Iron Deficiency Anemia and Its Association with Overweight and Obesity among Adolescents in Addis Ababa, Ethiopia

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IRON DEFICIENCY ANEMIA AND ITS ASSOCIATION WITH OVERWEIGHT AND OBESITY AMONG ADOLESCENTS IN ADDIS ABABA, ETHIOPIA

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This thesis, by Sara Gosaye is accepted in its present form by the board of examiners as fulfilling for the degree of masters of public health in public health nutrition.

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Abbreviations and Acronyms

AACAEB	Addis Ababa City Administration Education Bureau
AAU	Addis Ababa University
AOR	Adjusted Odds Ratio
BAZ	BMI for Age Z-score
CDC	Center of Disease Control and Prevention
CHS	College of Health Science
COR	Crude Odds Ratio
CRP	C-reactive protein
CSA	Central Stastical Agency
DDS	Dietary Diversity Score
DBM	Double Burden of Malnutrition
EDHS	Ethiopian Demographic and Health Survey
ENMS	Ethiopian National Micronutrient Survey
FERR	Ferritin
FFQ	Food Frequency Questionnaire
Hg	Hemoglobin
ID	Iron Deficiency
IDA	Iron Deficiency Anemia
IP	Intestinal Parasites
MOH	Ministry of Health
PI	Principal Investigator
SPH	School of Public Health
SOPs	Standard Operating Procedures
STFR	Soluble Transferrin Receptor
WHO	World Health Organization

Abstract

Background: Iron Deficiency Anemia (IDA) is a global public health problem among school age children and adolescents, which retards psychomotor development and impairs cognitive performance. However there is limited data on the prevalence of IDA and its association with overweight and obesity among adolescents in Ethiopian context.

Objective: To determine the magnitude of iron deficiency anemia and examine its association with overweight and obesity among adolescents in Addis Ababa, Ethiopia.

Method: A School based, cross-sectional study was conducted among 363 high school adolescents of Addis Ababa from March to April 2018. A multi-stage random sampling procedure was followed and participants were interviewed using structured questionnaire. Socio-demographic, economic and dietary data including 4 ml of venous blood sample was collected. The blood was used for serum iron, CRP & complete blood count analysis. Anthropometric data was also measured and entered in to WHO Anthro plus software to compute the nutritional indices. Data were analyzed using SPSS Version 20 software. For all statistical tests, significance level was set at p-value of <0.05.

Result: The overall prevalence of anemia, iron deficiency and IDA were 12.9% (95% CI: 9.6%-16.5%), 16.3% (95% CI: 12.4%-20.1%) and 7.4% (95% CI: 4.7%-9.9%) respectively. The majority 37 (78.7%) of anemic adolescents had mild anemia followed by moderate 9 (19.1%) and one severe anemia (2.1%). From the overall anemic adolescents 27 (57.3%) had iron deficiency (serum iron level of < 60μg/dl). Being overweight and obese showed an increased risk of IDA in which 15.4% of overweight or obese adolescents had IDA when compared with adolescents of normal weight (AOR = 4.2; 95% CI =1.21-17.29).

Conclusion and recommendation: IDA is a mild public health problem among school adolescents of Addis Ababa which had significant association with overweight and obesity. Therefore it is essential to launch school based interventions that targets excess body weight and poor iron status.

1 Introduction

1.1 Background

Anemia is a condition in which the number of red blood cells or their oxygen carrying capacity is insufficient to meet physiologic needs of the body (1). Anemia is established when the Hemoglobin (Hg) is below the cutoff point recommended by the World Health Organization (WHO) as mild if Hg level is between (10-11.9g\dl), moderate (7.0-9.9 g/dl,) or sever (<7g\dl) (2). Iron deficiency (ID) is the most widely prevalent nutritional disorder and is responsible for at least half of all anemias worldwide. It is considered to be the main cause of anemia in women, adolescents and children from developing countries (3).

Adolescence, the time period between 10 and 19 years of age, is characterized by rapid growth and development secondary to the first year of life. It is a period in the human life cycle in which up to 50% of adult weight and skeletal mass and more than 20% of adult height is achieved (4). Currently, there are about 1.2 billon adolescents constituting about one-fifth of the world's population and the majority of them are living in developing countries (5). The greater demand for iron in this age group is as a result of rapid pubertal growth, increase in lean body mass and blood volume (6), frequent infectious disease and parasitic infections (7), poor dietary intake and availability of iron (8), onset of menstruation, early marriage, pregnancy and lactation all of these factors mentioned contribute to adolescents especially girls to be vulnerable for IDA (9).

Overweight and/or obesity are also a serious public health challenge of the 21st century. Its magnitude among children and adolescents is increasing worldwide and currently one child in ten is overweight or obese (10). Obese children and adolescents are not only susceptible to complications such as hypertension, type 2 diabetes, stroke, and cardiovascular disease but also exposed to a variety of micronutrient deficiencies (11). There is growing evidence that overweight and/or obesity has become an emerging risk factor for the development of IDA the first reason is due to consumption of imbalanced diet which is high in carbohydrate, fat and sugar but poor in vitamins, minerals and micronutrients specifically iron and also because of repeated short-term restrictive dieting by overweight and/or obese individuals for the purpose of weight loss (12). The second reason is due to increased iron requirement

because of large blood volume, red cell and muscle mass, increased growth and development and higher basal iron losses with higher body weight (13).The third reason is due to impaired dietary iron absorption from the duodenum as a result of increased circulating hepcidin and obesity related chronic low grade inflammation, the fourth reason is due to increased sequestration of iron in the reticulo-endothelial system by adipocyte mediated release of inflammatory cytokines, Interleukin 1 and 2, tumor necrosis factor and hepcidin (14, 15).The fifth reason is an increased iron loss by menstruation because excess adiposity is associated with early pubertal development, overweight girls tend to mature and begin their menses at an earlier age. All the above mechanisms describe the coexistence of both under and over nutrition within the same individual leading to the occurrence of intra-individual Double Burden of Malnutrition (DBM) (16).

The burden of IDA is affecting both developed and developing countries and varies with a person's age, sex, diet, attitude and pregnancy. In developed countries, 4.3% to 20% of the population is affected by IDA, while in developing countries these figures range from 30% to 48%, whereas in Ethiopia its magnitude varies from 7% - 37.4% among school aged children and adolescents (17).

1.2 Statement of the problem

Anemia has multi-factorial causes, ranging from micronutrient deficiencies such as iron, folate and vitamin B_{12} to infectious diseases such as malaria and worm infections (18). It is estimated that anemia affects around 800 million children and women which is 43% of children, 38% of pregnant women, 29% of non-pregnant reproductive age women and 15% of adolescents globally. However the prevalence of anemia varied substantially across regions with more cases in South East Asia, Eastern Mediterranean and Africa Regions (19). In sub-Saharan Africa about half of adolescent girls are anemic (20). According to the Ethiopian Demographic and Health Survey (EDHS) reports, more than half (56%) of children 6-59 months, about one-fourth (23%) of women aged 15-49 years, about one-fifth (18.7%) of men aged 15-49 years (21), 13.4% of adolescent women aged 15-19 years and 17.8% of adolescent men aged 15-19 years were anemic (22).

The major proportion of anemia during adolescent period is IDA and it is the most common and widespread nutritional deficiency attributed to 50% of all anemias worldwide (2, 3). ID can delay psychomotor and physical development. It also impairs learning capability, cognitive function, behavior, work and school performance (23). Recent studies from developing countries have shown that ID is still a public health significance in adolescent girls (17, 24). The Ethiopian National Micronutrient Survey (ENMS) reports of 2015 showed that, the prevalence of ID among school age children (5 to 14 years) using Soluble Transferrin Receptor (STFR) and Ferritin (FERR) was found to be 19.5% and 9.1% respectively, whereas the prevalence of IDA using STFR, and FERR combined with Hg was found to be 7% and 4.4% respectively (25).

Overweight and/or obesity promote ID by inhibition of dietary iron uptake from the duodenum (14). Iron studies in overweight and obese children and adolescents found that prevalence of ID was higher among overweight and obese children and adolescents than non-obese children (15, 26). Overall the association of IDA with overweight/obesity doubles the ill health effects of the disease burden. Overweight and/or obesity more than doubled the likelihood of ID & IDA results in fatigability, weakness & exercise intolerance further exacerbating the development of overweight and obesity by decreasing the level of physical activity (26).

Nowadays many low and middle income countries are facing a “double burden” of malnutrition, while these countries continue to deal with the problem of under-nutrition, they are also experiencing a rapid increase in obesity and overweight at a rate of 30% faster than in developed nations (27). However the magnitude of IDA as a public health problem is still disputed and there is also scarcity of data on the magnitude & association of IDA with the nutritional status of adolescents in low and middle income countries like Ethiopia, with the complex ecologic context of poverty, parasitism, and malnutrition. Therefore this study was conducted to assess the magnitude of IDA and examine its relation with overweight and obesity among in-school adolescents of Addis Ababa, Ethiopia.

1.3 Significance of the study

This study generated evidence on the magnitude of anemia, iron deficiency, IDA and also the nutritional status of adolescents which is essential to design appropriate health and nutritional intervention measures.

Findings of this survey create opportunity for intersectoral collaboration among health, nutritional and educational sectors to improve adolescent health and nutrition by combating excess body weight and poor iron status.

It serves as a baseline for further studies and help for programmatic and policy implications since it uncovered the magnitude and severity of intra-individual double burden of IDA, overweight and obesity among adolescents.

2 Literature review

2.1 Magnitude of overweight and/or obesity

Globally, there is a rising prevalence of overweight and obesity in both developing and developed countries (28). The WHO estimated that by 2005, at least 1.6 billion and 400 million people aged above 15 years were overweight and obese respectively. It further projected for 2015, these statistics will increase to 2.3 billion for overweight and 700 million for obesity unless radical measures are taken to improve this increasing problem (29).

Obesity has increased significantly in children and adolescents worldwide in which 23.8% of boys and 22.6% of girls were overweight or obese in developed countries. Its prevalence has also increased in developing countries, from 8.1% to 12.9 for boys and from 8.4% to 13.4% for girls in 2013. High rates of overweight and obesity were seen particularly in Middle, Eastern and North African countries and notably among girls (30).

Based on a cluster analysis conducted in USA among adolescents, the prevalence of obesity was 14.6% in males and 11.0% in females, while five-year incidence was 10.6% and 14.1% among males and females respectively (31). In other ways a study in China among adolescents showed higher prevalence of overweight and obesity among boys (26.7%) than girls (16.6%) unlike other studies that showed higher prevalence in females (32).

It has been shown that obesity is rising alarmingly in developing countries as well despite the high prevalence of under nutrition. A prevalence study among school adolescents in India showed higher prevalence rates of overweight and obesity which was 28.5% and 4.2% respectively. It was found to be even highest when compared to rates from USA and Great Britain (33). Another study again in India among randomly selected school adolescents also showed 6.2 % and 5.2% prevalence of overweight and obesity respectively (34).

Prevalence study of overweight, obesity, and thinness among urban school-aged children and adolescents in southern Nigeria were 11.4%, 2.8%, and 13.0%, respectively. More females (3.7%) than males (1.8%) were obese. The prevalence of overweight was higher among adolescents aged 10 to 18 years (13%) than among children from 5 to 9 years old (9.4%) and was highest (23.1%) at age 15 years (35).

A systematic review conducted among Sub-Saharan African countries on a total of 283 articles revealed the trend towards increasing proportions of overweight and obesity over time in school-aged children while there was a persistent problem of underweight. For the

entire time period, weighted averages of overweight and obesity were 10.6% and 2.5% respectively (36).

In Ethiopia, cross sectional studies reported the prevalence of overweight to be between 7.6% and 13.9%. Those studies also found the magnitude of obesity ranged from 0.9% to 4.2% among high school adolescents in Addis Ababa (37-41).

2.2 Magnitude of Iron Deficiency Anemia

Iron deficiency is the most common and widespread nutritional disorder in the world. Over 30% of the world population are anemic and many due to iron deficiency (42). The highest prevalence of anemia exists in the developing countries where its causes are mainly micronutrient deficiencies which include iron, folate, vitamin B12 and vitamin A (43). A review of literatures on IDA among adolescents revealed a prevalence of around 20% and described the harmful effects of anemia in this age group (17).

Iron deficiency anemia is a major health problem in developing countries. A cross sectional study was conducted among adolescent girls aged 14-20 years in Iran, found a prevalence of 21.4%, 23.7% and 12.2%f for anemia, ID and IDA respectively. Around 57.3% of anemic girls were iron deficient (44). Correspondingly a study conducted among children and adolescents in Ethiopia, Kenya, Nigeria and South Africa showed prevalence of anemia ranged from 25% to 53%, ID from 12% to 29% and inadequate intake of iron from 13% to 100% (45).

In Ethiopia, the national prevalence of IDA using the corrected serum ferritin for inflammation combined with Hg adjusted for altitude for children 5 to 14 years of age who had IDA as measured from FERR and Hg below the cutoff points (i.e. FERR<12 µg/L and Hg <11g/dL) were 4.4% and from elevated sTfR and Hg below the cutoff points (sTfR > 4.4 mg/L and Hg <11 g/dL) were 7.0%. Children living in Ethiopian rural areas and the youngest age category had high risk of ID and IDA than urban residence and the older age category (25). Likewise a cross sectional study done among women of reproductive age in nine administrative regions of Ethiopia showed the prevalence rate of clinical anemia, anemia, ID and IDA were 11.3%, 30.4%, 49.7% and 17.0% respectively which indicated the existence of mild to moderate form of IDA in the country(46).

A community based cross-sectional study in Jimma town, Southwest Ethiopia among 616 school children aged 6 to 12 years found that the overall prevalence of anemia was 43.7%

and that of IDA using ferritin was 37.4% which is a moderate public health problem in the study site (47). Similarly a cross sectional study among 408 school adolescents aged 12-19 years in Bonga Town, Southwest Ethiopia showed 15.2%, 11%, 53% prevalence of anemia, iron deficiency anemia and microcytic hypochromic anemia respectively. More than 72% of anemic adolescents had low serum iron concentration. Being female, household size $\geq$ 5, father's illiteracy, intestinal parasitic infections and low BMI were identified as determinants of anemia among school adolescents (48).

2.3 Impact of overweight and/or obesity on IDA

Iron deficiency and overweight and/or obesity are global epidemics affecting billions with regional disparities. ID and obesity do not only represent the coincidence of two frequent conditions but are molecularly linked and mutually affect each other. Obesity may promote ID by inhibition of dietary iron uptake from the duodenum (14).

Health in childhood and adolescence has an impact on health in adulthood, and the comorbidities of overweight and/or obesity are of primary concern. Not only may obesity-related inflammation contribute to the development of diabetes mellitus, cardiovascular disease and but also linked to occurrence of ID and IDA (11).

A study on evaluation of ID among obese and non-obese children showed that mean serum iron levels were lower among overweight and obese children in comparison with control group (49). Correspondingly a cross sectional study among 500 adolescents Subjects with abnormal BMI predicts more IDA than individuals with normal BMI. Unfeasible BMI is a risk factor for IDA developing in adolescents' period (50). According to a review done in 2016 on iron studies in overweight and obese children and adolescents, it was found that prevalence of ID or risk of ID was higher among overweight and obese children and adolescents than non-obese children (15).

In contrast to the above findings, the adiposity of the European adolescents was sufficient to cause chronic inflammation but not sufficient to impair iron status and cause ID i.e mean serum ferritin values were significantly higher in overweight/obese adolescents than in thin/normal-weight adolescents (51). Similarly a cross sectional study in Iranian Population, showed no difference in Hg concentrations, MCV, serum iron, total iron binding capacity, transferrin saturation index and ferritin between normal weight, overweight and obese persons (52).

A cross sectional study among Taiwanese adolescents found that the relationship between being overweight & ID depends on which indicator is used to define ID, so that being overweight or obesity would be a risk factor for ID in adolescents, if ID is defined by low serum iron levels but it will not be true if ID is defined by low serum ferritin levels because of obesity related chronic low grade inflammation that may increase plasma ferritin level independently of body iron stores (16). Similarly, a case control study in Iran showed that mean serum iron levels were lower among obese children in comparison with control group. However, ferritin concentrations were similar in both groups (49).

2.4 Factors associated with IDA

2.4.1 Dietary intake

The highest prevalence of anemia exists in the developing countries where its causes are mainly micronutrient deficiencies which include iron, folate, vitamin B12 and vitamin A (18) . IDA is found to be the most common form of anemia among adolescent because of the increased requirements related to rapid growth and development. The most frequent habits adapted by this age group include skipping meal, reducing the intake of fruits and vegetables, and the increasing consumption of sodas and changing of main meals for snacks. These habits can result in ID and increase the risk of obesity. IDA was observed in many studies among overweight and obese adolescents and young adults .While others shows an inverse relationship between hemoglobin level and BMI (53, 54).

Dietary nutrient intake plays an important role in the well-being of an individual. Study conducted in Kenya, levels of anemia depends on the individual's daily dietary intake. The intake of hem versus non-hem iron was likely to be 10.7% and 74.7% respectively adequate. Extent of inadequacy was likely to be 100% for both hem and non-hem iron. The participant who had inadequate daily dietary iron intake were 10 times more likely to develop anemia as compared to the respondents who had adequate daily iron intake (55).

Similarly a significant association has been reported in a study conducted in Afar region, North East Ethiopia, where low consumption of meat, vegetables, egg, fruits and high consumption of milk significantly related to the occurrence of Anemia (56). Likewise a study done in Jimma town showed not-consuming protein source foods, dairy products and discretionary calories were predictors of IDA (47).

2.4.2 Infection and Anemia

Infections like malaria and helminthes such as hookworms, whipworms (Trichuristrichiura) and Ascaris lumbricoides contribute to IDA by ingesting blood and by destructing intestinal mucosa during feeding. Studies showed that malaria and hookworm infections greatly increases the odds of anemia (57).

Hookworm infection is recognized as the main causes of anemia in poor communities. "The two species of hookworms Ancylostomaduodenale and Necatoramericanus cause about 0.2 mL and 0.15 mL blood loss per day respectively". It causes ID by chronic intestinal blood loss. Although statistically not significant, Children infected with hookworm and Trichuris have had lower Hg concentration and a higher prevalence of anemia (58).It is also supported by another study conducted in Kenya in which respondents who tested positive for ova of Ascaris were 8 times more likely to develop anemia than those who tested negative (55). However the study conducted among women of reproductive ages in Ethiopia shows no significant association between parasitic infection and anemia attributed to parasitic density (59).

2.4.3 Socioeconomic and demographic factors

Socio-economic status limits the availability and consumption of foods of animal origin. Study indicated that majority of participant with anemia had moderately poor socioeconomic level and 87% of anemic patients had red meat intake for once a week or less (60). Similarly a study conducted among adolescent girls in a rural area, showed prevalence of anemia was significantly higher in lower socio-economic status families than families with middle socio-economic status. Adolescent girl's mothers with primary or less education shows significantly higher prevalence of anemia than girls of highly educated mother's. On the other hand, some studies reported no significant association with father's education and occupation (61).

A cross sectional study which was conducted in rural Tamil Nadu found that there was reduction in the mean Hb as the age increased (62). Another study which was conducted in Belgaum among 840 adolescent girls, found that the prevalence of anemia was high among the late adolescents as compared to the early adolescents. History of excessive menstrual bleeding and menarche status were the most common risk factors associated with anemia in adolescent girls (63).

2.5 Laboratory diagnosis of Iron Deficiency Anemia

Hemoglobin values, one of the indicators of iron status, vary with age, sex, state of pregnancy, altitude, and smoking. Due to these reasons, adjustment is required in population based surveys when interpreting Hg values (64). Some studies have used Hg concentration as an indicator of IDA but anemia can be caused by other factors including malaria, parasitic infection, inflammation and nutritional deficiencies in addition to ID (64).

Ferritin, an iron storage protein, and transferrin receptors which control the entry of iron bearing transferrin into cells, are major iron biomarkers. The total tissue concentration of ferritin is proportional to the amount detected in the serum and higher serum ferritin indicates the availability of corresponding amounts of storage iron (65). However, serum ferritin is not reliable as an indicator in the presence of infection because ferritin concentration increases with inflammation as a result of the acute phase response to disease (65).

The evaluation of the iron status in addition to dietary intake, mainly relies on biochemical indicators, especially for the early stages of ID, usually ID occurs in three sequentially developing stages: depleted iron stores, iron deficient erythropoiesis and iron deficiency anemia. These stages can be analyzed biochemically and there is now an agreement that the measurement of Hg, ferritin and soluble transferrin receptor (sTfR), complemented with indicators of acute and chronic infections, is the best procedure for evaluating iron status. Unfortunately this is usually a difficult and costly procedure (66).

The most important indicator for the iron status is the measurement of ferritin. The serum or plasma content correlates well with the iron stores and in the first stage of ID the concentration of ferritin decreases, which makes it the most sensitive parameter. Low ferritin always indicates storage iron depletion. Since ferritin is increased by a number of factors, especially infection and inflammation, a high value is not inevitably a sign of a good iron status, to solve this problem it is helpful to measure parameters for acute and chronic infection, to discover subjects in which the ferritin concentration might be increased by infection or inflammation. Currently the most used parameter for acute infections is C-reactive protein (CRP) and for chronic infections Alpha-1 glycoprotein (AGP). Another solution is to measure an indicator like sTfR, which is less influenced by infection (67).

2.5 Proposed conceptual framework for the study

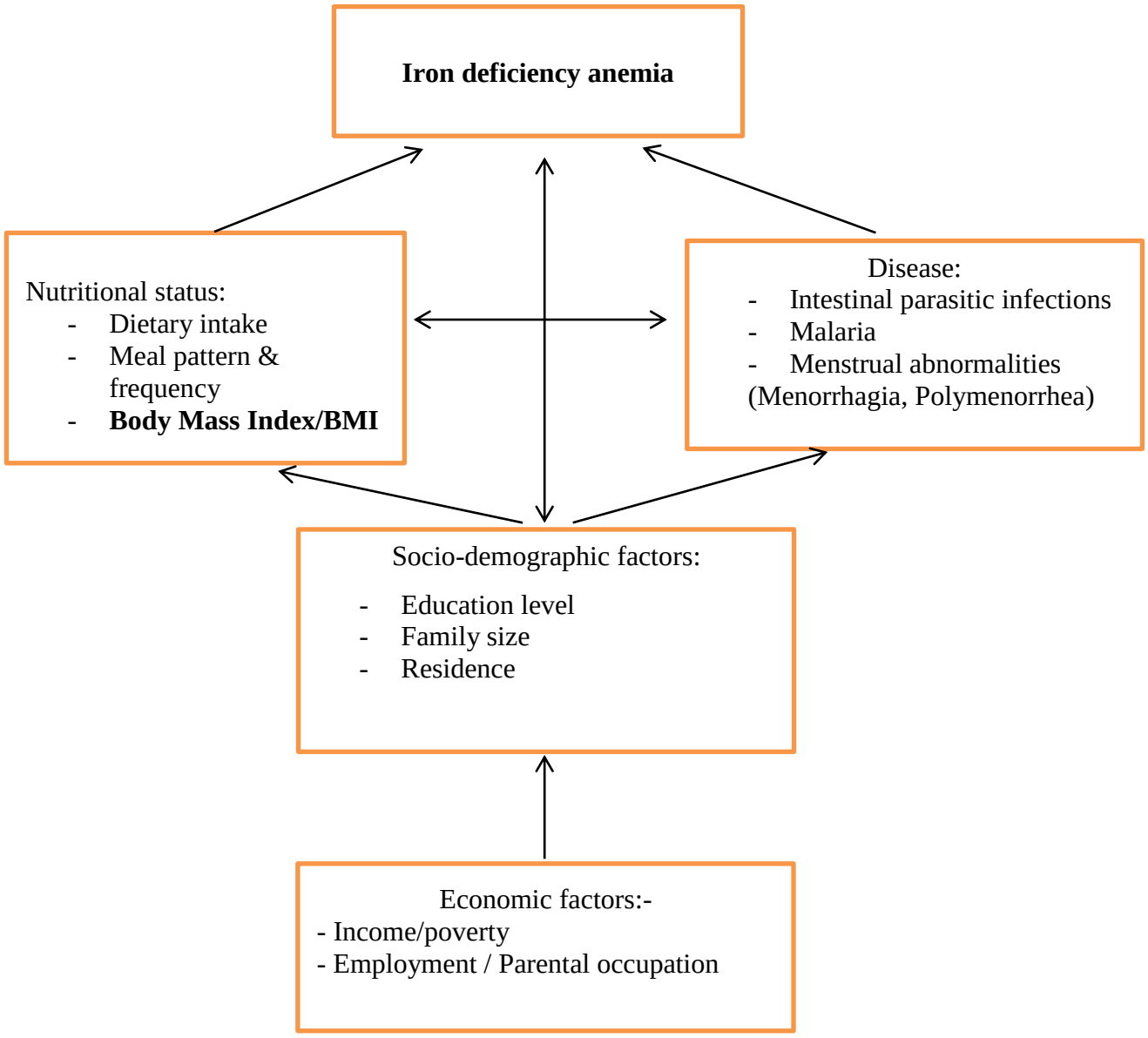

Figure 1 Conceptual frame work for predictors of IDA among adolescents adapted from different literatures (17, 18, 64).

3 Objectives

3.1 General objective

- To determine the magnitude of Iron Deficiency Anemia and examine its association with Overweight and Obesity among adolescents in Addis Ababa, Ethiopia, 2018.

3.2 Specific objectives

- ✓ To investigate the prevalence of Iron Deficiency Anemia among high school adolescents in Addis Ababa, Ethiopia, 2018.
- ✓ To examine the association between Iron Deficiency Anemia and Overweight and Obesity among high school adolescents in Addis Ababa, Ethiopia, 2018.

4 Methodology

4.1 Study Area

The study was conducted in Addis Ababa, the capital and the largest city of Ethiopia which covers an area of 527 square kilometers. It is found with an altitude of 2355 meters above sea level and is located at $9^0$1'48"N $38^{0\ 44'24"}$ with subtropical highland climate. The city has three layers of administration: city government, 10 sub cities namely: Arada, Yeka, Gulele, Addis Ketema, Akaki-kality, Nefassilk-Lafto, Lideta, Bole, Kolfe-keranio and Kirkos and 99 district administrations. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), it is home for various ethnicities with a total population of 3,384,569 with annual growth rate of 3.8%, adolescents constitute 635,903 which is 23.2% of the total population & those from 15-19 years are 385,713 that is 14.1%. All of the population is urban inhabitant (68).

According to 2016 report of Addis Ababa City Administration Education Bureau (AACAEB), there are 2798 schools in all sub cities. Out of total school 806 are primary, 93 secondary (9-10), 10 preparatory (11-12), 114 general secondary and preparatory (9-12). From those schools 287 are governmental, 736 are non-governmental (69).

4.2 Study Period

The study was conducted from March 1 to April 30, 2018 in Addis Ababa, Ethiopia.

4.3 Study Design

A school based cross sectional study was conducted among high school adolescents (Grade 9-12) in Addis Ababa, Ethiopia.

4.4 Population

4.4.1 Source population

The source population for the study included, all high school adolescent students (grade 9-12) enrolled in governmental and non-governmental high schools of Addis Ababa during the study period.

4.4.2 Study population

The study population included randomly selected high school adolescents who were enrolled in the selected governmental and non-governmental high schools of Addis Ababa during the study period.

4.4.3 Inclusion criteria

All high school adolescents who were enrolled in the selected governmental and non-governmental high schools of Addis Ababa.

4.4.4 Exclusion criteria

- Adolescents who are on treatment of anemia & who had recent blood transfusion
- Adolescents with visible physical deformity
- Pregnant and lactating adolescents

4.5 Sample size determination

The sample size is calculated for each specific objectives using Epi info version 7Stastical software

For the first objective (Prevalence of IDA)

Using the formula of sample size determination for single population proportion by Epi Info window version 7 statistical software based on the following assumptions.

The single proportion formula, $n= Z^2_{\alpha/2}\, p\,(1-p)/d^2$; Where,

Z= 1.96 at 95% confidence interval

P= prevalence of IDA among school adolescents 11% (48) .

d= margin of error (4%)

n= number of sample = 235

n_{total*}= total sample size after adding 10% non-response rate= 258.5

N= Final number of sample size after considering design effect of 1.5 = **388**

For the second objective (Effect of overweight on IDA)

Using the formula of sample size determination for double population proportion by Epi Info window version 7 statistical software

$$n= \frac{[z\,\alpha/2\,\sqrt{(1+1/r)} + z\beta\sqrt{p1\,(1-p1) + p2\,(1-p2)/r}]^2}{(p1 - p2)^2}$$

With the assumptions of:-

P1= prevalence of IDA among overweight and obese adolescents 23.68% (70).

Odds ratio/OR = 4.23

n= number of sample = 80

n_{total*}= total sample size after adding 10% non-response rate= 88

N= Final number of sample size after considering design effect of 1.5 = **132**

Therefore, the sample size calculated for the first objective using single population proportion formula yielded the largest sample size, so it was used as the final sample size of the study.

4.6 Sampling procedures

A multi-stage stratified sampling procedure was used to obtain a representative sample of study participants. Firstly secondary and preparatory schools (grade 9 – 12) was stratified by ownership as governmental and non-governmental schools, then by grade level & sections respectively.

Among the total 114 general secondary and preparatory schools in Addis Ababa, 11 are governmental and 103 are non-governmental high schools (69). A total of 10 schools, 7 non-governmental and 3 governmental high schools were selected randomly. A sample of student was distributed proportionally between governmental and non-governmental schools by considering the size of students in each school. Four sections from each selected school in which one section from each grade level (grade 9 – 12) was selected randomly. Then students were allocated proportional to the size of the total number of students in each selected sections. Finally study participants were selected randomly (Figure 2).

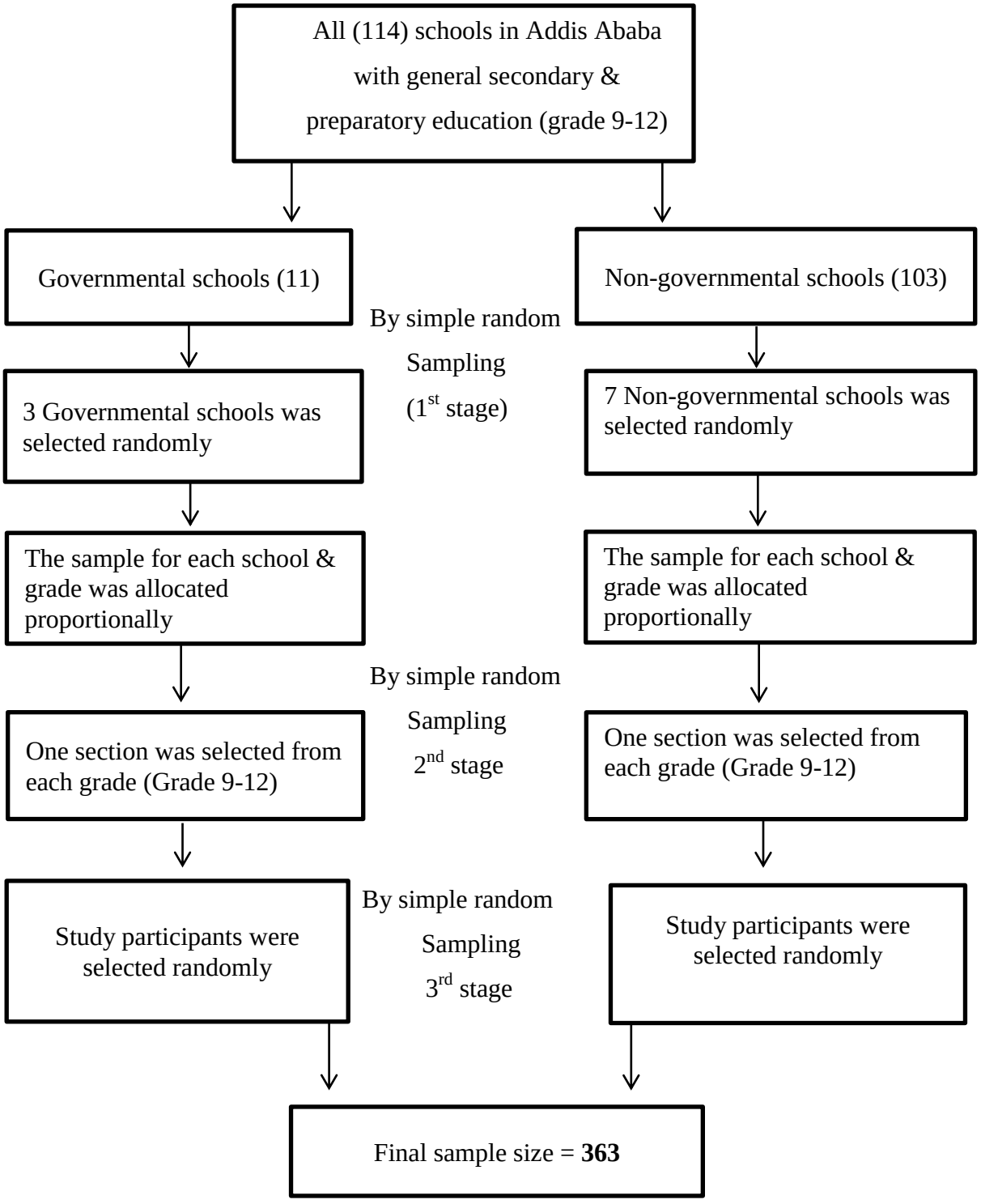

Figure 2 Schematic presentations of Sampling Technique and Procedure

4.7 Data collection tools and procedures

4.7.1 Data collection instrument

Interviewer administered structured questionnaires

Interviewer administered questionnaires were used to collect data. The questionnaire consists of information on socio-demographic and economic status adapted from EDHS (22). Qualitative information on habitual food intake and usual food consumption pattern was assessed by using Food frequency questionnaire (FFQ) which was modified from the Helen Keller International FFQ and used previously in Jimma, Ethiopia to estimate the dietary practices of adolescents (47, 71). The questionnaire was first prepared in English and translated to local language (Amharic) and back to English to keep its consistency.

Deworming (anthelmintic treatment) of adolescents: - To avoid the confounding effect of intestinal parasites on the level of Hg, a single oral dose of deworming tablet (400 mg Albendazole) was given to the study participants a month prior to blood sample collection.

Anthropometric measurements

Height: Measurements of height was carried out using a wooden height measuring board with a sliding head bar/ stadiometer. The study subjects were asked to stand straight on leveled surface with shoes off, heels together, eyes looking straight ahead (Frankfurt plane), hands freely by the side, head, shoulder blades and buttocks are against the board/wall. The moving head piece of the stadiometer was lowered to rest flat on the top of the head and reading was noted to the nearest 0.1cm.

Weight: Measurement of weight was done without shoes and with minimum clothes by using a battery powered digital scale to the nearest 0.1kg. It was calibrated against known weight regularly and error of the weighing scale was checked before taking the weight and corrected when required before each session. The same measurer took all the anthropometric measurements to avoid variability.

Measurement scales were handled carefully and were calibrated daily before data collection, the data collectors checked whether the scales are at 0.00 reading before each measurement and all measurements were recorded in the questionnaire.

BMI: Body weight in kilograms divided by height in meters squared. Underweight, normal weight, overweight & obese adolescents was classified based on BMI for age z- scores

(BAZ) as being; underweight: ≤ -1SD, normal weight: > -1SD & <+1SD, overweight: ≥+1SD & +2SD, Obesity: ≥ +2SD (72).

4.7.2 Blood sample collection and analysis

Complete blood count

Blood samples were obtained for biochemical and hematological screening tests. A trained and experienced laboratory professional performed venipuncture aseptically to obtain a maximum of four milliliter of venous blood using sterile, single-use, 5cc disposable syringe. All the necessary safety measures and standard operating procedures were followed during blood sample collection. 70% ethanol alcohol was used as disinfectant.

Two milliliter of the whole blood was kept in EDTA (Ethylene-diamine-tetra-acetic acid) containing test tube which can serve as an anticoagulant & used for complete blood count analysis within 2 hours of collection. The blood in the EDTA test tube was used to assess red blood cell count (RBC), hemoglobin (Hg), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) using manual mode sample running by Sysmex xt-1800i hematology analyzer.

Anemia is defined as Hg <12 g/dL for boys < 15 years & for girls > 12 years whereas Hg values of <13 g/dL were considered anemic for adolescent boys of age ≥ 15 years after adjusting for altitude was made according to the equation recommended by UNICEF/ UNU/WHO (64). The correction for altitude (2355m) of Hg cutoffs points was calculated to define anemia at the altitude of Addis Ababa. Hg value was also adjusted for smoking status before analysis and IDA is defined as low serum iron levels and low hemoglobin (anemia).

Serum iron & CRP

The remaining two milliliter of whole blood was kept in serum separator tube (SST) at room temperature and allowed to clot. After which it was centrifuged, the serum was separated and kept in plastic nunc tubes at -20^{o}C. Serum iron and CRP were measured by using a COBAS INTEGRA 400 plus clinical Chemistry analyzer (Roche Diagnostics GmbH, D-68305 Mannheim, Germany).

ID (with or without anemia) and iron deficiency anemia (IDA) was defined using the age and sex specific thresholds proposed by UNICEF and the WHO (64). Because serum iron

value is elevated in the presence of inflammation, its concentration was adjusted for inflammation by using C-reactive protein (CRP). It was classified as high if CRP level is >5 mg/L (73), iron deficiency was defined as serum iron concentration of < 60 μg/dl (16, 74). Finally IDA was diagnosed when there is both iron deficiency and anemia. All the laboratory tests were done in hematology and clinical chemistry laboratories of Ethiopian Public Health Institute.

4.7.3 Data collectors

Four data collectors (One laboratory professional and three health officers) and one supervisor (senior health officer) were recruited. The principal investigator also took the responsibility to control quality of data and proper taking of anthropometric measurement. A two days training was given for the supervisor and data collectors about the main purpose of the study, on weight and height measurements, data collection techniques and procedures based on the questionnaires. The training was given by the principal investigator (PI). Any doubt in the questioner was clarified and standardization of data collectors on measurement errors was done during the training. Pre-test was conducted on 5% of high school adolescents other than the sampled participants. Any error found during the process of pre-testing was corrected in the final version of the questionnaire.

4.8 Study Variable

4.8.1 Dependent Variable

- Iron deficiency Anemia/ IDA

4.8.2 Independent variable

- Age
- Sex
- Grade level
- Type of school (governmental and non-governmental)
- Family size
- Father’s and mother’s occupation
- Father’s and mother’s education
- Economic status (Family’s ownership of fixed household assets and housing condition)

- BAZ (Body Mass Index for age Z score)
- Number of meals per day
- Habit of meal skipping
- Habit of tea/coffee intake
- Food consumption frequency
- Menstrual status (Duration and length of menses)
- Smoking status

4.9 Operational definitions

- Iron Deficiency: Corrected serum iron for inflammation value of < 60 μg/dl
- Anemia: Altitude adjusted Hg <12 g/dl for adolescent girls and Hg <13 g/dl for adolescent boys
- Mild anemia: Altitude adjusted Hg level of 10 to 11.9 g/dl for adolescent girls and Hg level of 10 to 12.9 g/dl for adolescent boys
- Moderate anemia: Altitude adjusted Hg level of 7 to 9.9 g/dl
- Severe anemia: Altitude adjusted Hg level of less than 7g/dl
- IDA: Combination of iron deficiency and anemia
- Raised C-reactive protein: CRP >5mg/l
- Overweight: BMI for age Z-score ≥ +1 and < +2 SD
- Obesity: BMI for age Z-score ≥ + 2 SD
- Snack: Any food consumed in-between meals
- Dietary pattern: Habitual decision an individual makes when choosing foods to eat
- Dietary Diversity Score (DDS): The sum of food groups consumed over the reference period
- Low DDS: Consumption of ≤ 3 food groups
- Medium DDS: Consumption of 4–6 food groups
- High DDS: Consumption of > 6 food groups

4.10 Data processing and analysis

The data was coded, entered and cleaned using EpiData Version 3.1. All Stastical tests were performed using SPSS version 20 software. The WHO 2007 growth reference was used as a standard reference for classifying adolescents based on BMI for age using WHO Anthro plus software version 1.0.4. BMI for age Z-score (BAZ) ≤ -1 were classified as underweight, >-1 and < +1 as normal weight, ≥ +1 and < +2 as overweight and ≥ + 2 as obese.

Data were cleaned for outliers and corrected by transforming in to categorical variable if they were numeric or by omitting extreme values (highest and lowest value).The dataset on WHO Anthro plus software has been merged with SPSS dataset using unique variable (identification number).

Principal component analysis was used to generate wealth index from fixed assets: first all study participants were asked on the questionnaire about the family ownership of fixed assets in their house with a score of "1" given to those who own the asset and score of "0" given to those who did not own. Then, all the items asked were assessed for internal consistency. Wealth index was categorized into quintiles to give poorest, poor, medium, wealthy and wealthiest status.

Adjusted Hb concentration was calculated as Hg =−0.032× (altitude in meters ×0.0032808) +0.022× [(altitude in meters ×0.0032808)^2] to subtract the adjustment from the measured Hg concentration at the relevant altitude (2,355 meters above the sea level) to get the sea-level value (64). Furthermore adjusted serum iron concentration was calculated by using regression correction approach formula, that is (serum iron) $_{\text{adjusted}}$ = (serum iron) $_{\text{unadjusted}}$ − B_1 (CRP $_{\text{observed}}$) for those with raised level of CRP > 5mg/l. CRP regression coefficient (B_1) is calculated by running a linear regression model where the dependent variable is serum iron values and the independent variable is CRP values & then by extracting slopes from explanatory variables (73, 75). All the above adjustments were done using SPSS version 20 Stastical Software.

Descriptive statistical analysis was conducted using frequency, percentage, mean (SD), median (IQR). Summary tables, graphs and charts were also used to describe the study population by explanatory variables.

Both bivariate and multivariate logistic regression analysis were performed to determine the association between explanatory and outcome variable. First a bivariate analysis was done for each independent variable and crude odds ratio (COR) with 95% confidence intervals was obtained to identify factors associated with the outcome variable (IDA), then significant variables observed in the bivariate analysis was subsequently included in the multivariable logistic regression model. Multicollinearity of the independent variables was also checked by variable of influence factor (VIF) and no variable was found to have VIF of greater than four. Finally, adjusted odds ratio (AOR) with 95% Confidence Interval at p-value < 0.05 was considered as statistically significant.

4.11 Data quality management

Data quality was assured before, during and after data collection process.

Before data collection: Pre testing of questionnaire was undertaken to check the validity and acceptability of the questionnaires. Practical exercise on height and weight measurements, theoretical training and mock interviews on data collection techniques and procedures was practiced by the data collectors to ensure the quality of the field operation and to minimize technical and observation bias.

During data collection: Completeness & consistency of the data was checked by the supervisor together with the principal investigator. Measurement scales for height & weight was carefully handled and calibrated. All laboratory instruments were checked for their expiry date. Safety measures and standard operating procedures were followed during specimen collection and all laboratory procedures.

After data collection: The supervisor and the principal investigator together rechecked the completeness and consistency of the data before transferring it into computer software. The data was coded & entered using EpiData vesion 3.1 stastical software.

4.12 Ethical consideration

The ethical approval for this study was obtained from ethical Review Committee of Addis Ababa University, College of Health Sciences School of public health prior to initiation of the study. A formal support letter was written to AACAEB by school of public health and AACAEB communicated the selected schools via formal letter. After getting permission from the schools, both written and verbal informed consent was obtained from adolescents greater than 18 years old and from parents/guardians of those under 18 years by sending them information sheet and consent form through their corresponding study adolescent.

Then the eligible and the volunteer students were included in the study. The purpose of the study was explained to the study participants and they were informed that the instruments and procedures used in the study do not cause any harm to them and their right to withdraw the consent and stop participation at any time without any form of prejudice. Confidentiality of the information and privacy of the respondents was assured at each step of the study process.

Infection was reduced by following aseptic techniques and by wearing gloves during blood collection. After the testing is complete, the instruments were placed in puncture resistant container for further safe disposal. Participants were informed about their Hg level and those confirmed as having severe anemia was referred to the nearby health facility. The blood specimens were used only for the intended purpose, and leftover specimens was discarded according to the national guidelines.

4.13 Dissemination of results

The final report of the study will be submitted to AAU, CHS SPH. It will also be sent to Addis Ababa Health Bureau. In addition great efforts will be made to disseminate the result through presentation in different seminars, workshops, scientific conferences and probable publication in scientific journals.

5 Results

5.1 Descriptive statistics

5.1.1 Socio demographic & economic characteristics

Of the total 388 sampled high school adolescents, 363 had participated with a response rate of 93.6%. The mean age of study subjects was 16.6 (±1.32 SD) years, where 195 (53.7%) of the participants were between 17 and 19 years. Over half (52.6%) of the respondent were from governmental schools and 200 (55.1%) of them were females. Three fourth (74.4%) of the respondents were Orthodox Christian, followed by Protestant 42 (11.6%) and Muslim 35 (9.6%). Two thirds (66.4%) of the respondents had less than five family members and the average household family size of the respondent's was 5.2 (±1.8 SD).

Among fathers of adolescents 126 (34.7%) were college graduates and above, 136 (37.5%) had secondary education while slightly over a quarter (26.7%) of the mothers were college graduates. 228 (62.8%) fathers were government or private employees followed by 71(19.6%) merchants, whereas 145 (39.9%) respondent's mothers were housewife and 142 (39.1%) were government or private employees (Table 1).

Table 1 Socio-demographic & economic characteristics of governmental and non-governmental high school adolescents in Addis Ababa, Ethiopia, 2018

Variables	Frequency	Percent (%)
Sex		
Male	163	44.9
Female	200	55.1
Age (year)		
Middle adolescent (14-16)	168	46.3
Late adolescent (17-19)	195	53.7
Religion		
Orthodox	270	74.4
Catholic	7	1.9
Protestant	42	11.6
Muslim	35	9.6
Other	9	2.5
School type		
Governmental	191	52.6
Non-governmental	172	47.4

Grade level		
9th grade	93	25.6
10th grade	89	24.5
11th grade	95	26.2
12th grade	86	23.7
Family size		
1-5	241	66.4
> 5	122	33.6
Father educational status		
No formal education	27	7.4
Primary school	31	8.5
Secondary school	136	37.5
Technical school & above	126	34.7
Other	43	11.8
Mother educational status		
No formal education	46	12.7
Primary school	65	17.9
Secondary school	129	35.5
Technical school &	97	26.7
above Other	26	7.2
Wealth quintile		
Poorest	76	21.0
Poor	75	20.7
Medium	80	22.1
Rich	70	19.3
Richest	61	16.9

5.1.2 Magnitude and severity of anemia, iron deficiency and IDA

Altitude adjusted hemoglobin was used to determine the prevalence of anemia and its value ranged from 9.0 to 17.6 g/dl with mean Hg concentration of 14.5 g/dl (±1.3 SD) for males and for female in ranges from 6.7 to 16.8 g/dl with mean Hg concentration of 13.2 g/dl (±1.2 SD). The overall prevalence of anemia, ID and IDA was found to be 12.9% (95%CI = 9.6%-16.5%), 16.3% (95%CI = 12.4%-20.1%) and 7.4% (95%CI = 4.7%-9.9%) respectively. Out of the 47 anemic adolescents 37 (78.7%), 9 (19.1%) and 1 (2.1%) had mild, moderate & severe anemia respectively. The magnitude of anemia was 35 (17.5%) in female and 12 (7.4%) in male adolescents (Figure 3).

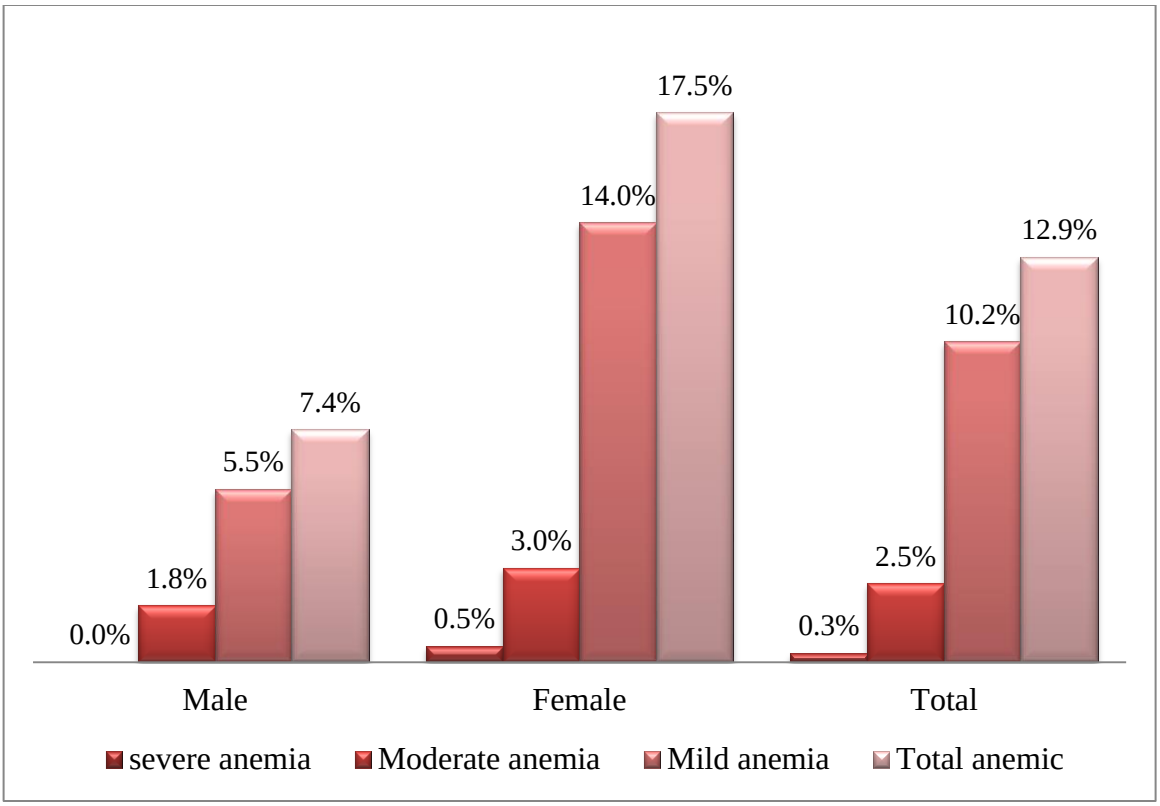

Figure 3 Prevalence and severity of anemia among male and female high school adolescents in Addis Ababa, Ethiopia 2018

Among the 363 participants, 304 (83.7%) had a normal iron status (Adjusted serum iron $\geq$ 60 µg/dl), 32 (8.9%) had ID without anemia & 27 (7.4%) had suffered from IDA (Hg > 13 g/dl for males & Hg > 12 g/dl for females). The value of adjusted serum iron for CRP ranged from 18.9 to 323.4 µg/dL, with mean serum iron concentration of 103.1 µg/dl ($\pm$ 41.3 SD). Out of 59 ID subjects, 18 were boys (30.5%) and 41 were girls (69.5%). The prevalence of IDA was 6 (3.7%) in male and 21 (10.5%) in female adolescents (Figure 4).

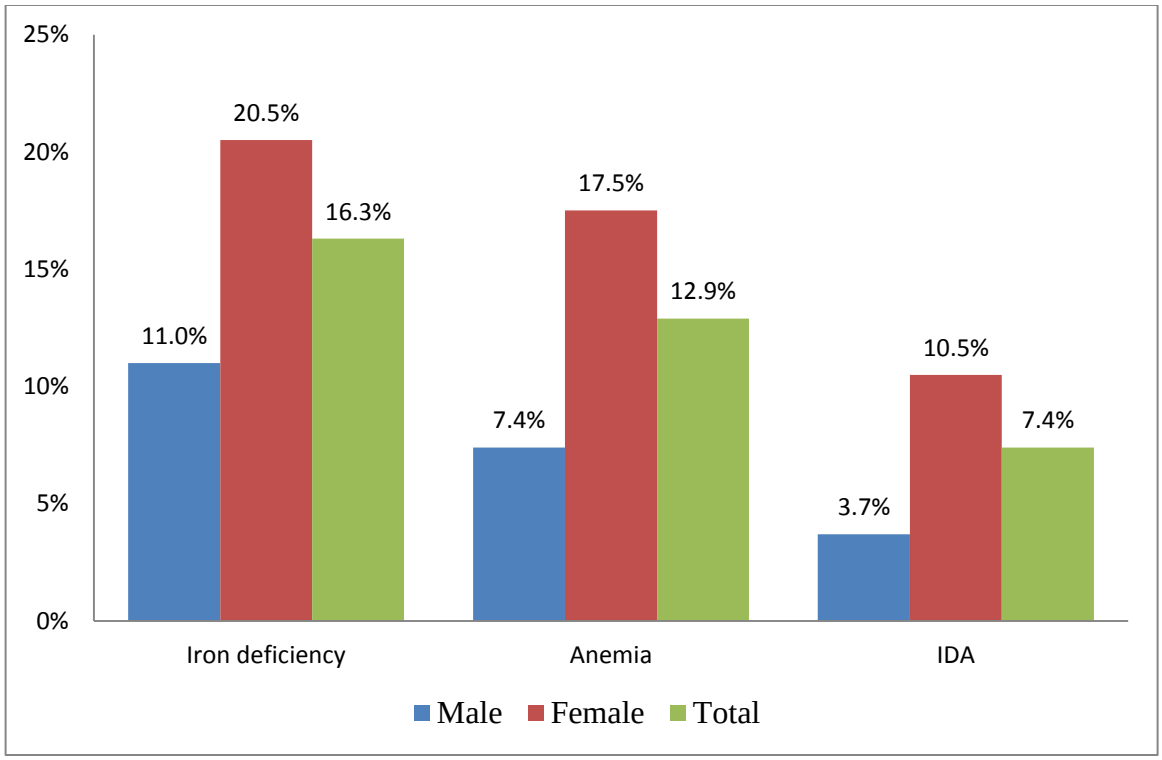

Figure 4 Percentage of iron deficiency, anemia and iron deficiency anemia among male and female high school adolescents in Addis Ababa, Ethiopia, 2018

From the total of 47 anemic adolescents, more than 57% of them had serum iron concentration (< 60 µg/dl) (Figure 5).

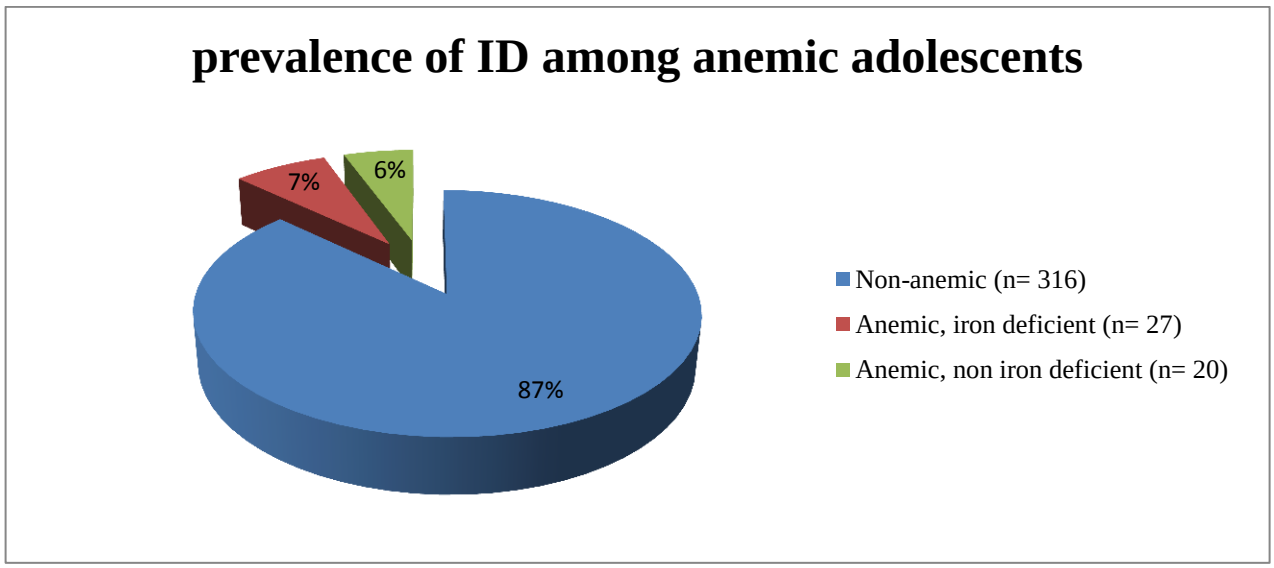

Figure 5 Prevalence of iron deficiency among anemic high school adolescents in Addis Ababa, Ethiopia, 2018

5.1.3 Inflammation status among high school adolescents

Inflammatory condition of the adolescents was assessed by using C-reactive protein level. Raised CRP (> 5mg/l) indicates those who are infected but not yet showing clinical evidence of a disease. The value of CRP among the study participants ranged from < 0.00 mg/l to 102.13 mg/l with mean CRP concentration of 1.86 mg/l (± 6.49 SD). The overall magnitude of inflammation was 34 (9.4%), in which females and adolescents of age 17-19 years accounted 23 (67.6%) and 18 (52.9%) of it respectively. Overweight and obesity also accounted for 15 (44.1%) of the inflammation (Table 2).

Table 2 Prevalence of inflammation as measured by CRP > 5mg/l stratified by sex, age and BMI of high school adolescents in Addis Ababa, Ethiopia, 2018

Variable	Frequency	Percentage (%)
Sex		
Male	11	32.4
Female	23	67.6
Age (years)		
Middle adolescent (14-16)	16	47.1
Late adolescent (17-19)	18	52.9
BAZ		
Underweight (< -1 SD)	6	17.6
Normal (>-1 & < 1 SD)	13	38.2
Overweight (> 1 & < 2 SD)	9	26.5
Obese (> 2 SD)	6	17.6

5.1.4 Anthropometric measurements among respondents

The WHO 2007 growth reference was used as a standard reference for classifying adolescents based on BMI for age Z score. Of the 363 subjects assessed, 40 subjects were overweight, 12 were obese and 96 were underweight, giving overweight, obesity and underweight prevalence rates of 11.0% (95%CI = 7.4%-14.0%), 3.3% (95%CI = 1.7%-5.2%) and 26.4% (95%CI = 22.8%-30.6%) respectively. The combined prevalence of overweight and obesity was 14.3% (95%CI = 10.7%-17.6%) (Figure 6).

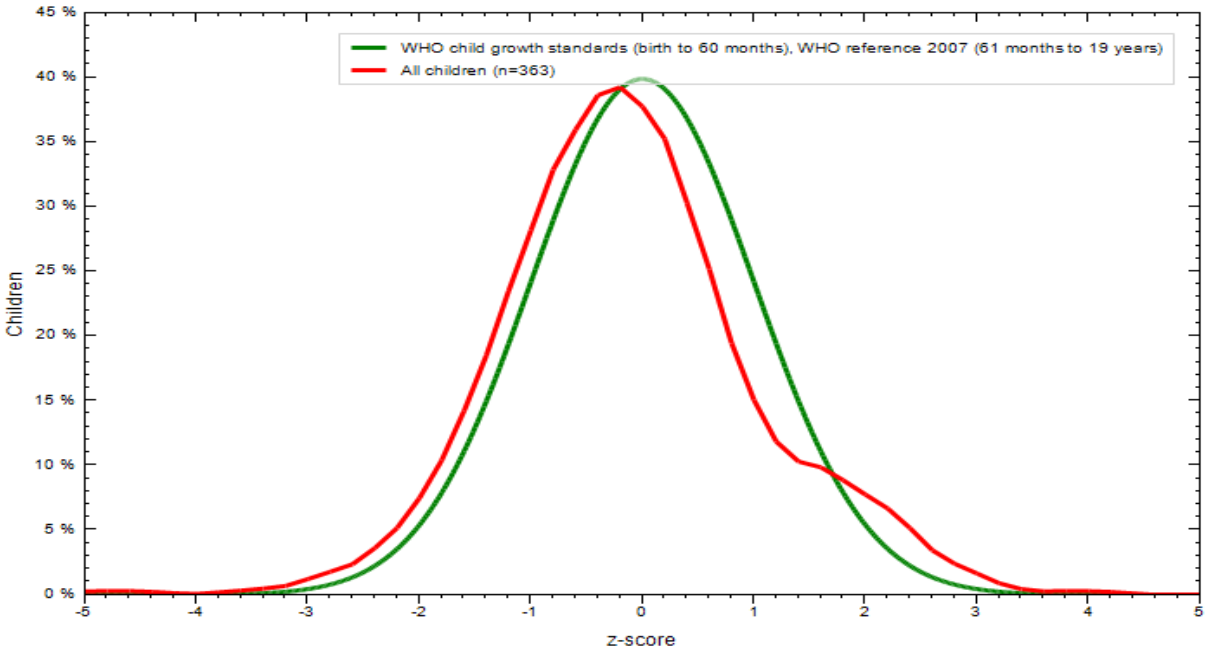

Figure 6 Comparison of BMI for age Z-score (BAZ) of high school adolescents in Addis Ababa with the 2007 WHO growth reference population (n=363)

Overweight/obesity prevalence was the highest among 34 (17.0%) female adolescents than 18 (11.0%) male adolescents (Figure 7).

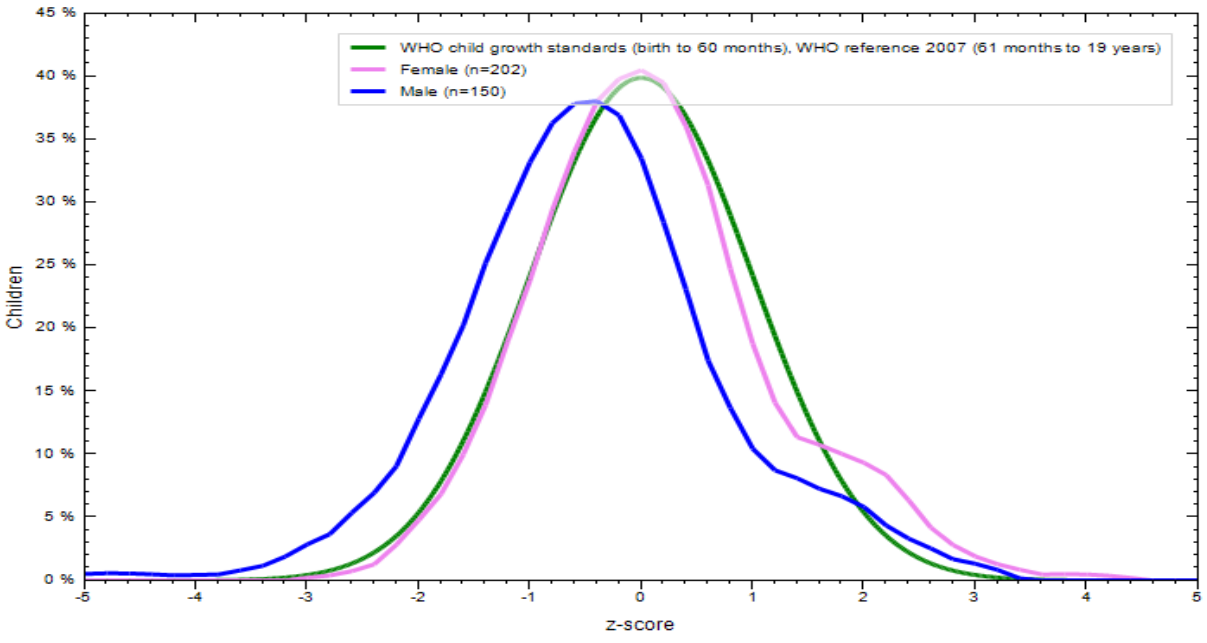

Figure 7 Comparison of BMI for age Z-score (BAZ) of high school adolescents in Addis Ababa classified by sex with the 2007 WHO growth reference population (n=363)

5.1.5 Prevalence of Anemia, ID & IDA among student across BMI categories

The participants were categorized by BAZ into underweight (96: 26.4%), normal (215: 59.2%), overweight (40: 11.0%) and obese (12: 3.3%). The magnitude of IDA in every BMI section is as follows: underweight 11 (11.5%), normal weight 8 (3.7%), overweight 5 (12.5%) and obese 3 (25.0%). The overall prevalence of IDA among overweight and obese adolescents was 15.4% (Figure 8).

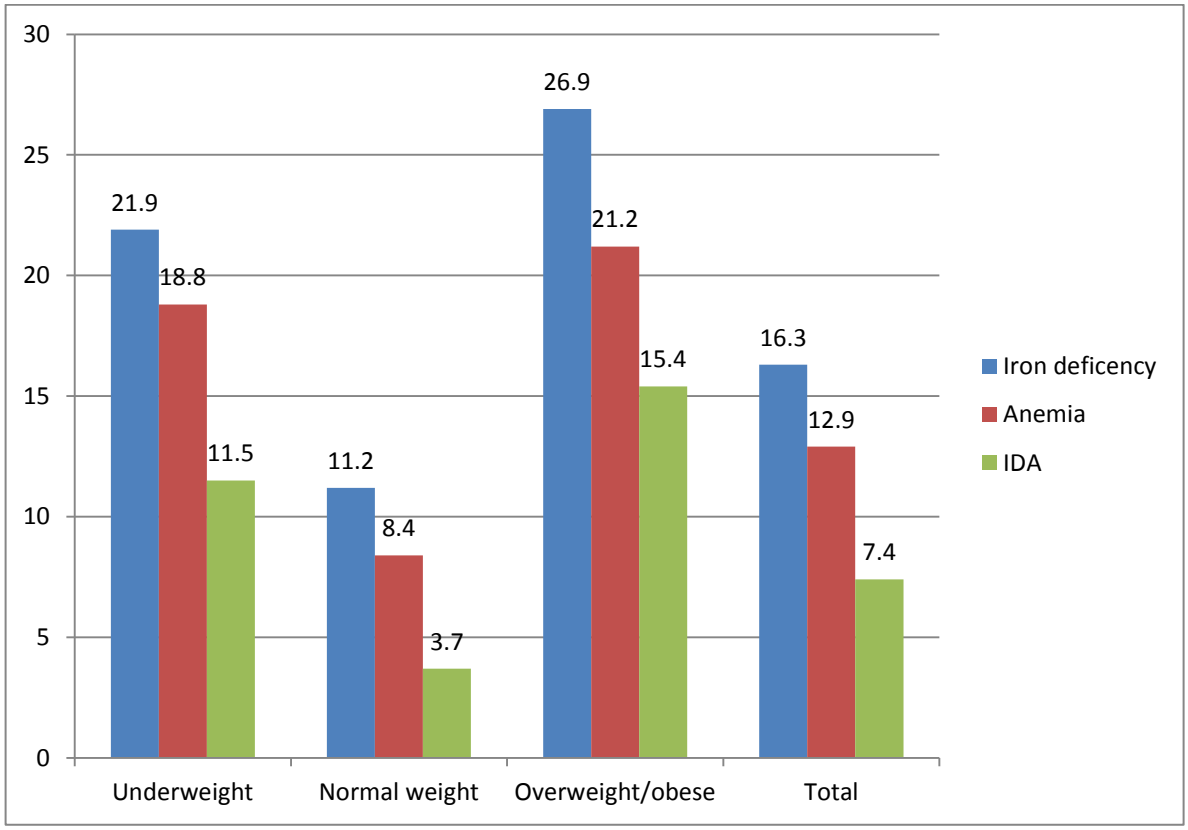

Figure 8 Prevalence of Anemia, ID & IDA among high school adolescents in Addis Ababa across different BMI categories

5.1.6 Food consumption frequency & dietary habit of adolescents

Dietetic history was obtained by using the food frequency questionnaire (FFQ), which is used to obtain qualitative information about the usual food consumption pattern. Almost all (97.8%) of the adolescents consumed cereal based food sources at least once in a day. However; a substantial proportion of adolescents did not take 267 (73.6%) dairy products and 160 (44.1%) animal source foods (meat, egg and fish) at all in the week. One third (33.1%) and 263 (72.5%) of the study participants took fruits and vegetables once or more per day respectively (Table 3).

Table 3 Dietary habit of high school adolescents according to Food Frequency Questionnaire (FFQ) in Addis Ababa, Ethiopia 2018

Variables	Frequency	Percent (%)
Cereals & grains		
Once/more per day	355	97.8
3-6 times per week	8	2.2
Legumes and nuts		
Once/more per day	184	50.7
3-6 times per week	142	39.1
1-2 times per week	34	9.4
Twice or less per month	3	0.8
Vegetables		
Once/more per day	263	72.5
3-6 times per week	58	16.0
1-2 times per week	35	9.6
Twice or less per month	7	1.9
Fruits		
Once/more per day	120	33.1
3-6 times per week	98	27.0
1-2 times per week	104	28.7
Twice or less per month	41	11.3
Dairy products		
Once/more per day	43	11.8
3-6 times per week	32	8.8
1-2 times per week	21	5.8
Twice or less per month	267	73.6
Meat, egg & Fish		
Once/more per day	44	12.1
3-6 times per week	64	17.6
1-2 times per week	95	26.2
Twice or less per month	160	44.1

Dietary pattern and intake of tea/coffee with food

Pattern of meal consumption per day indicated that 180 (49.6%) of the respondents were consuming three meals per day. Over half (55.6%) of them had a habit of skipping meal and breakfast 192 (52.9%) was the commonly skipped meal, followed by dinner 115 (32.5%). The reasons for skipping meal were fasting 85 (42.1%), no appetite 71 (35.1%) and no time 52 (25.7%). More than half (55.9%) of the participants took tea or coffee immediately (within one hour) after meal (Table 4).

Table 4 Dietary pattern and eating habit of high school adolescents in Addis Ababa, Ethiopia, 2018

Variables	Frequency	Percent (%)
Regular meal intake		
Yes	161	44.4
No	202	55.6
Breakfast		
Daily	171	47.1
Not daily	192	52.9
Lunch		
Daily	280	77.1
Not daily	83	22.9
Dinner		
Daily	245	67.5
Not daily	118	32.5
Snack		
Daily	199	54.8
Not daily	164	45.2
Intake of tea/coffee immediately after meal		
Yes	203	55.9
No	157	43.3

5.1.7 Dietary Diversity Score (DDS)

The dietary diversity score (DDS) was calculated by counting the intake of different food groups over a period of a day. Out of the different food groups cereals, vegetables, legumes, tubers and fruits were daily consumed by 355 (97.8%), 263 (72.5%), 184 (50.7%), 141 (38.8%) and 120 (33.1%) of adolescents respectively. The consumption of meat, which is good sources of bio- available iron, was 8%. Mean DDS was found to be 3.3 ($\pm$1.34 SD).

Over half (57.0%), 136 (37.5%) and 20 (5.5%) of the adolescents had low, medium and high dietary diversity score respectively (Figure 9).

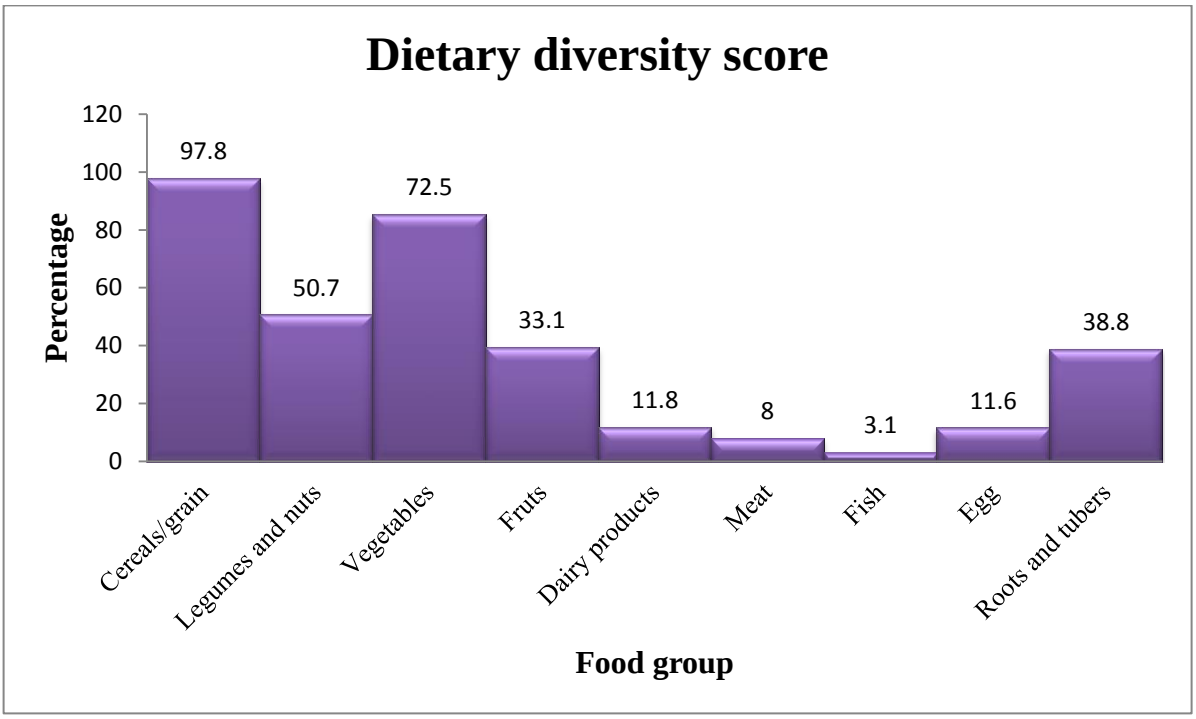

Figure 9 Food groups consumed daily by high school adolescents (n=363) in Addis Ababa, Ethiopia, 2018

5.1.8 Knowledge about Anemia

Of the total 363 adolescents, 333 (91.7%) have heard about the term anemia. However 42 (11.6%), 191 (57.4%) and 158 (47.4%) of them don't know about the sign & symptoms, causes and preventive mechanisms of anemia respectively.

Among the signs and symptoms of anemia headache, vertigo, weakness and blurring of vision was known by 76.9%, 24.2% and 9.4% of the respondents respectively. From the causes of anemia 18.5%, 15.2% and 13.2% of them answered deficiency of iron rich foods, loss of excess blood and deficiency of vitamins respectively. Fruits, green vegetables and animal source foods accounted for 24.5%, 20.1% & 16% of the answers from the prevention of anemia (Table 5).

Table 5 Knowledge about Anemia among high school adolescents (363) in Addis Ababa, Ethiopia 2018

Variables	Frequency	Percent (%)
Heard about anemia		
Yes	333	91.7
Never heard	30	8.3
Knows about signs & symptoms		
Yes	291	87.4
Don't know	42	11.6
Knows about cause of anemia		
Yes	142	42.6
Don't know	191	57.4
Know about anemia prevention		
Yes	175	52.6
Don't know	158	47.4

5.1.9 Menstrual and smoking status of high school adolescents

Almost all (98%) of the female high school adolescents experienced menarche and among them 103 (52.6%) started their menses before the age of thirteen. The mean age of menarche was 13.3 (±1.33 SD). Over half (55.6%) of females have less than five days duration of menstrual bleeding. Seven (1.9%) of male high school adolescents were smokers and they smoke less than 3 pieces of cigarette per day (Table 6).

Table 6 Menstrual and smoking status of high school adolescents N= (363) in Addis Ababa, Ethiopia 2018

Variables	Frequency	Percent (%)
Status of menarche		
Attained	196	98.0
Not attained	4	2.0
Age of onset of menses		
$\leq$ 13 years	103	52.6
> 13 years	93	47.4
Duration of bleeding (days)		
< 5 days	109	55.6
$\geq$ 5 days	87	44.4
Sanitary pads used per day		
< 3 pads	99	50.5
$\geq$ 3 pads	97	49.5

5.2 Bivariate and multivariate logistic regression analysis

Sub-analysis was performed in the bivariate and multivariate regression model by excluding those underweight adolescents from the analysis so as to examine the association between overweight and/or obesity and IDA when compared with normal weight individuals.

After controlling the effect of other predictor variables in the final model of the multivariate regression, overweight and/or obesity, consumption of meat, egg & fish ≥ once per day, daily snack consumption and duration of menses ≥ 5 days per month were the variables that were significantly associated with iron deficiency anemia with p-value <0.05, (Table 7).

In this study, the odds of being iron deficiency anemic was 4.2 times higher among overweight and/or obese adolescents than in normal weight adolescents, (AOR = 4.2; 95% CI =1.21-17.29).

In addition, Meat, egg & fish consumption of at least once per day was found to have 0.13 times decreased odds of being iron deficiency anemic than those who consumed twice or less per month. (AOR = 0.13; 95% CI = 0.02- 0.88).

Moreover, the odds of being iron deficiency anemic was 4.7 times higher among adolescents who have a daily snack consumption pattern than those who don't consume snacks daily, (AOR = 4.7; 95% CI= 1.10-21.7).

Furthermore, female adolescents with a menstrual bleeding of ≥ 5 days had 4.4 times higher odds of being iron deficiency anemic than those with a menstrual bleeding of less than five days, (AOR = 4.4; 95% CI=1.13-21.2).

Table 7 Bivariate and multivariate analysis showing association between overweight and/or obesity and IDA among high school adolescents in Addis Ababa, Ethiopia, 2018

Variable		Iron deficiency anemia		COR(95%CI)	AOR(95%CI)	P-value
		Yes (N, %)	No (N, %)			
Sex						
	Male	2 (1.9%)	105 (98.1%)	1.0	1.0	
	Female	14 (8.8%)	146 (91.2%)	5.03 (1.12-22.62)*	0.68 (0.005-95.9)	0.88
Age						
	14-16 years	7 (6.1%)	107 (93.9%)	1.0	1.0	
	17-19 years	9 (5.9%)	144 (94.1%)	0.96 (0.35-2.65)	0.69 (0.19-2.52)	0.57
Family size						
	1-5	6 (3.3%)	174 (96.7%)	1.0	1.0	
	> 5	10 (11.5%)	77 (88.5%)	2.85 (1.02-7.93)*	2.4 (0.62-8.93)	0.21
BAZ						
	Normal	8 (3.7%)	207 (96.3%)	1.0	1.0	
	Overweight & obese	8 (15.4%)	44 (84.6%)	4.7 (1.7-13.2)*	**4.2 (1.21-17.29)***	**0.034**
Meat, egg & Fish						
	≥ once/day	1 (1.5%)	65 (98.5%)	0.11 (0.01-0.88)*	**0.13 (0.02-0.88)***	**0.037**
	3-6 times/week	2 (4.2%)	46 (95.8%)	0.31 (0.07-1.47)	0.46 (0.06-3.45)	0.12
	1-2 times/week	3 (4.2%)	69 (95.8%)	0.31 (0.08-1.17)	0.14 (0.01-1.69)	0.45
	≤ twice/ month	10 (12.3%)	71 (87.7%)	1.0	1.0	
Fried foods						
	≥ once/day	10 (8.8%)	103 (91.2%)	1.0	1.0	
	3-6 times/week	1 (2.0%)	49 (98.0%)	0.21 (0.03-1.69)	0.23 (0.02-2.51)	0.23
	1-2 times/week	2 (4.7%)	41 (95.3%)	0.50 (0.11-2.39)	0.49 (0.05-4.81)	0.55
	≤ twice/ month	3 (4.9%)	58 (95.1%)	0.53 (0.14-2.01)	1.21 (0.18-7.95)	0.84
Habit of meal skipping						
	Yes	13 (9.0%)	131 (91.0%)	3.96 (1.1-14.3)*	4.96 (0.99-24.9)	0.052
	No	3 (2.4%)	120 (97.6%)	1.0	1.0	
Dinner consumption pattern						
	Daily	8 (4.7%)	163 (95.3%)	1.0	1.0	
	Not daily	8 (8.3%)	88 (91.7%)	1.85 (0.67-5.10)	2.05 (0.49-8.64)	0.33

Snack consumption pattern					
Daily	13 (9.2%)	129 (90.8%)	4.1 (1.14-14.73)*	**4.66 (1.10-21.7)***	**0.042**
Not daily	3 (2.4%)	122 (97.6%)	1.0	1.0	
Taking tea/coffee within one hour of meal					
Yes	12 (9.0%)	121 (91.0%)	3.22 (1.01-10.3)*	3.60 (0.88-14.7)	0.07
No	4 (3.0%)	130 (97.0%)	1.0	1.0	
Age of onset of menses					
$\leq$ 13 years	8 (10.8%)	66 (89.2%)	1.0	1.0	
> 13 years	6 (7.2%)	77 (92.8%)	0.64 (0.21-1.95)	0.52 (0.12-2.25)	0.38
Duration of menstrual bleeding					
< 5 days	4 (4.3%)	90 (95.7%)	1.0	1.0	
$\geq$ 5 days	10 (15.9%)	53 (84.1%)	4.25 (1.27-14.2)*	**4.44 (1.13-21.2)***	**0.044**

*** = statistically significant**

6 Discussion

The main purpose of the study was to investigate the magnitude of IDA and to evaluate its association with overweight and/or obesity among high school adolescents in Addis Ababa. Findings of this study showed that, one from eight adolescent was anemic and one from six was iron deficient, which indicated that both anemia and ID are a public health significant diseases among adolescents, in school communities of Addis Ababa based on the WHO (> 5%) standards (64). The study also found a positive association between being overweight or obese and iron deficiency anemia.

In the present study the prevalence of anemia, ID and IDA among high school adolescents was found to be 12.9%, 16.3% and 7.4% respectively. This is much lower than a nationwide study done in Ethiopia among reproductive age women that showed the prevalence rate of anemia, ID and IDA to be 30.4%, 49.7% and 17.0% based on Hg and serum ferritin concentration (46). This variation could be attributed to the difference in study setting, study population and in the diagnostic approach used for assessment of IDA. On the other hand, the study found a higher prevalence of anemia among adolescent girls (16.5%) than boys (8.3%) but this difference was not statically significant. In addition EDHS report of 2016 found magnitude of anemia in Addis Ababa to be 15.9% among women and 6.9% for men (21). This variation might be due to the difference in the age group that EDHS estimates women aged 15-49 and men with age of 15-59 years, but this study examines adolescents of age 14-19 years, which is the highest period of iron requirement due to growth & development and the difference in sample size could also be another reason.

The magnitude of iron deficiency was found to be 16.3% in this study whereas the Ethiopian National Micronutrient survey reports of 2016 showed that prevalence of iron deficiency among non-pregnant women of reproductive age in Addis Ababa was 25% using sTfR & 9.1% using ferritin for the diagnosis of ID (25). And the variation for this could be due to the use of serum iron levels for diagnosing iron deficiency and the difference in the study population that both female and male school adolescents in the age group of 14-19 years were included in the present study. In contrast the magnitude of IDA (7.4%) was much lower than a study conducted among adolescent girls aged 14-20 years in Iran that found a prevalence of 21.4%, 23.7% and 12.2% for anemia, ID and IDA respectively (44). While the

study in Jimma found 37.5% prevalence of IDA (47). The possible explanation for this large variation might be due to high burden of intestinal parasitic infection in these areas (33.9%), which can result in gastro-intestinal blood loss, red cell destruction & contribute significantly to the occurrence of IDA. In addition this study was school based and was carried out in an urban population, which might decrease the prevalence in this study.

Outcomes of this research showed that, the prevalence of overweight among adolescents was 11.0% and that of obesity was 3.3% based on BMI for age Z score classification. This finding was nearly similar with the result of a systematic review conducted among Sub-Saharan African countries which found 10.6% and 2.5% prevalence of overweight and obesity among school-aged children and adolescents (36). However it was lower than that of developed country such as USA (31). This variation could be due to the difference in dietary intake and socio-economic differences between the developing and the developed world.

Overweight/obesity is a risk factor for many diseases such as hypertension, type 2 diabetes, stroke and cardiovascular disease but they are also exposed to micronutrient deficiencies including IDA (11). The results of this study also showed that, the rate of IDA among overweight & obese adolescents is 4.2 times higher than that of adolescents with normal weight. Almost one of every seven overweight/obese adolescents had IDA which is similar with previous studies that mentioned a positive association between obesity & IDA (15, 26, 49, 50, 76). However this finding is in contrast with other studies (16, 51, 52) . The possible reason for this discrepancy might be due to the use of serum ferritin as one of the diagnostic criteria for ID in those studies, because ferritin is an acute-phase protein whose serum levels are plausibly elevated in states of inflamation, independently of body iron stores thus underestimating the true magnitude of ID. Lack of data on inflammatory marker (CRP) and the difference in the study population could also provide an explanation for this variation.

On the other hand, studies indicated that the relationship between overweight/obesity and iron deficiency can be attributed to an increase in the concentration of hepcidin, a 25 amino-acid peptide hormone produced in the liver and adipose tissue. Increased levels of serum hepcidin leads to decreased dietary iron absorption from the duodenum and increased sequestration of iron in the reticuloendothelial system consequently resulting in hypoferemia

and diminished availability of iron for erythropoiesis (14, 15, 26). Although hepcidin concentration was not measured in the present study, measurement of CRP clearly indicated that magnitude of inflammation increased with increasing BMI.

The magnitude of inflammation among overweight and obese adolescents was found to be 44.1% in the current study. This supports the view that overweight and obesity in adolescents is an inflammatory state that increases acute-phase inflammatory proteins such as CRP. This is in line with other studies in which higher BMI was associated with higher levels of CRP (51, 77, 78). Adipose tissue is characterized by production of pro-inflammatory cytokines such as interleukin-1 (IL-1), IL-6 and tumor-necrosis-factor-α (TNF-α) sustaining a chronic low-grade systemic inflammatory state.

The study also found that adolescents who consume snacks daily were found to have higher risk of being iron deficiency anemic. This could be due to the fact that during snack time most adolescents prefer to eat fast foods and soft drinks which are rich in calorie but poor in their nutrient content (17, 36, 47). These habits can result in iron deficiency and increase the risk of being overweight or obese as well. In addition, adolescents also have a habit of skipping meals and changing the main meals for snacks which can result in inadequate intake of micronutrients including iron.

The association between frequent consumption of meat, egg & fish with decreased odds of IDA in this study could be explained by high content of heme-iron in animal food products. This is similar with other studies (43, 45, 47, 55, 56). Our body mainly depends on diet as a source of iron. Heme-iron is more bioavailable and has a high affinity to bind with hemoglobin thus enhancing the oxygen carrying capacity of red blood cells.

7 Strength and limitation of the study

7.1 Strength of the study

As a major strength, this research study tried to address the double burden of malnutrition by examining the two extremes of over and under nutrition. In addition to that, as of the author's knowledge this is the first study to examine the association of overweight and obesity with IDA in Ethiopian context, so it can inspire other researchers on this particular area and it can also serves as a base line for further studies. Anthropometrical, bio-chemical and dietary data were collected to assess iron status in relation to body weight. Finally the study tries to give comprehensive information by including both male and female adolescents from governmental & non-governmental high schools.

7.2 Limitation of the study

This study is not without limitations; the first limitation of the study is that the level of serum ferritin which is the most appropriate test for the diagnosis of IDA was not measured, because of stock out (unavailability) of ferritin test at the time of the survey. Moreover, the use of serum iron for the diagnosis of IDA is also another limitation of the study because its result is influenced by day to day variation and by recent dietary intake. Additionally dietary intake was assessed by using food frequency questionnaire which is less sensitive to measures absolute intake of specific nutrients and it mostly relies on respondent's memory so it is prone to recall & social desirability bias.

8 Conclusion and recommendation

8.1 Conclusion

The findings of this study indicated IDA to be a mild public health problem among high school adolescents in Addis Ababa. The study also got significant association between IDA and overweight and obesity.

8.2 Recommendation

For Ministry of Health

- Intersectoral collaboration among health, nutritional and educational sectors need to be enhanced to decrease the double burden of malnutrition by combating both excess body weight and poor iron status.
- It is crucial to consider overweight and obese adolescents for iron deficiency prevention programs.

For schools

- Awareness creation programs need to be enhanced to increase the knowledge of adolescents about anemia.

For researchers

- Additional studies containing ferritin, sTfR and AGP tests are also recommended.
- Further research with advanced dietary assessment method (repeated 24 hour recall) is recommended so as to assess adequacy of iron.
- Longitudinal (cohort/experimental) studies will better show the direction and causality of association between overweight and/or obesity and IDA.

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10 Annexes

Annex 1: Participant information sheet (English version)

Good morning/ afternoon.

My name is _____ and I am here on behalf of Sara Gosaye, student of Addis Ababa University School of public health. She is conducting a research on "Assessment of iron deficiency anemia and its relation with overweight and obesity among adolescents in Addis Ababa, Ethiopia 2018". She received permission from Addis Ababa University, Addis Ababa city administration educational bureau and the respective sub city education offices to conduct this study.

You are selected to participate in this study because you are currently attending in one of the selected schools for the study purpose. Your participation is purely based on your willingness & you have the right to choose not to take part in this study. If you choose to take part, you also have the right to stop at any time. If you are willing to participate or refuse or decide to withdraw later, you will not be subjected to any harm.

If you agree to participate in the study, you will be interviewed about your background information, habitual dietary intake and your knowledge about anemia. Your weight and height will also be measured using standard measuring instruments. Only light closes will be wearing during weight measurement and height will be measured with bare foot. Blood sample will also be collected by experienced laboratory professional for hematological examination of iron deficiency anemia three weeks after deworming medication (Albendazole) is given for you. The measurement and interview will take about 30 minutes.

The study will provide evidence on the double burden of malnutrition with in an individual by determining the magnitude of overweight, obesity and iron deficiency anemia. It will also create opportunity for intersectoral collaboration among health, nutritional and educational sectors to improve adolescent health by combating both excess body weight and poor iron status. It could also enable the government and health organizations to design appropriate intervention strategies and tackle opposite ends of the malnutrition spectrum.

The information that you provide will be kept confidential by using code numbers and locking the data. Your name will not be written on the questionnaire. No one will have

access to the non-coded data except the principal investigator and the data will not be used for purposes other than the study. Your willingness and active participation is very important for the success of this study.

INFORMED CONSENT AND/OR ASCENT FORM

Based on the understanding of the above information, are you willing to participate in this study?

A) Yes

B) No

If yes, I will continue and

If no I will skip to next participant after writing the reasons of refusal ———————————

Respondent (For both under and above 18 years old)

Signature _____Date_____

Respondents Parent (for those under 18 years old)

Signature _____Date_____

Name of the person obtaining parental permission ———————————————————

Interviewer

Name_____ Signature_____

Questionnaires ID number_____

Date of interview_____ Starting time_____ Completed_____

Result of interview

A) Completed

B) Not completed

C) Partially completed

D) Refused

Checked by Supervisor: Name _____Signature_____

For further explanation use the Principal Investigator's Address;

Name: Sara Gosaye Woldegiorgis

Email: sarinago7@gmail.com

Cell phone: +251 912874826

Annex III: Survey Questionnaire (English Version)

Name of the school _____

Student's code / Identification number _____

Date of data collection ____/ _____/ _____

Part1. Background information

Instruction: Ask the following questions carefully and circle the response

No.	Questions	Responses	Skip
101	How old are you?	____, _____, _____ (Day, Month, year)	
102	Sex of respondent	Male……. 1 Female……..2	
103	Which grade are you now?	_____	
104	School ownership	Governmental…… 1 Non-governmental……. 2	
105	What is your religion?	Orthodox ……..… 1 Catholic……..… 2 Protestant …….……. 3 Muslim ……..…. 4 Other (Specify) _____ 5	
106	What is the size of your family? (**total number of individuals living in the house including you**)	_____	
107	What is your father's occupation?	Government/private employee…….. 1 Merchant…… 2 Daily laborer…….. 3 Unemployed……. 4 Other (specify)_____ 5	
108	What is your mother's occupation?	Government/private employee…….. 1 Merchant…… 2 Daily laborer…….. 3 Housewife/unemployed……. 4	

		Other (specify)_____ 5	
109	What is your father's educational Status?	Illiterate (can't read and write)…… 1 Read and write only……. 2 Primary school (grade 1-8)…….. 3 Secondary school (grade 9-12)…… 4 Some college or technical school…. 5 College graduate or above…… 6 I don't know……. 7 Father is not alive……. 8	
110	What is your mother's educational status?	Illiterate (can't read and write)…….. 1 Read and write only….,……. 2 Primary school (grade 1-8)……..… 3 Secondary school (grade 9-12)…..… 4 Some college or technical school..…. 5 College graduate or above…...…..…. 6 I don't know…….…….…… 7 Mother is not alive……..…… 8	
111	What was your last year's rank in the class?	_____	

Part2. Household socio-economic status (Wealth Index)

The next questions ask about your household assets, services and housing conditions			
No.	**Questions**	**Response**	**Skip**
1. Household assets & services – In answering the questions below please think of assets & services available in your household			
201	Television	Yes..…… 1 No…..…. 2	
201	Radio/tape recorder	Yes..…… 1 No…..…. 2	
203	Mobile Telephone	Yes..…… 1 No…..…. 2	
204	Non-mobile/fixed telephone	Yes..…… 1 No…..…. 2	
205	Electric stove	Yes..…… 1 No…..…. 2	

206	Refrigerator	Yes..…… 1 No…..…. 2	
207	Laundry Machine	Yes..…… 1 No…..…. 2	
208	Sofa	Yes..…… 1 No…..…. 2	
209	Bicycle/motorcycle	Yes..…… 1 No…..…. 2	
210	Car	Yes..…… 1 No…..…. 2	
211	Domestic servant	Yes..…… 1 No…..…. 2	
2. Housing Condition – please answer the following questions thinking about the housing condition of your household			
212	How much is the average monthly income of the family?	_____ Birr	
213	Home ownership	Private……. 1 Government……. 2 Rent……. 3 Other (specify) ——————— 4	
214	Number of rooms in the house?		
215	Number of individuals per sleeping room	_____	
216	Roofing material	Natural material……..…. 1 Corrugated iron ……..…. 2 Tiles……..…… 3 Other (specify) ——————— 4	
217	Flooring material	Mud……..……. 1 Parquet/polished wood …..….. 2 Cement…….……. 3 Ceramic tiles……. 4 Carpet……..……. 5 Other (specify) ——————— 6	

Part 3 knowledge assessment of Anemia

Instruction: Ask the following questions carefully and circle the response

No.	Questions	Responses	Skip
301	Have you heard about the term anemia?	Yes …… 1 No……2	**If 2, skip to 401**
302	What are the signs and symptoms of anemia? (**More than one answer Possible)**	Weakness ..... 1 Headache & vertigo.....2 Pale eyes & skin..... 3 Tinnitus…….... 4 Irritability…….....… 5 Blurring of vision……..... 6 Impaired school & work performance.... 7 Other (Specify)_____ 8 Don't Know ……. …..... 9	
303	What are the causes of anemia? (**More than one answer possible**)	Loss of excess blood..... 1 Parasitic infections……...……..… 2 Malaria……...… 3 Menstruation……..... 4 Deficiency of Iron rich foods…..…… 5 Deficiency of vitamins in foods……..... 6 Being under or overweight……..… 7 Other (Specify)_____ 8 Don't Know……..... 9	
304	Which food items are good to prevent anemia? (**More than one answer possible**)	Green leafy vegetables……...…… 1 Meat, fish & egg…..……..... 2 Fruits……..….. 3 Enjera ……..…….4 Milk & milk products…….. 5 Other(Specify)_____ 6 Don't now…… 7	

PART 4. Questions that relate to dietary practices with special reference to eating habits. Instruction: Ask the following questions carefully and circle the response

The next questions ask about your dietary and health habits within the last one year			
No	Questions	Responses	Skip
401	Do you take your meals regularly?	Always regular…… 1 Irregular…...……..... 2	
402	How many times do you usually eat	One…… 1	

	per day?	Two…… 2 Three…..…… 3 Four and above……..….. 4	
403	How often do you eat Breakfast?	Daily……... 1 Three or four times per week…. 2 Once or twice per week……. 3 Rarely……. 4	
404	How often do you eat Lunch?	Daily……... 1 Three or four times per week…. 2 Once or twice per week……. 3 Rarely...……. 4	
405	How often do you eat dinner?	Daily……... 1 Three or four times per week…. 2 Once or twice per week……. 3 Rarely ……. 4	
406	How often do you take snacks?	Daily……... 1 Three or four times per week…. 2 Once or twice per week……. 3 Rarely ……. 4	
407	Do you have a habit of skipping meals?	Yes……. 1 No…….. 2	**If 2 skip to 410**
408	Which meal do you usually skip?	Breakfast…… 1 Lunch……. 2 Dinner……. 3	
409	What is the reason for skipping meal?	Loss of appetite…….. 1 No time…… 2 Just habit……. 3 Fasting…… 4 Not prepared on time…….. 5	
410	Do you usually take tea/coffee with a meal?	Yes…….. 1 No…… 2	

Part 5 Food Frequency Questionnaire/FFQ to assess habitual dietary intake

Instruction: For each food item listed below, indicate with a checkmark (√) the category that best describes the frequency with which you usually eat that particular food item. Thinking about the **last week**, how frequently did you eat the following food items?

Food item	More than once per day	Once per day	3-6 times per week	Once or twice per week	Twice per month or less	Never
Cereals/ Grains						
Teff (Enjera)						
Wheat (Bread, Pasta, Macaroni)						
Barley (Kollo, Porridge, Bread)						
Sorghum						
Maize						
Rice						
Legumes & nut						
Chickpea						
Soya bean						
Pea						
Lentil						
Bean (Kollo, Nifro, shiro)						
Nut/ peanut						
Vegetables						
Tomato						
Chili						
Fosaliya						
Kosta						

Lettuce						
Cabbage						
Pumpkin						
Spinach						
Cauliflower						
Fruits						
Orange						
Banana						
Apple						
Papaya						
Avocado						
Pineapple						
Mango						
Strawberry						
Lemon						
Dairy products						
Milk						
Cheese						
Yogurt						
Flesh foods/ Meat						
Beef						
Lamb						
Chicken						
Goat/Mutton						
Organ meat (liver, heart, kidney)						
Egg						
Fish						
Roots & tubers						
Potato						
Sweet Potato						

Carrot						
Beetroot						
Fats & Oils						
Oil						
Butter						
Sweets/ calorie rich foods						
Soft drinks (Coca, Pepsi, Miranda)						
Fast foods (Pizza, Burger, Chips), cakes & cookies						
Sugar, honey, marmalade, Chocolates & candies						
Spice & beverages						
Spices						
Alcoholic beverages (Beer, Wine…)						
Non-alcoholic beverages						

PART6. Questions on cigarette smoking status

Instruction: Ask the following questions carefully and circle the response

NO.	**Questions**	**Response**	**Skip**
601	Do you smoke cigarettes?	Yes…….. 1 No…… 2	**If 2, skip to 701**
602	How many cigarettes do you smoke per day?	_____Cigarettes/day	

PART 7. Questions on menstrual status (only for females)

Instruction: Ask the following questions carefully and circle the response

No.	Questions	Response	Skip
701	Do you attain your Menarche?	1.Attained 2.Not attained	**If 2, skip to 801**
702	Age of onset on menses	_____ years	
703	Length of blood flow in each menses	_____days	
704	How many sanitary pads do you use per day?	_____Pads/day	

PART8. Anthropometric and laboratorial measurements

No	Anthropometric & Biochemical indices	Result
801	Height (cm)	☐☐☐.☐ Cm
802	weight (kg)	☐☐☐.☐ Kg
803	Hemoglobin (Hg)	
804	Hematocrit (Hct)	
805	Mean cell volume (MCV)	
806	Mean cell hemoglobin (MCH)	
807	Mean cell hemoglobin concentration (MCHC)	
808	Red blood cell count (RBC)	
809	White blood cell count (WBC)	
810	Serum iron	
811	CRP	

Thank you very much!!

Annex 3: Informed Consent and/or Ascent form (Amharic version)

<u>አዲስ አበባ ዩኒቨርስቲ ጤና ሣይንስ ፋኩልቲ የህብረተሰብ ጤና አጠባበቅ ትምህርት ክፍል የተጠያቂዎች/ መላሾች የመረጃ ቅፅ</u>

ጤና ይስጥልን እንደምን ነዎት

_____ እባላለሁ፡፡ የመጣሁት በአዲስ አበባ ዩኒቨርስቲ ጤና ሳይንስ ኮሌጅ የህብረተሰብ ጤና አጠባበቅ ትምህርት ክፍል የሁለተኛ ዲግሪ ለማግኘት በተማሪ ሳራ ጎሳዬ የሚደረግ የምርምር ጥናትን ወክዬ ነው፡፡ ጥናቱ በጉርምስና ወቅት የሚከሰት በአይረን (በብረት) ማዕድን ዕጥረት ምክኒያት የሚመጣ የደም ማነስ በሽታ እና ከመጠን ባለፈ ውፍረት መካከል ያለውን ግንኙነት ለማወቅ ይረዳ ዘንድ በአዲስ አበባ በሚገኙ የግል እና የመንግስት ት/ቤቶች ላይ እየተካሄደ ሲሆን ከአዲስ አበባ ዩኒቨርሲቲ ፣ ከአዲስ አበባ ትምህርት ቢሮና ከተመረጡት ትምህርት ቤቶችም ፍቃድ አግኝታለች፡፡

በዚህ ጥናት ላይ የሚሳተፉ ተማሪዎች በእጣ ከተመረጡት ትምህርት ቤቶች መካከል በአንዱ ውስጥ የሚማሩ ሲሆኑ እርስዎም እድሉ ደርስዎት አንዱ/አንዷ ለመሆን በቅተዋል፡፡ በዚህ ጥናት ላይ መሣተፍ በእርስዎ ሙሉ ፍቃደኝነት ላይ የተመሰረተ ነው፡፡በመሆኑም የእርስዎ ተሣትፎ ለዚህ ጥናት ከፍተኛ አስተዋፅዎ ስለሚያደርግ መልካም ፈቃድዎ ሆኖ በጥናቱ እንደሚሳተፉ ተስፋ አደርጋለሁ፡፡ ነገር ግን ጥናቱ ላይ ባለመሳተፍዎ ወይም ጥናቱን በማቋረጥዎ ምክንያት የሚደርስብዎ አንዳችም ችግር /ጉዳት አይኖርም፡፡

በጥናቱ ለመሳተፍ ከተስማሙ የተወሰኑ ጥያቄዎችን ስለአጠቃላይ ግላዊና ማህበረሠባዊ መረጃዎች ፣ አዘውትረው ስለሚመገቡአቸው ምግቦች ፣ ስለ አመጋገብ ልምድ እና ደም ማነስን በተመለከተ ያለዎትን እዉቀት የሚመዝኑ ጥያቄዎችን እጠይቅዎታለሁ፡፡ በተጨማሪም ክብደትዎና ቁመትዎን እንዲሁም በብረት(አይረን) ማዕድን ዕጥረት ምክኒያት የሚመጣ የደም ማነስ በሽታ ምርመራ የካበተ ልምድ ባላቸው የጤና ባለሙዎች እና ደረጃቸውን በጠበቁ መሳሪያዎች ይደረግሎታል፡፡ ክብደት በሚለካበት ጊዜ ቀለል ያሉ ልብሶች እንዲሁም ቁመት በሚለካበት ጊዜ ደግሞ በባዶ እግር ይሆናል፡፡ ለአንጀት ትላትል በሽታ መከላከያ ይሆን ዘንድ የAlbendazole ክኒንም ይስጦታል፡፡ መጠይቁና ልኬቱ በአጠቃላይ 30 ደቂቃ ይህል ይፈጃል፡፡

ከዚህ ጥናት የሚሰበሰበው መረጃ ለተለያዩ የመንግስት እና መንግስታዊ ላልሆኑ ድርጅቶች ፣ ለጤና ባለሙያዎች ፣ ፖሊሲ አውጪዎችና ሌሎች የሚመለከታቸው አካላት በጉርምስና ወቅት በአይረን/በብረት ማዕድን ዕጥረት ምክኒያት የሚመጣ የደም ማነስ በሽታን እንዲሁም ከመጠን ያለፈ ውፍረትና ተያያዥ ችግሮቹን የመከላከያና መቆጣጠርያ መንገዶችን እንዲቀርፁና እንዲተገብሩ እንደ መነሻ ይሆናል የሚል ፅኑ እምነት አለን፡፡

በመጨረሻም ከእርስዎ የምንሰበስበው መረጃ ከስምዎ ጋር አይያያዝም፡፡ ስምዎት እንደማይጠቀስና ለማንም አካል አልፎ እንደማይሰጥ ልናረጋግጥ እንወዳለን፡፡ የዚህ ጥናት ውጤት ግን ተጠርዞ እና ተዘጋጅቶ ለሚመለከታቸው የጤና ድርጅቶ ወይም ለሌሎች አካላት ሊሰጥ ይችላል፡፡

<u>የስምምነት መጠየቂያ/ማረጋገጫ ቅፅ</u>

ከላይ በሰጠዎት መረጃ መሰረት በጥናቱ ላይ ለመሳተፍ ፍቃደኛ ነዎት?

1. አዎ 2. አይደለሁም

የቤተሰብ ፍቃድ ያገኘው ልጅ ስም _____ ክፍል _____

የተሳታፊ ቤተሰብ ፊርማ (ከ 18 አመት በታች ለሆኑ ልጆች) ፊርማ_____ ቀን_____

የተሳታፊ ፊርማ (ከ 18 አመት በታችም በላይም ላሉ ልጆች) ፊርማ_____ቀን_____

ፍቃደኛ ካልሆኑ ምክኒያቱን ፅፈው

የመረጃ ሰብሳቢ

ስም_____ፊርማ_____

የተጠያቂው መለያ ቁጥር (ክፍልና ቁጥር) ––––––––––––––––––

መጠይቁ የተካሄደበት ቀን_____የተጀመረበት ሰአት_____ያለቀበት ሰአት_____

የቃለ መጠይቁ ውጤት

1. ሙሉ በሙሉ የተሞላ
2. በከፊል የተሞላ
3. ምንም ያልተሞላ

በተቆጣጣሪዎች ተረጋግጧል፡ ስም————ፊርማ————

ለተጨማሪ ማብራሪያ የዋና አጥኚውን አድራሻ ይጠቀሙ

ስም፡ ሳራ ጎሳዬ

ኢሜይል: sarinago7@gmail.com

ስልክ +251 912874826

Annex 4፡Survey questionnaires (Amharic version)

የትምህርት ቤቱ ስም _____

የተጠያቂው መለያ ቁጥር——————————————

መጠይቁ የተካሄደበት ቀን _____/ _____/ _____

ክፍል1. መሰረታዊ መረጃን የሚመለከቱ ጥያቄዎች

ለቀረቡት ጥያቄዎች መልስዎ የሆነውን በመልስ ሳጥን ውስጥ ያለትን ቁጥሮች በማክበብ ይግለፁ፡፡

ተ.ቁ	ጥያቄ	መልስ	ወደ ሚቀጥ ለው ጥያቄ ይሂዱ
101	ዕድሜህ/ሽ ስንት ነው?	_____, _____, _____ (ቀን, ወር, አመት)	
102	ፆታ	ወንድ..... 1 ሴት..... 2	
103	የትምህርት ደረጃ	_____	
104	የት/ቤቱ አይነት	1. መንግስታዊ 2. መንግስታዊ ያልሆነ	
105	ሃይማኖትህ/ሽ ምንድን ነው?	1. ኦርቶዶክስ 2. ካቶሊክ 3. ፕሮቴስታንት 4. ሙስሊም 5. ሌላ (ዝርዝር ይግለጹ) _____	
106	የቤተሰብዎ የቤተሰብ መጠን ከእርስዎ ጋር ምን ያህል ነው?	_____	
107	የአባትዎ / አሳዳጊ ሙያዉ ምንድነው?	1. የመንግስት/የግል ተቀጣሪ 2. ነጋዴ 3. የቀን ሰራተኛ 4. ስራ የሌለው 5. ሌላ ጥቀስ_____	
108	የእናትዎ / አሳዳጊ ሙያዋ ምንድነው?	1 የመንግስት/የግል ተቀጣሪ 2. ነጋዴ 3. የቀን ሰራተኛ 4 የቤት ዕመቤት/ ስራ የሌላት 5. ሌላ ጥቀስ_____	

109	የአባትዎ/ አሳዳጊ የትምህርት ሁኔታ ምንድነው?	1. ያልተማረ (ማንበብና መፃፍ የማይችል) 2. ማንበብና መፃፍ የሚችል 3. የመጀመሪያ ደረጃ (ከ1ኛ-8ኛ ክፍል) 4. ሁለተኛ ደረጃ (ከ9ኛ-12ኛ) 5. የተወሰነ የኮሌጅ ወይም ቴክኒክና ሙያ ትምህርት ያለው 6. ኮሌጅ ያጠናቀ ወይም ከዛ በላይ 7. አላውቅም 8. አባቴ በህይወት የለም	
110	የእናትዎ / አሳዳጊ የትምህርት ደረጃ ምንድነው?	1. ያልተማረች (ማንበብና መፃፍ የማትችል) 2. ማንበብና መፃፍ የምትችል 3. የመጀመሪያ ደረጃ (ከ1ኛ-8ኛ ክፍል) 4. ሁለተኛ ደረጃ (ከ9ኛ-12ኛ ክፍል) 5. የተወሰነ የኮሌጅ ወይም የቴክኒክና ሙያ ትምህርት ያላት 6. ኮሌጅ ያጠናቀቀች ወይም ከዛ በላይ 7. አላውቅም 8. እናቴ በህይወት የለችም	
111	በባለፈው አመት ከክፍል ስንተኛ ደረጃ ወጣህ/ሽ?	_____	

ክፍል 2. የቤተሰብን የሀብት ደረጃ የተመለከቱ ጥያቄዎች

የሚቀጥሉት ጥያቄዎች የሚኖሩበት ቤት ውስጥ ስለሚገኙ ንብረቶችና የቤት አሰራር ሁኔታ ይመለከታል			
ተ.ቁ	ጥያቄ	መልስ	**ወደ ሚቀጥ ለው ጥያቄ ይሂዱ**
1. የቤት ንብረት እና አገልግልቶች ፡- እባክዎ የሚቀጥለትን ጥያቄዎች ቤትዎ ውስጥ ስለሚገኙ ንብረቶችና አገልግልቶች እያሰቡ ይመልሱ			
201	ቴሌቪዥን	1. አዎ 2. የለም	
202	ራዲዮ/ቴፕ	1. አዎ 2. የለም	
203	ሞባይል/ተንቀሳቃሽ ስልክ	1. አዎ 2. የለም	
204	የቤት (የመስመር) ስልክ	1. አዎ 2. የለም	
205	የኤሌክትሪክ ምድጃ (ስቶቭ)	1. አዎ 2. የለም	
206	ማቀዝቀዣ (ፍሪጅ)	1. አዎ 2. የለም	
207	የልብስ ማጠቢያ ማሽን	1. አዎ 2. የለም	
208	ሶፋ	1. አዎ 2. የለም	
209	ብስክልት/ሞተርብስክሌት	1. አዎ 2. የለም	
210	መኪና	1. አዎ 2. የለም	
211	የቤት ሰራተኛ	1. አዎ 2. የለም	
2. የቤት አሰራር ሁኔታ፡- እባክዎ የሚቀጥሉትን ጥያቄዎች ስለሚኖሩበት ቤት አሰራርና ሁኔታ እያሰቡ ይመልሱ			
212	የቤተሰብዎ አማካኝ ወርሃዊ ገቢ ምን ያህል ነው?	_____ ብር	
213	የሚኖሩበት ቤት ባለቤትነቱ የማን ነው?	1. የግሌ 2. የመንግስት 3. ከግለሰብ ኪራይ 4. ሌላ ካለ ይገለፅ----------	
214	የሚኖሩበት ቤት ስንት ክፍል አለው?		
215	በቤትዎ ውስጥ በአንድ የመኝታ ክፍል ስንት ሰው ይጠቀማል?		
216	የሚኖሩበት ቤት ጣሪያው ምንድን ነው?	1. የተፈጥሮ ቁስ (ለምሳሌ ሳር ወይም እንጨት) 2. ቆርቆሮ 3. ሸክላ 4. ሌላ ካለ ይገለፅ _____	

217	የሚኖሩበት ቤት ወለሉ ምንድን ነው?	1. አፈር 2. ጣውላ 3. ሲሚንቶ 4. ሴራሚክ (ሽክላ) 5. ስጋጃ (ምንጣፍ) 6. ሌላ ካለ ይገለፅ ————————

ክፍል 3. ደም ማነስን በተመለከተ ያለዎትን እዉቀት የሚመዝኑ ጥያቄዎች

ለቀረቡት ጥያቄዎች መልስዎ የሆነውን በመልስ ሳጥን ውስጥ ያለትን ቁጥሮች በማክበብ ይግለፁ፡፡

ተ.ቁ	ጥያቄዎች	መልስ	ወደ ሚቀጥ ለው ጥያቄ ይሂዱ
301	ከዚህ በፊት ስለ ደም ማነስ በሽታ ሰምተው ያውቃሉ?	አውቃለሁ…… 1 አላውቅም…..……2	መልሱ 2 ከሆነ ወደ ጥያቄ ቁጥር 401 ይሂዱ
302	የደም ማነስ በሽታ ምልክቶች ምን ምንድን ናቸው? **(ከአንድ በላይ መልስ ይቻላል)**	የድካም ስሜት..... 1 የራስ ምታትና ማዞር.....2 የአይንና የቆዳ መገርጣት..... 3 ጆሮ ላይ ጢዝዝ የሚል ድምጽ መሰማት..... 4 መንጫነጭ…..…… 5 የእይታ ብዥ ማለት…..…..... 6 የትምህርትና የስራ ውጤት መቀነስ..... 7 ሌላ ካለ ጥቀስ_____ 8 አላውቅም…… ….... 9	
303	የደም ማነስ በሽታ መንስኤዎች ምን ምንድን ናቸው? **(ከአንድ በላይ መልስ ይቻላል)**	ከመጠን ያለፈ ደም መፍሰስ ..... 1 የአንጀት ትላትል በሽታዎች……..… 2 የወባ በሽታ..... 3 የወር አበባ…….…….... 4 በአይረን የበለጸጉ ምግቦች እጥረት.…… 5 በቫይታሚን የበለጸጉ ምግቦች እጥረት.……... 6 ከመጠን በላይ/በታች የሆነ ክብደት…..…… 7 ሌላ ካለ ጥቀስ _____ 8 አላውቅም……..…….... 9	
304	የደም ማነስ በሽታን ለመከላከል የሚጠቅሙት የምግብ አይነቶች ምን ምንድን ናቸው? **(ከአንድ በላይ መልስ ይቻላል)**	አረንገዴ ቅጠላማ አትክልቶች……..…… 1 ስጋ አሳ እና እንቁላል……..……..... 2 ፍራፍሬዎች…..……..…. 3 እንጀራ.. ……..……4 ወተትና የወተት ተዋጽኦዎች…….. 5 ሌላ ካለ ጥቀስ _____ 6 አላውቅም……..…… 7	

ክፍል 3. የአመጋገብ ሁኔታን የተመለከቱ ጥያቄዎች

ከዚህ ቀጥሎ ያሉት ጥያቄዎች በተለምዶ አዘውትረው ስለሚመገቡአቸው ምግቦች የተመለከቱ ናቸው፡፡ እባክዎ ጥያቄዎቹን ሲመልሱ ባለፈው አንድ ወር ውስጥ አዘውትረው የተመገቡአቸውን ምግቦች ያስቡ፡፡

ተ.ቁ	የምግብ አይነቶች	በቀን ከአንድ ጊዜ በላይ	በቀን አንድ ጊዜ	በሳምንት ከ 3 እስከ 6 ጊዜ	በሳምንት 1 ወይም 2 ጊዜ	በወር 2 ጊዜ ወየም ከዛ በታች	በልቼ አላውቅም
601	ሰብሎች						
	ጤፍ (እንጀራ)						
	ማሽላ						
	በቆሎ (ቂንጪ፣ ጥብስ፣ ቅቅል)						
	ስንዴ (ዳቦ፣ ፓስታ፣ ማካሮኒ)						
	ገብስ (ዳቦ፣ ገንፎ፣ ቆሎ)						
	ሩዝ						
602	ጥራጥሬ						
	ባቄላ (ሽሮ፣ ቆሎ፣ ንፍሮ)						
	አተር ክክ						
	ሽንብራ						
	አኩሪ አተር						
	ምስር ክክ						
	ለውዝ/ አቾሎኒ ቂቤ						
603	አትክልቶች						
	ቲማቲም						
	ጥቅል ጎመን						
	ዱባ						
	ጎመን						
	ሰላጣ						
	ቆስጣ						
	ቃሪያ						
	ፎሶሊያ						
	አበባ ጎመን						
604	ፍራፍሬ						

	ብርቱካን						
	አቮካዶ						
	ሙዝ						
	ማንጎ						
	ሎሚ						
	ፖም						
	ፓፓያ						
	አናናስ						
	እንጆሪ						
605	የወተት ውጤቶች						
	ወተት						
	አይብ						
	እርጎ						
606	ስጋ						
	የበሬ ስጋ						
	የበግ ስጋ						
	የዶሮ ስጋ						
	የፍየል ስጋ						
	ኩላሊት ፣ ጉበት ፣ ልብ						
607	እንቁላል						
608	አሳ ቱና / ሳርዲን						
609	ስራስሮች						
	ቀይ ስር						
	ካሮት						
	ስኳር ድንች						
	ድንች						
610	የቅባት ውጤቶች						
	ዘይት						
	ቂቤ						
611	ጣፋጮች						

	ለስላሳ መጠጦች						
	ስኳር፣ ማር፣ ማማራታ፣ ቸኮሌት ከረሜላ						
	ድንች ጥብስ፣ ፒዛ፣በርገር፣ ኬክ፣ ኩኪስ						
612	ቅመማ ቅመሞችና መጠጦች						
	ቅመማ ቅመሞች						
	አልኮል ያልሆኑ መጠጦች						
	የአልኮል መጠጦች						

ክፍል 4. የሚቀጥለው ጥያቄ የአመጋገብ ስርዓት፣የምግብ ሁኔታ እና ልምድን ይመለከታል.

ለቀረቡት ጥያቄዎች መልስዎ የሆነውን በመልስ ሳጥን ውስጥ ያለትን ቁጥሮች በማክበብ ይግለፁ፡፡

ተ.ቁ	ጥያቄ	መልስ	ወደሚቀጥለው ጥያቄ ይሂዱ
401	ምግብ ሰዓትህን ጠብቀህ ትመገባለህ?	1. ሁሌጊዜ ሰዓቴን ጠብቄ እመገባለሁ 2. ሰዓቴን አልጠብቅም	
402	ሁልጊዜ ቁርስ ትመገባለህ?	1.በየቀኑ 2. በሳምንት አንድ/ሁለት ጊዜ 3. በሳምንት ሶስት/አራት ጊዜ 4. አልፎ አልፎ	
403	ሁልጊዜ ምሳ ትመገባለህ?	1.በየቀኑ 2. በሳምንት አንድ/ሁለት ጊዜ 3. በሳምንት ሶስት/አራት ጊዜ 4. አልፎ አልፎ	
404	ሁልጊዜ እራት ትመገባለህ?	1.በየቀኑ 2. በሳምንት አንድ/ሁለት ጊዜ 3. በሳምንት ሶስት/አራት ጊዜ 4. አልፎ አልፎ	
405	ከመደበኛ የምግብ ፕሮግራምህ ውጪ ምን ያህሌ ጊዜ መክሰስህን ትመገባለህ.?	1.በየቀኑ 2. በሳምንት አንድ/ሁለት ጊዜ 3. በሳምንት ሶስት/አራት ጊዜ	

		4. አልፎ አልፎ	
406	መደበኛ ምግብህን በቀን ስንት ጊዜ ትመገባለህ ?	1. አንድ ጊዜ 2. ሁለት ጊዜ 3. ሶስት ጊዜ 4. አራት ጊዜ	
407	የምትዘለው ምግብ ካለ, ብዙ ጊዜ የሚሆነዉ የትኛው ነው?	1.ቁርስ 2. ምሳ 3. እራት	
408	ምግብህን በሰአቱ የማትመገብበት ምክኒያት ምንድን ነው ?	1. የምግብ ፍላጎት አለመኖር 2. የጊዘ አለመኖር 3. ልምድ ሆኖብኝ 4. በጾም ምክንያት 5. የምግብ በሰአቱ አለመዘጋጀት	
409	ከምግብ ጋር ሻይ ወይም ቡና የመጠጣት ልምድ አለዎት ?	1. አዎ 2. አይ	

ክፍል 5. የወር አበባ ሁኔታን የተመለከቱ ጥያቄዎች (ለሴቶች ብቻ)

ለቀረቡት ጥያቄዎች መልስዎ የሆነውን በመልስ ሳጥን ውስጥ ያለትን ቁጥሮች በማክበብ ይግለፁ፡፡

ተ.ቁ	ጥያቄዎች	መልስ	ወደሚቀጥለው ጥያቄ ይሂዱ
501	የወር አበባ ማየት ጀምረሻል ?	1. አዎ 2. አይ	
502	የወር አበባ ማየት የጀመርሽው በስንት አመትሽ ነው?	_____አመት	
503	በወር ምን ያህል ቀን ይፈስሻል ?	_____ቀናት	
504	በቀን ምን ያህል ሞዴስ ትጠቀሚያለሽ ?	_____ሞዴስ	

ክፍል 6. የሲጋራ ማጨስ ሁኔታን የተመለከቱ ጥያቄዎች

ለቀረቡት ጥያቄዎች መልስዎ የሆነውን በመልስ ሳጥን ውስጥ ያለትን ቁጥሮች በማክበብ ይግለፁ፡፡

ተ.ቁ	ጥያቄዎች	መልስ	ወደሚቀጥለው ጥያቄ ይሂዱ
601	ሲጋራ ታጨሻለሽ/ ታጨሳለህ ?	1. አዎ 2. አይ	
602	በቀን ምን ያህል ሲጋራ ታጨሻለሽ/ ታጨሳለህ ?	_____ ሲጋራ	

ክፍል 7 የሰውነት መጠን ልኬት እና የላብራቶሪ ዉጤቶች

ተ.ቁ	የሰውነት መጠን ልኬት እና የላብራቶሪ ምርመራዎች	**ዉጤት**
701	ቁመት (በሴንቲ ሜትር)	☐☐☐.☐ ሴ.ሜ
702	ክብደት (በኪሎ ግራም)	☐☐☐.☐ ኪ.ግ
703	Hemoglobin (Hg)	
704	Hematocrit (Hct)	
705	Mean cell volume (MCV)	
706	Mean cell hemoglobin (MCH)	
707	Mean cell hemoglobin concentration (MCHC)	
708	Red blood cell count (RBC)	
709	White blood cell count (WBC)	
710	Serum iron	
711	CRP	

ስለትብብርዎ ከልብ እናመሰግናልን!!!