencies, proportions and appropriate summary tables, graphs and charts was made to present background determine independent predictors for the outcome variable among adolescence participants.

Anthropometry data was processed by entering the data in toWHO anrtho-plus 2007 software to determine the BMI of the participants.Dietary diversity score was interpreted by using WHO guide. Less than 3 food groups consumed per 24hours is considered low DDS, 4 - 5 as medium DDS score and 6 and above as high DDS .

4.12.3 Ethical considerations

Ethical clearance was obtained from the Ethical Board of the Addis Ababa University College of natural and computational science. Consent was taken from parents/guardians of the children and

and the children themselves. Confidentiality was maintained and also only the voluntary children's participated in the study.

5. Result

5.1 Socio-demographic and anthropometric characteristics of the study participants

A total of 423 children were selected, among whom complete response of the anthropometric measurements and blood samples were obtained from 417 students with the response rate of 98.5%. The mean ± SD age was 16.96 ± 1.14 years ranged between 15 and 19 years. From the total of 417 respondents there were, 15 years olds 45 (10.8%), 16 years old 114 (27.3%), 17 years old 101 (24.2%) 18 years old 124 (29.7%) and 19 years of age 33 (7.9%).

Table 5. Demographic and socio-economic characteristics of study Participant (n=417)

Characteristics	Frequency (n)	Percentage (%)
Region		
Addis Ababa	417	100
Religion		
Orthodox Christian	313	75.1
Protestant Christian	38	9.1
Muslim	66	15.8
Total	417	100
Guardian education level		
Primary	38	9.1
Secondary	268	64.3
Higher	111	26.6
Total	417	100

As the above table shows all the study participants are from Addis Ababa with orthodox and protestant Christians religions 75.1 and 9.1 percent respectively and with 15.8 percent of populations are Muslims. Most of the study participants' guardians that is 64.3 percent are educated up to secondary education, 26.6 are educated at higher level and 9.1 percent are educated only up to primary education level.

Table 6. Dietary Habits of study participant (n=417)

Characteristics	Frequency	Percentage
Meal per day		
2 to3 times	285	68.3
4 and above	132	31.7
Total	417	100
Skipping meal		
Yes	285	68.3
No	132	31.7
Total	417	100
Meal skipping habit		
Breakfast	139	33.3
Lunch	146	35.0
No	132	31.7
Total	417	100
Reason for skipping meal		
No appetite	164	39.3
No time	41	9.8
Just habit	38	9.1
Fasting	42	10.1
Total number skipping meal participants	285	68.3
No skipping meal	**132**	**31.7**
Tea or coffee with in 1hr of meal	352	84.4
Yes	65	15.6
No	417	100
Total		

As summarized in the above table (Table 6) more than 53%of the study participants were skipping meal at least once a day. Although most of them bring their lunches to school, there are stating that they have no appetite to eat so they are giving their lunches to the needy or some who did not bring lunch are buying after school snacks such as potato chips or some other biscuits and crackers. From the 53% about 19% of them are skipping breakfast because they are fasting; meal is not prepared on time or just a habit.

From the 417 study participants none of them have a smoking habit and also they have never taken any kind of supplementation including iron or folate.

5.2 Anthropometric measurements among respondents

From 417 study participants most are in the normal BMI for Age range where as there were no obese participants.

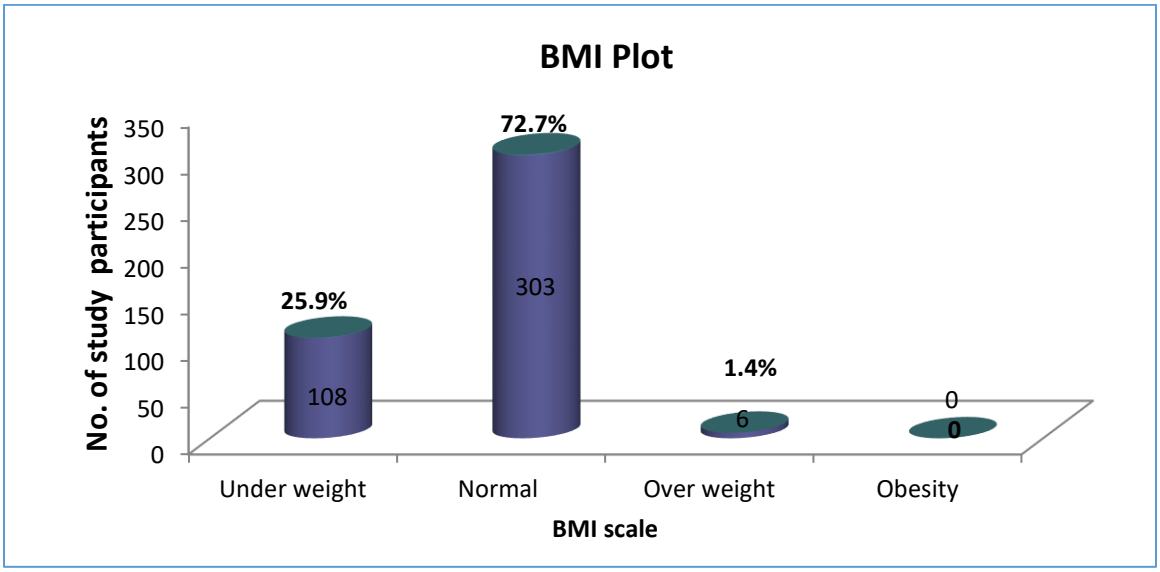

Figure 4: - BMI representation of study participants

As shown in the figure above 108(25.9%) of the participants are underweight 303(72.7%) are within the normal range whereas the rest 6(1.4%) are overweight.

All of the 417 study participants have started theirmonthly menstrual cycle. Fifty nine percent (246) of the population had their menarche at the age of less than or equal to 13 and the remaining 41 %(171) at the age of greater than 13 years of age. The duration of bleeding was less than 5 days for 62% (259) and greater than or equal to 5 days for 38% (158). Excessive bleeding was reported by 21 % (88) and in the remaining 79% (329) it was reported is normal.

5.3 Magnitude and severity of anemia

Among the 417 study participants the finding shows a mean hemoglobin level of 12.9±1.07g/dl with the range from 9.9 to 16.9 g/dl. The prevalence of mild degree of anemia among school girls age between 15 to19 was found to be 54(12.9 %) and 2(0.5%) were moderately anemic.

The rest 361(86.6%) had haemoglobin levels within the normal range.

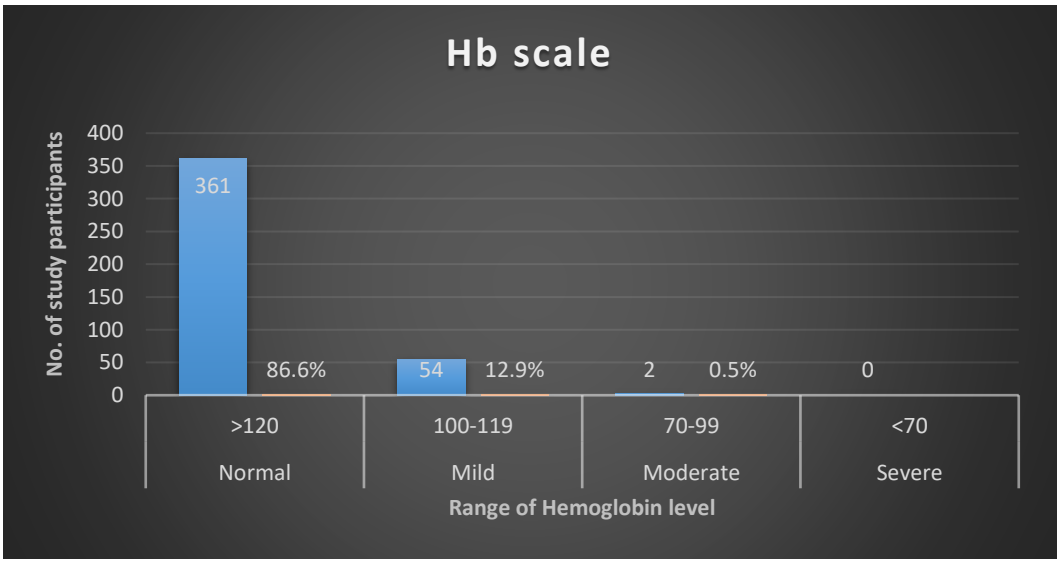

Figure 5 number of study participants and related hemoglobin status (n=417)

5.4 Dietary Diversity Score (DDS)

Diet diversity score was calculated by adding the number of food groups that were consumed by the participants within 24 hours prior to sample collection. The food groups were classified in to 9 groups which are starchy staples(cereals), tubers, fruit, vegetables, meat, egg, fish, legume (nuts and seeds), milk and dairy products. in this study food groups are categorized into low dietary diversity (<=3food groups), medium dietary diversity (4–6) food groups and high dietary diversity (>6).Sixty percents of study participants (251) had low DDS which means they consumed 3 or less food types within 24 hours prior to data collection,and165(39.8%) hadmediumDDS.

Table 7.The number of food taken within 24 hours (n=417)

Food category	Frequency	Percentage
Starchy staples(cereals)	402	96.4
Tubers	101	24.0
Fruits	128	30.7
Vegetables	226	54.2
Meat	173	41.5
Fish	10	2.4
Egg	85	20.4
Legumes, nuts and seeds	219	52.5
Milk and milk products	58	13.9
The mean dietary diversity score was found to be 3.46 SD±0.97		

Prior to blood sample collection a 24 hour dietary diversity score shows that 182 participants have consumed iron rich animal source foods and 235 have not consumed iron rich foods. Consumption of fruits and vegetables among participants is low as only 30.7% of the participants consumed any type of fruit within 24 hour and only 54% of the population had consumed some type of vegetable.

Table 8. Comparing BMI and Hb level (n=417)Correlations

	Method	**BMI**	**Hemoglobin level adjusted by altitude (g/dl - 1 decimal)**
BMI	Pearson Correlation	1	0.157**
	Sig. (2-tailed)		0.001
	N	417	417
Hemoglobin level adjusted by altitude (g/dl - 1 decimal)	Pearson Correlation	0.157**	1
	Sig. (2-tailed)	0.001	
	N	417	417

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

Assessment of the correlation done between BMI and Hb level hemoglobin indicate that hemoglobinis significantly correlated with body mass index (p=0.01).Table 9 below indicates that, from the survey population those with low BMI are 3.2 times more likely to be anemic than those of with normal BMI. Similarly, for daily meals/day, those who skip meals are also 2 times more likely to be anemic than those who don't skip meals.

Tabel 9. BMI vs daily meal skipping habit

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	BMI	1.234	0.295	17.543	1	.000	3.435	1.928	6.118
	Constant	-3.555	0.457	60.519	1	.000	0.029		
Step 2[b]	Mealsper day	.769	0.372	4.263	1	.039	2.157	1.040	4.473
	BMI	1.189	0.297	16.043	1	.000	3.283	1.835	5.872
	Constant	-4.067	0.538	57.134	1	.000	0.017		

a. Variable(s) entered on step 1: BMI

b. Variable(s) entered on step 2: mealsper day.

6. Discussion

The present study was undertaken to assess prevalence of anemia in school going adolescent girls in AkakiKality region and also its correlation with body mass index and dietary diversity score by using 24hour recall method. Anthropometric measurements were taken and also blood samples were analyzed using hemo-cue-301.Most of the anemic subjects are either under weight or they have a meal skipping habit, as the statistical analysis shows. As the result shows from 417 study participants 13.4 % (56) found to be anemic. As the result from the data shows study participants who have a meal skipping habit are 2 times more likely to be anemic than those who are not skipping meal. Reason given for skipping from 417 participants 124(29.7%) say they have no appetite (mostly at lunch time) 33(7.9%) say no time (mostly breakfast) 25(6%) just a habit 42(10.1%) fasting the rest 193 have no skipping habit.

Lunch is the most skipped meal of the day 146(35%) and breakfast 78(18.7%) after meal time 65(15%) drink tea or coffee within one hour after meal the rest 352 do not drink tea or coffee.

From 417 study participants 108(25.9%) were under weight whereas 303(72.7) were in the normal range and 6(1.4%) were overweight. BMI as a risk factor underweight subjects are 3.2 times more likely to be anemic than those who are in the normal range.

The overall prevalence of anemia among studied adolescent was 13.4%. This shows that anemia is mild public health problem based on the WHO (5-19.9%) standards(WHO, 2011). This result is lower than the WHO estimate of 27% of anemia prevalence among adolescent girls in developing countries and the prevalence of anemia from a study conducted among adolescent's girls of India in which about 28 percent of adolescents were anemic(Sajneetha S, 2015;).

According to study done by EDHS the higher prevalence of anemia among adolescent from rural areas may be due to dietary deficiency or poor dietary patterns.For instance meat consumption was 23% in rural and milk consumption which has high concentration of calcium and casein which are potent inhibitors of non-heme iron was182(80.5%) in rural areas. Association of rural residence with anemia has also been reported earlier (EDHS, 2011).

By doing binary logistic regression this study shows that the underweight study participants were 3.2 times more likely to be anemic than those with the normal BMI and also anemia is correlated with number of meal consumed per day (meal skipping habit) that is those who skip once or more meal per day have 2.15 times chance of being anemic than those who have no meal skipping habit.

7. Strength and Limitations of the study

7.1 Strength of the study

Hemoglobin was measured using a Hemo-Cue hemoglobin analyzer (HemoCue hb301+), which is accurate and precise method for measurement of Hb and recommend method for field research work. Hemoglobin level adjustment for altitude was also made(WHO, 2011).

7.2 Study limitations

Only one '24 hour recall' dietary diversity score was taken in which the current nutritional intake was analyzed, in which it is difficult to interpret in to iron level status.

WASH data was not included and study participant who have any diseases related to anemia have been excluded by exclusion health criteria.

8. Conclusion and Recommendation

8.1 Conclusion

The present study revealed anemia to be mild public health problem in the school going adolescent girls in Addis Ababa Akaki high school. The major explanatory variables for anemia were BMI and meal consumed per day (meal skipping habit). In this case being underweight and meal skipping could be considered a fair indicator of mild anaemia in adolescent school children in AkakiSubcity.

The proportion of anemia was higher among girls with BMI score below 18.5(who were under weight) and with low less than 3 dietary diversity score and those who have meal skipping habit are twice more vulnerable to develop anemia than the others. Most of the study participants were in the lower middle class, there are no significant differences between socioeconomic status, diet hygiene and sanitation practices. Compared to other regions of Ethiopia, Addis Ababa has the lowest prevalence of adolescent anemia e.g. southwest Ethiopia r**e**gi**o**n has 15.2%, Somali region has 31%,(EDHS, 2011).

The reasons behind why some skip meals (when they have actually taken lunch to school but don't eat it) could be explored further to help find solutions within the local setting, and improve dietary intake even in the current settings.

Micronutrient deficiency and under nutrition are conditions that are set into the population and have deep roots from infancy, childhood and adolescent with impacts and reverberations continuing into adulthood.

Increasing of micronutrient intake and nutritional status is one of the most important targets to improve the health of a nation including preventing the development of anaemia. To achieve this, improving the diversity of the food group a population consumes is one of the key measures.

8.2 Recommendation

Education on healthy eating could help with increasing knowledge of adolescents who are old enough to make healthier choices from available resources in the environment. This may help them realize that locally available sources of iron like green leafy vegetables can help them in becoming healthier. Education can encompass diet quality based on available resources, benefits of adequate nutritional intake, regular meals and even including skill based training on food preparation and composition.

Such measures like health education on dietary diversification and hygiene and encouraging health seeking behaviors should *and* could start while they are young and in school (school age and adolescence) as these measures are lifetime health promoting skills that would benefit not only the children but society as a whole as and when they become productive adults and family heads/ mothers.

Home fortification mixtures with appropriate amounts of absorbable Fe compounds can be formulated to improve or maintain the Fe status of infants, children, pregnant and non-pregnant women.

Interventions such as supplementation and strategies aimed at addressing anemia and awareness about its consequences should be created by policy makers.

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Annexes

Annex 1: CONSENT FORM

I have read the above information and I have had the opportunity to ask questions and any question that I have asked have been answered for me and I have been satisfied with it. Therefore, I voluntarily agree to participate in the study and I have understood that I have the right to withdraw from the study at any time without affecting my right.

Signature of volunteer: _____Date: _____

Signature of Data collector: _____Date:_____

Annex 2:Questionnaire

1. Name ----------

2. Grade----------

3. Age ---------- weight-------- height----------

4. Marital status

Married ------- single-------- widowed--------

5. Religion

Orthodox Christian ----- Muslim-----protestant Christian ------ catholic Christian ---- other---

6. Guardian education level

Illiterate ------ primary school----- secondary school------ higher------- above--------

7. Do u have any medical conditions?

Yes ---- No------

8. If yes what is your medical conditions ----------

9. Are u on any medication?

Yes---- NO-------

10. If yes on what medication ----------

11. Have u ever taken an iron, foliate, vitamin or zinc supplementation

Yes ----- No------

12. If yes is u taking it now?

Yes ------- No------

13. If yes describe the supplementation ----------

14. Have you ever been diagnosed with anemia

Yes ------ No-----

15. If yes when

Within 1month------ 3months -------- 6monthes--------- more than a year---------

16. Have you ever donated blood

Yes----- NO------

17. If yes

Within this month----- 3 months------- 6months ----- more ------

18. Have you ever had a blood transfusion?

Yes------ No-------

19. If yes when

Within this month----- 3 months------- 6months ----- more ------

20. Smoking habbit

Yes------ No--------

21. How many days dose your menstrual cycle usually lasts ----------

21. Food intake within these 24 hours

Consumption at the time of	food items
Breakfast	
Lunch	
Dinner	
Snacks	
Drinks	
Other	

22. tea/coffee within one hour of meal

Yes------ No-----

23. Meals per day

Once------ twice------ three times------- four and above

24. Do you have a meal skipping habit?

Breakfast-------- lunch-------- dinner------ No------

25. Frequency of skipped meal

Once per week------ twice per week----- three times and more per week------

26. Reason for skipping meal

No appetite----- no time------ just habit------- fasting------ not prepared-------

Hemoglobin and anthropometric Measurement

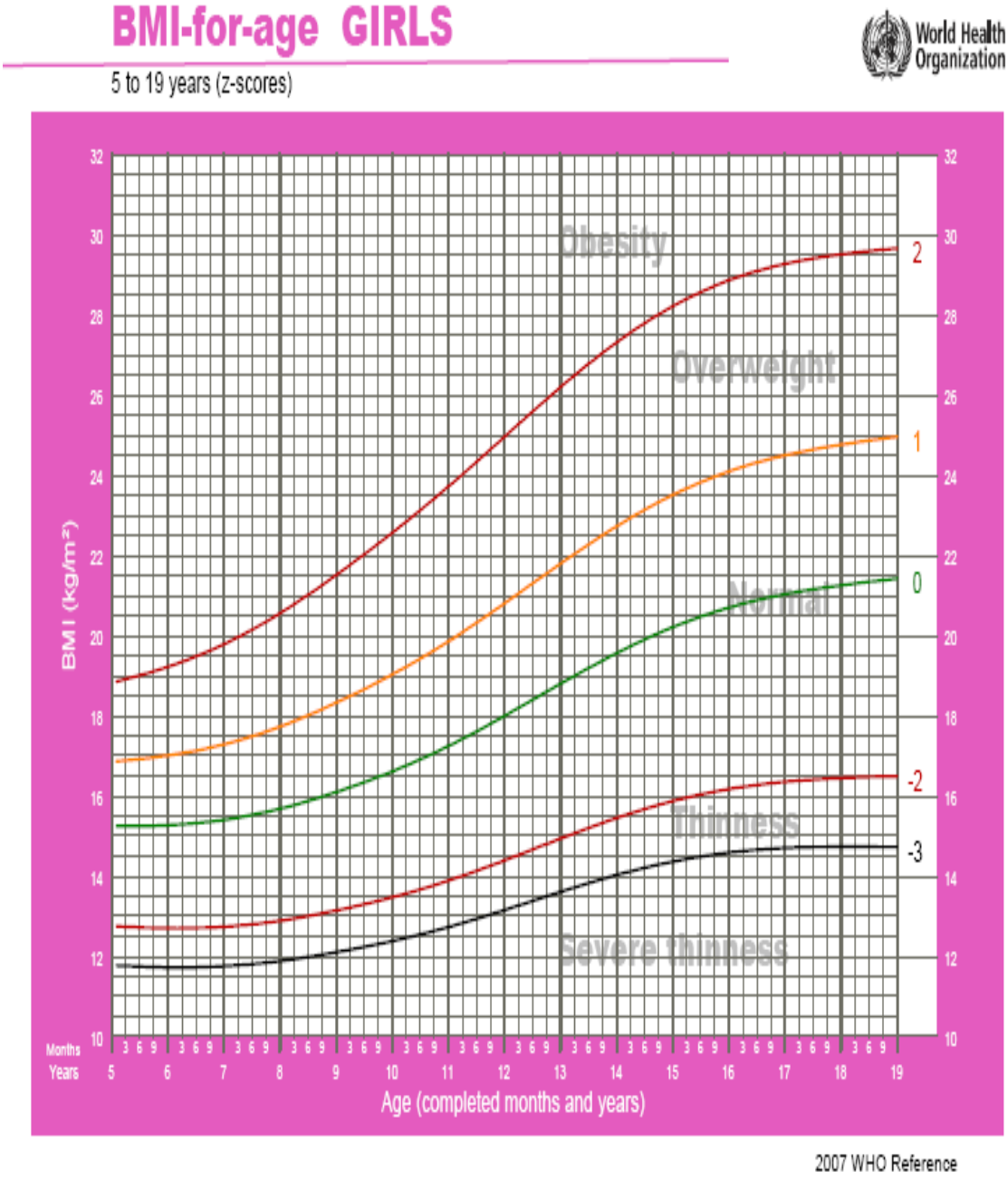
27. Hight---------- cm

28. Weight--------- kg

29. Hemoglobin---------- g/dl

Thank you!!!

Appendix 3: WHO reference for BMI 5 to 19 years of girls



Declaration

I under signed, declare that this is my original work and has not presented in this or any other University and all of sources of material used for this thesis have been duly acknowledged

Name: Frehun Abebe (BSc)

Date_____ Signature _____

Approval of the primary Advisor

This thesis work has been submitted for examination with my approval as University advisor

Name: DR. Zelalem Debebe (MD)

Date._____ Signature _____