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Adolescent girls' nutrition in Wolaita and Hadiya zones, Southern Ethiopia: Evaluetion of diets, nutritional status and the effect of iron-folic acid supplementation

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Abbreviations/Acronyms

AIDS	Acquired immunodeficiency syndrome
AOR	Adjusted Odds Ratio
BMI	Body Mass Index
COR	Crude Odds Ratio
CRP	C-reactive Protein
DDS	Dietary Diversity Score
DE	Design Effect
Df	Degree of Freedom
DL	Deciliter
EDHS	Ethiopia Demographic and Health Survey
Hb	Hemoglobin Concentration
HIV	Human Immune Deficiency Virus
IFAS	Iron-folic Acid Supplementation
IRB	Institutional Review Board
LMICs	Low and Middle Income Countries
NNP	National Nutrition Program
PPS	Probability Proportionate to Size
RCT	Randomized-Controlled Trial
SF	Serum Ferritin
SFol	Serum Folate
SD	Standard Deviation
SNNPR	Southern Nation Nationalities and Peoples Region
SPSS	Statistical Package for the Social Sciences
SRS	Simple Random Sampling
TB	Tuberculosis
TEM	Technical Error of Measurement
WHO	World Health Organization
WIFAS	Weekly Iron-folic Acid Supplementation

Abstract

***Background**: Undernutrition, anemia and low dietary diversity are the most common causes of morbidity and mortality among adolescent girls throughout the world, especially in South-East Asia and Africa. Even though adolescence is a window of opportunity to break the intergenerational cycle of undernutrition, adolescent girls are the neglected groups.*

Objective of this study is to assess nutritional status, low dietary diversity, anemia, and their associated factors among adolescent girls in Wolaita and Hadiya Zones, Southern Ethiopia. In addition to these this study has identified the barriers and facilitators of nutrition service utilization, and the effect of iron folic acid supplementation among adolescent girls in southern Ethiopia.

***Methods**: This study was conducted in Wolaita zone and Hadiya zone. These Zones were selected purposely. The study has used a mixed study design (cross-sectional quantitative, qualitative, and randomized control).*

*Community-based cross-sectional study was conducted from April 30/2019 to May 30/2019. A multistage sampling method was used to select a sample of **843** adolescent girls. A structured questionnaire was used to collect socio-demographic and dietary data through a face to face interview. Anthropometric measurement was collected from all adolescent girls and entered in WHO anthro plus software for Z-score analysis. Venous blood sample was collected from all selected adolescent girls. Hemoglobin level was measured in venous blood samples using a Hemocue photometer which was processed in the field (Hemocue R, Hb 301+ system).*

Structured 24-hour dietary recall (24HR) interview was conducted to capture detailed information about all foods and beverages consumed by the respondent in the past 24 hours, most commonly, from early morning to early morning of the previous day. In addition to this, a food frequency questionnaire was conducted to know usual frequency of consumption of food over the time period.

Data were entered in the computer using EPI-data 4.4.2 and exported to SPSS version 21.0 for further analysis. Variables which shown significant association (p-value ≤ 0.25) in the bivariate logistic analysis were included in the final multivariable logistic regression model. Odds ratios for logistic regression along with 95% confidence interval were estimated. P-value less than 0.05 were declared as level of statistical significance.

For qualitative study, health extension workers, school leader and gender focal person, health center expert and youth center leader from each village were involved in this study. For Focus group discussion: Eight adolescent girls in one group have participated from each village. For the selection of the participant, the purposive sampling method was applied to get the best information. Each audiotape interview was

professionally transcribed word by word in wolaitegna and Hadiyagna (local language) and then translated to English.

For intervention study, community-based, individually randomized trial (RCT) was conducted at four villages of Wolaita and Hadiya zones from April to September 2019. During recruitment, adolescent girls age range in 10-19 years (226 in total) were randomly assigned to the intervention group (G1=113) and control group (G2=113). Weekly IFA supplementation was given to the intervention groups for three months, and nothing was given to control groups. For assessment of micronutrient status, 5ml venous blood sample was collected at baseline and at the end of the intervention. Primary outcomes were analyzed based on intention to treatment analysis principle. *The prevalence of anemia was calculated based on the hemoglobin levels measured in venous blood samples using a Hemocue photometer which was processed in the field (Hb 301+ system). Specimens were transported on dry ice to the Ethiopian public health institute and analyzed for serum ferritin, serum folate and C-react protein by Immune turbid metric methods with a clinical chemistry analyzer (Cobas 6000 system; Roche Diagnostic GmbH) at the Ethiopian Public Health Institute.*

***Results**: Thinness (27.5%) and stunting (8.8%) were found to be public health problems in the study area. Age [AOR (95% CI) = 2.91 (2.03-4.173)], family size[AOR (95% CI) = 1.63(1.105-2.396)], monthly income [AOR (95% CI) = 2.54(1.66-3.87)], taking deworming tablet [AOR (95% CI) = 1.56(1.11-21)], fathers educational status [AOR (95% CI) = 2.45(1.02-5.86)], source of food for family [AOR (95% CI) = 5.14(2.1-12.8)], visit by health extension workers [AOR (95% CI) = 1.72(1.7-2.4)] and hand washing before eating and after using toilet [AOR (95% CI) = 2.25(1.079-4.675)] were significantly associated with thinness and stunting among adolescent girls in Wolaita and Hadiya zones, southern Ethiopia.*

The mean (± SD) blood hemoglobin level of the study participants was 12.23±1.16 g/dL and 37% of the study participants were moderately anemic (Hg 7-12gm/dl) and 0.2% of the study participants were severely anemic (Hg<7g/dL). Overall prevalence of anemia was 37.2% among adolescent girls in the study area. Anemia is found to be a public health problem in the study area, because according to *WHO, within 20– 39.9 % cut-off point is moderately public health problem. Family monthly income, illness with cough and malaria in the past two weeks and BMI for age were the main predictors of anemia among adolescent girls in Wolaita and Hadiya Zones, Southern Ethiopia.*

The mean dietary diversity score of the study participants was 3.56 (±1.2). In this study, 72.4% of the study participants had low dietary diversity score. Low dietary diversity score was found to be a public health problem in the study area. Family monthly income, fathers and mothers educational status, not taking nutrition education and decision-making power were the main predictors of low dietary diversity score among adolescent girls in southern Ethiopia.

Barriers for nutrition service utilization among adolescent girls were lack of awareness for study participants and their families, shortage of iron-folic acid and deworming tablets, lack of trained experts who were responsible for the nutrition service implementation, low economic status of the family, lack of coordination among different sectors for nutrition service, low educational status of the adolescent girls' family. Facilitators for nutrition service utilization among adolescent girls in the study area were supplementation of iron-folate and deworming tablets was without payment. In addition to this utilization of social and community networks motivated the utilization of nutrition services among adolescent girls. Awareness creation training should be given for adolescent girls and their families, and male adolescent before the implementation of nutrition service provision.

In intervention study about 47-49% of adolescents had marginal iron store (<50µg/l). Hb, SF, and SFol concentrations increased in the intervention group, but not in the control group (P< 0.05). Marginal iron store decreased from 49% to 12% after three-months of WIFAS; whereas, the proportion of adolescents with elevated SF (>150µg/l) was slightly higher in the WIFAS than in the control group (P= 0.06). WIFAS intervention for three-months was effective in reducing iron and folate deficiency in adolescent girls. Future studies should evaluate the long-term impact of intermittent WIFAS.

The inter-sectorial collaboration should be there to implement community-based health and nutrition programs i.e. school teachers and agricultural experts should work together with health experts to improve nutritional status of adolescent girls. In addition to this, awareness-creation training should be given for adolescent girls and their families, and male adolescent before the implementation of nutrition service provision. Similarly, community-based Iron folic acid supplementation and deworming tablet supplementation program should be implemented to help adolescent girls who are at risk of anemia. Family monthly income and education, malaria prevention mechanism, providing nutrition education and decision-making power should be improved. Future studies should evaluate the long-term impact of intermittent WIFAS.

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***Keywords**: adolescent girls, anemia, dietary diversity score, determinants, facilitoter, barriers, nutrition service utilization, WIFAS and nutritional status*

Contents

Organization of the Dissertation

The dissertation has **six** chapters. **Chapter one** presents general information on the study, study objectives, and indicates research gaps to be filled in this study.

Chapter two presents a **literature review** that covers a brief description of undernutrition, anemia, dietary diversity, their determinant factors, barriers, and facilitators of nutrition service utilization and the effect of iron-folic acid supplementation on micronutrient status. It also presents the conceptual framework of the determinants of nutritional status, low dietary diversity, and low hemoglobin concentration.

Chapter three presents a description of the materials and methods applied in this study. It clearly describes the study area, study design and period, source population, study population, sample size calculation, sampling procedures and statistical analysis of the study.

Chapter four presents the results of the study in the form of published article, submitted or draft manuscript. This chapter is organized as follows:

Section 4.1**(**Published at PLOS ONE journal) presents the result from undernutrition and its determinants among adolescent girls. It describes the findings on socio-demographic characteristics, health-related factors, health and sanitation-related factors, comparison of height-for-age, comparison of BMI-for-age, pie-chart representation of BMI for age z-score, pie-chart representation of height for age z-score.

Section 4.2 **(**Article published on Cogent food and agriculture, Taylor and Francis group) shows dietary diversity score and its determinants among adolescent girls. It indicates a mean dietary diversity score, frequently consumed food groups, and associated factors.

***Section 4.*3** (**Paper ready for submission to journal**) indicates barriers and facilitators of nutrition service utilization among adolescent girls: a qualitative cross-sectional study.

***Section 4.*4 (**Paper ready for submission to journal) indicates blood hemoglobin level and its determinants among adolescent girls. It indicates a mean blood hemoglobin concentration and prevalence of all forms of anemia and associated factors.

***Section 4.*5** (**Paper published in the Scientific Reports journal**) indicates effects of community-based weekly iron-folic acid supplementation on serum ferritin, folate, and hemoglobin level among adolescent girls: Randomized control trial. This section indicated intervention results and biological sample analysis results.

Chapter five gives a general discussion of the findings of the study.

Chapter six presents the general conclusions and recommendations.

Chapter 1- Introduction

CHAPTER ONE: Introduction

1.1 Background

Adolescence is the age range of 10-19 years and it is a period of transition from childhood to adulthood. Adolescent age group comprises 20% of the global population(WHO, 2005b). Malnutrition, particularly undernutrition is highly prevalent among adolescents in developing countries(CSA, 2016; Ng *et al*., 2014). The first 1000 days of life is faster growing stage followed by adolescent stage and which needs quantity and quality diet. So, they need important nutrients such as protein, iron, and other micronutrients to support the adolescent growth spurt and meet the body's increased demand for iron during menstruation(Walls *et al*., 2018). Unhealthy nutritional status among adolescents is an important determinant of poor health outcomes(Moreno *et al*., 2008). Undernutrition is affecting the health status of adolescent girls. In addition to causing significant mortality, it creates a long-lasting effect on the growth, development, and physical fitness of survivors (Demilew and Emiru, 2018). This in turn, affects their ability to learn and work at maximal productivity(Martins *et al*., 2011). Malnutrition has also weak social and economic development of a population that affect the economy of the country as whole (Black *et al*., 2003). When the nutritional status of adolescent girls' was not improved, they have a high risk of mortality and more likely to give birth to low birth weight infants(Melaku *et al*., 2015). So, adequate nutrition is key and is associated with better lives and with potential intergenerational benefits(Bay *et al*., 2016a). Adolescent girls' mental development and physical growth during puberty increase requirements for protein, energy, vitamins and minerals, and deficiencies can lead to anatomical, physiological, and functional disturbances (Salam *et al*., 2016b).

Undernutrition can pass from generation to generation because adolescent girls that enter pregnancy with the poor nutrient store are more likely to give birth to low birth weight baby or intrauterine

growth restricted baby that is more vulnerable to metabolic disorders later in life(Guilloteau *et al*., 2009). A focus on adolescent girls is also important because their nutritional and health status prior as well as at pregnancy can influences newborn health and fetal growth.

Adolescent girls' undernutrition and health is an important factor for adverse neonatal/ fetal outcomes, such as preterm births, stillbirths, low births weight and increased risk of mortality(Cnattingius and Villamor, 2016). Better nutrition lowers the risk of chronic diseases and better academic achievement. Healthy growth and development essentially needs a balanced diet which includes a variety of foods from different food groups(WHO, 2014).

Undernutrition in adolescents may has transgeneration passage due to epigenetic effect, but the vast majority of cases are linked with food insecurity, poor care, and poor socioeconomic status(MoH, 2008). Short maternal stature, prematurity, cigarette smoking, infections, drug and alcohol use, indoor and outdoor air pollution, closely spaced pregnancies, domestic violence, stress, hypertension and malaria are important factors for the intergenerational effect of undernutrition(Nutrition and Institute, 2000).

Undernutrition among adolescent can be determined by using BMI-for-age, which is a recommended indicator for assessing thinness, overweight and obesity, and height- for- age for stunting in adolescents 10-19 years. Based on these indicators, an adolescent is defined as stunting those with their height for age is <-2SD and thinness those with their body mass index for age is <-2SD according to 2007 WHO new growth reference(WHO, 2007).

In South-East Asia and Africa regions, a large number of adolescent girls suffer from chronic undernutrition and anemia, which adversely impacts their health and development, as well as their offsprings contributing to the intergenerational cycle of malnutrition(Wasnik and Rao, 2012). A study conducted in Ahvaz-Iran indicated that the mean and SD of the dietary diversity score was

6.81±1.75(Vakili *et al*., 2013). Similarly, a study conducted at the University of the Philippines indicated that the average DDS of the adolescents was 3.94 (Bullecer *et al*., 2012). A study from northern Ethiopia reported high levels of stunting (26.5 %) and thinness (58.3 %) (Mulugeta *et al*., 2009).

Low dietary diversity was reported from studies conducted in different parts of Ethiopia (Melaku *et al*., 2017, Worku, 2017). As indicated in a study conducted at Central Ethiopia, 58.8% of adolescent girls did not meet the minimum dietary diversity score of 5 out of 10 food groups, and the mean dietary diversity score was only 4.2 (Roba *et al*., 2016).

A magnitude of anemia was estimated as 24.8% globally and it is worldwide public health problem. Most of the global disease burden of anemia is high in the developing world, with the highest prevalence in South East Asia and Africa (WHO, 2008, *Central* Statistical Agency, 2011). Anemia can be of multiple causes of including cancer, hypothyroidism, lead poisoning, toxic chemical exposure, kidney disease, bone marrow not functioning, vitamin deficiency or nutrient absorption issues, HIV, malaria, parasitic infection, enzyme deficiencies, etc. Parasites that are causing anemia are hookworm, whipworm, and schistosomiasis infection(Farid *et al*., 1969). Iron and folate deficiencies are also the most common causes of anemia. Approximately, 50% of cases of anemia are considered to be due to iron deficiency but this can vary depending on the living environment of the community (Balarajan *et al*., 2011).

Adolescent girls are vulnerable especially to iron deficiency due to accelerated increase in requirements for iron, poor dietary intake of iron, menstrual losses, high rate of infection and worm infestation as well as the social norm of early marriage and adolescent pregnancy (Balarajan *et al*., 2011).

Prevalence of iron deficiency anemia was high in Nepal (56.3%), India (60%), and Kenya (30.5%) (Sinha *et al*., 2012, Deshpande *et al*., 2013, Leenstra *et al*., 2009). The prevalence of anemia was 32% in Babile district, Eastern Ethiopia (Teji *et al*., 2016). Finding from Ethiopia demographic and healthy survey indicated that the prevalence of anemia in Ethiopia among the age group of 15–19-year-old females was 19.9% (Central Statistical Agency, 2016).

Health and nutrition services for adolescents will serve as a future investment for breaking the cycle of intergenerational poor health. Promoting healthy practices of adolescent girls and protecting young people from health risks is critical to the future of countries' health and social infrastructure to the prevention of health problems in adulthood (Nandan *et al*., 2007).

Nutrition service utilization is often limited because of low adherence by the target population(Gebremedhin *et al*., 2014). In the case of iron supplementation, low adherence due to the unavailability of the tablets was the most common reason that participants did not take iron–folate supplements(Galloway and McGuire, 1994). Lack of nutrition communication efforts must be solved to increase understanding of the importance of taking supplements and to address any fears or misconceptions related to supplementation (Zoellner *et al*., 2009).

Nutrition services in high-income countries, as well as low- and middle-income countries targeting adolescents, are highly fragmented, poorly coordinated, and uneven in quality (Chatterjee and Baltag, 2015). In addition, health expertise faces several challenges with adolescents as they require specialized skills for consultation, interpersonal communication, and interdisciplinary care services (Salam *et al*., 2016a). A study conducted at Peru indicated that barriers of nutrition service are inadequate program support such as lack of political commitment and financial support, insufficient delivery of services such as lack of supplies, access, training, and motivation of health-care

professionals, and participants factors such as misunderstanding of instructions and adverse side effects(Gross *et al*., 2006).

Iron supplementation has a positive effect on hemoglobin level, serum ferritin levels, and cognitive abilities among adolescent girls. Moreover, iron-folate supplementation enhances adolescent micronutrient status and growth (Sunil Sazawal; 2006, Piush Kanodia; 2016, Aditi Sen and Shubhada Kanani ; 2000, Leenstra *et al*., 2009). However, these studies used school-based supplementation, which did not include girls that were not attending school. Further more; most of the studies did not include the side effects of iron-folic acid supplementation. These studies did not include the inflammatory effects of iron-folate supplementation among this age group. This study is very important to confirm the results of different studies in the Ethiopian context. This study can fill the knowledge gap on the effect of iron-folate supplementation on serum ferritin, folate, hemoglobin level, and weight gain. The findings are essential for designing appropriate interventions to enhance the supplementation for a vulnerable population.

Thus, I have undertaken an intervention study to investigate the effect of community-based weekly supplementation of IFA for 3 months on serum ferritin, folate, blood hemoglobin concentration and weight gain among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia.

Thus, nutritional status, dietary diversity, blood hemoglobin concentration, barberries of nutrition service utilization, and the effect of iron-folic acid supplementation among adolescent girls are important to timely address malnutrition in this age group.

1.2 Objectives

1.2.1 General objectives

To assess nutritional status, dietary diversity, blood hemoglobin concentration, barriers of nutrition service utilization, and effect of iron-folic acid supplementation among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia

1.2.2 Specific objectives

1. To determine the prevalence of stunting and thinness and their predictors among adolescent girls

2. To identify dietary diversity score and its predictors among adolescent girls

3. To determine blood hemoglobin level and its predictors among adolescent girls

4. To identify barriers and facilitators of nutrition service utilization among adolescent girls

5. To determine the effect of community-based weekly iron-folic acid supplementation on serum ferritin level among adolescent girls

6. To evaluate the effect of community-based weekly iron-folic acid supplementation on serum folate level among adolescent girls

7. To examine the effect of community-based weekly iron-folic acid supplementation on the hemoglobin concentration among adolescent girls

1.3. Research questions

1. Is the magnitude of undernutrition public health problem among adolescent girls in Wolaita and Hadiya Zones, Southern Ethiopia?

2. What are the factors affecting nutritional status among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia?

3. Is the magnitude of anemia public health problem among adolescent girls in Wolaita and Hadiya Zones, Southern Ethiopia?

4. What are the factors affecting blood hemoglobin concentration among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia?

5. Is the magnitude of low dietary diversity score public health problem among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia?

6. What are the factors affecting dietary diversity score among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia?

7. What are the barriers to nutrition service utilization among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia?
8. What are the facilitators for nutrition service utilization among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia?
9. Does community-based weekly iron-folic acid supplementation have an effect on hemoglobin concentration, serum ferritin, and folate level among adolescent girls?

1.4. Significance of the Study

Adolescence represents a window of opportunity to prepare a nutritionally healthy adult life. Some nutritional problems originating early in life can be potentially corrected, in addition to addressing and maintaining the nutritional status (Delisle *et al*., 2001). It may also be time to consolidate and shape lifestyle behaviors and healthy eating thereby postponing or preventing the onset of nutrition-related chronic disease in adulthood.

Better understanding of nutritional status, dietary diversity score, blood hemoglobin level, and the effect of iron-folic acid supplementation among adolescent girls will have many important public health and policy implications. To the level of my knowledge, there is no study documented in the study area among adolescent girls. Therefore, the results of this study will give information to community health workers, the ministry of health, the ministry of agriculture, and non-governmental organizations that are interested in the safe and effective implementation of nutrition programs to improve the nutritional status of adolescent girls. The findings of this study will be potentially critical to guide health systems planning and strengthening the nutrition services for the implementation of the national nutrition program. The findings can also be used to improve existing policies and programs targeting adolescent girls' nutrition, particularly the prevention and management of stunting, thinness, and underweight in Ethiopia.

Chapter 2 – Literature Review

CHAPTER TWO

2. Literature Review

2.1 Undernutrition among adolescent girls

Prevalence of undernutrition has not declined much in the past 3 decades (Murtagh and Collaboration, 2017). In developing countries the burden of adolescents' undernutrition is not considered as severe. Nowadays it is becoming main public health problem, and interferes with the completion of normal growth and development. This problem gradually leads to weak performance in school, limits maximum productivity and delays menstruation (Organization, 2005). Undernutrition during this period contributes to growth and developmental failure in the prospective children leading to intergenerational cycle of malnutrition(Belachew *et al*., 2011).

Studies conducted in different counties indicated that severe and moderate prevalence of underweight is highest in South Asia; one in 5 girls aged 5–19 years and nearly one-third of their male peers are underweight(Murtagh and Collaboration, 2017). According to the global school-based student health survey, about 4% of girls aged 13–15 years are underweight, although more than 10% of surveyed girls were underweight in Mauritius, Sudan, Bangladesh, Maldives, Cambodia, and Vietnam(Akseer *et al*., 2017). The mean BMI for adolescents aged 10–19 in East Africa, South Asia, Southeast Asia, Central Africa and West Africa were <20 for both female and male adolescents in 2016(Bentham *et al*., 2017).

Another studies from developing countries indicated that the magnitude of stunting among schoo adolescent girls was 12.1% in Kenya, 57.8% in Nigeria and 64.2% in Tanzania (Saydah *et al*., 2013; Lobstein *et al*., 2015). A study conducted among selected secondary school adolescent girls in Nigeria indicated that 21.3% were underweight(Onabanjo & Balogun, 2014). Similarly, study conducted in

Tanzania among adolescent girls indicated that the prevalence of undernutrition was 21%(Cordeiro *et al*., 2012a).

A study conducted in Ethiopia indicated that the overall magnitude of girls with BMI-for-age Z score less than < −2SD was 13.6 %, while 4 % were with less than −3 SD. The overall magnitude of height-for-age Z-scoreless less than −2 SD was 31.5 %, while 14.7 % were with less than−3 SD(Wassie *et al*., 2015). A study conducted at Adama city, indicated that thinness (BMI for age Z score <-2) was 21.3% and 15.6% of the adolescents were stunted. In this study among 21.3% of adolescents with malnutrition, 59.1% and 42.5% of them were born from mothers and fathers who attended school respectively(Roba *et al*., 2016). Another study conducted in Adwa town among school adolescent girls indicated that the overall magnitude of stunting and thinness was 12.2% and 21.4% respectively(Gebregyorgis *et al*., 2016). Another research conducted in 2009 in Tigray, indicated that the magnitudes of thinness and stunting were 58.3%, and 26.5%, respectively(Mulugeta *et al*., 2009). Similarly, a study conducted among adolescent school girls in the Mizan District, southwestern Ethiopia indicated that the overall prevalence of mild stunting, thinness, and being overweight among adolescent girls were 29.3%, 24.4%, and 6.4%, respectively (Berheto *et al*., 2015a).

2.2 Determinants of undernutrition among adolescent girls

A study from different parts of Ethiopia indicated that age, dietary diversity score, and nutrition service utilization were factors affecting low BMI-for-age in adolescent girls. Food insecurity, nutrition and health information were factors determining low height-for-age in adolescent girls (Wassie *et al*., 2015).

A study conducted in Southern Ethiopia among school adolescents indicated that learning at a government school, mothers with no formal education, owning no cattle, skipping meals, and illness in 2 weeks before the survey was significantly associated with thinness. Students who had their own

house and have cattle were more likely to develop overweight/obesity. Maternal education of secondary school was significantly associated with the stunting(Teferi *et al*., 2018). Similarly, study conducted among adolescent girls from rural communities of Tigray, northern Ethiopia indicated that lack of latrine facilities was significantly associated with thinness and stunting. Also, age was a strong predictor of stunting and thinness in this study (Mulugeta *et al*., 2009).

A study conducted among adolescent girls in bale zone Ethiopia indicated that monthly income, meal frequency, meal skipping, and dietary diversity were the associated factor for the nutritional status of adolescent girls(Mohammed & Tefera, 2015). A study conducted in northern Ethiopia among adolescents indicated that age and residency were associated with stunting(Melaku *et al*., 2015).

A community-based cross-sectional study conducted in Amhara Regional State of Ethiopia indicated that being in the age group 10–14 years, poor dietary diversity score, utilizing community-based nutrition service were factors significantly associated with thinness among adolescent girls and having nutrition and health information, living in food secured households were factors affecting low height-for-age in study subjects(Wassie *et al*., 2015). A study conducted among school adolescents indicated that there is a positive association between the socioeconomic status and the nutritional anthropometric indices of participants(Rampersaud *et al*., 2005). Similarly, family type, family size, birth order, physical exercise, nature of mothers' work, and time spent viewing television doesn't have a significant influence on the adolescents' body mass index percentile(Kelvin and Sanusi, 2016) . A study conducted at school adolescent girls in Adama City indicated that predictors of under-nutrition among adolescent girls were: being born from uneducated father and mother, their fathers' occupation of being a merchant, adolescents with low dietary diversity, monotonous diet, and adolescents attending government schools (Roba *et al*., 2016). A study conducted at Gondar City northwest Ethiopia indicated that the middle age of adolescence, unsatisfactory media exposure, and poor mother's

education were significantly associated with stunting (Birru *et al*., 2018a). However, these studies used only school adolescent girls who were not representative of adolescent girls who were not at school.

2.3 Growth of adolescent girls

Adolescence is a critical period of accelerated linear growth. The most important event that makes the growth in adolescence differ from that in childhood is the adolescent growth spurt, which is related to puberty (Almlund *et al*., 2011). Different studies indicated that physical growth faltering affected a substantial share of children in the age range 8 to 15 years, with major negative consequences for cognition and school outcomes (Fink & Rockers, 2014).

A study conducted among selected secondary schools adolescent girls in Nigeria indicated that 21.3% were underweight (Onabanjo & Balogun, 2014). Similarly, a study conducted in western Kenya indicated that the overall prevalence of stunting and thinness was 12.1 and 15.6%, respectively (Leenstra *et al*., 2005). Likewise , the study conducted in Tanzania among adolescent girls indicated that the prevalence of undernutrition among adolescents in this study was 21% (Cordeiro *et al*., 2012b). However, these studies used only school girls which cannot include non-schooling girls. Another study conducted in Adwa Town among adolescent school girls indicated that, overall prevalence of thinness and stunting was 21.4% and 12.2% respectively (Gebregyorgis *et al*., 2016). Another study conducted in 2009 at rural communities of Tigray, Northern Ethiopia, indicated that prevalence of stunting and thinness were 26.5% and 58.3%, respectively (Mulugeta *et al*., 2009). Similarly, study conducted in school adolescent girls in the Mizan District, southwestern Ethiopia indicated that overall prevalence of mild stunting, thinness, and being overweight among adolescent girls were 29.3%, 24.4%, and 6.4%, respectively (Berheto *et al*., 2015b). However, all these studies did not assess the general prevalence of undergrowth of adolescent girls in the community. Because of they used only school adolescent girls which did not include out of school adolescent girls.

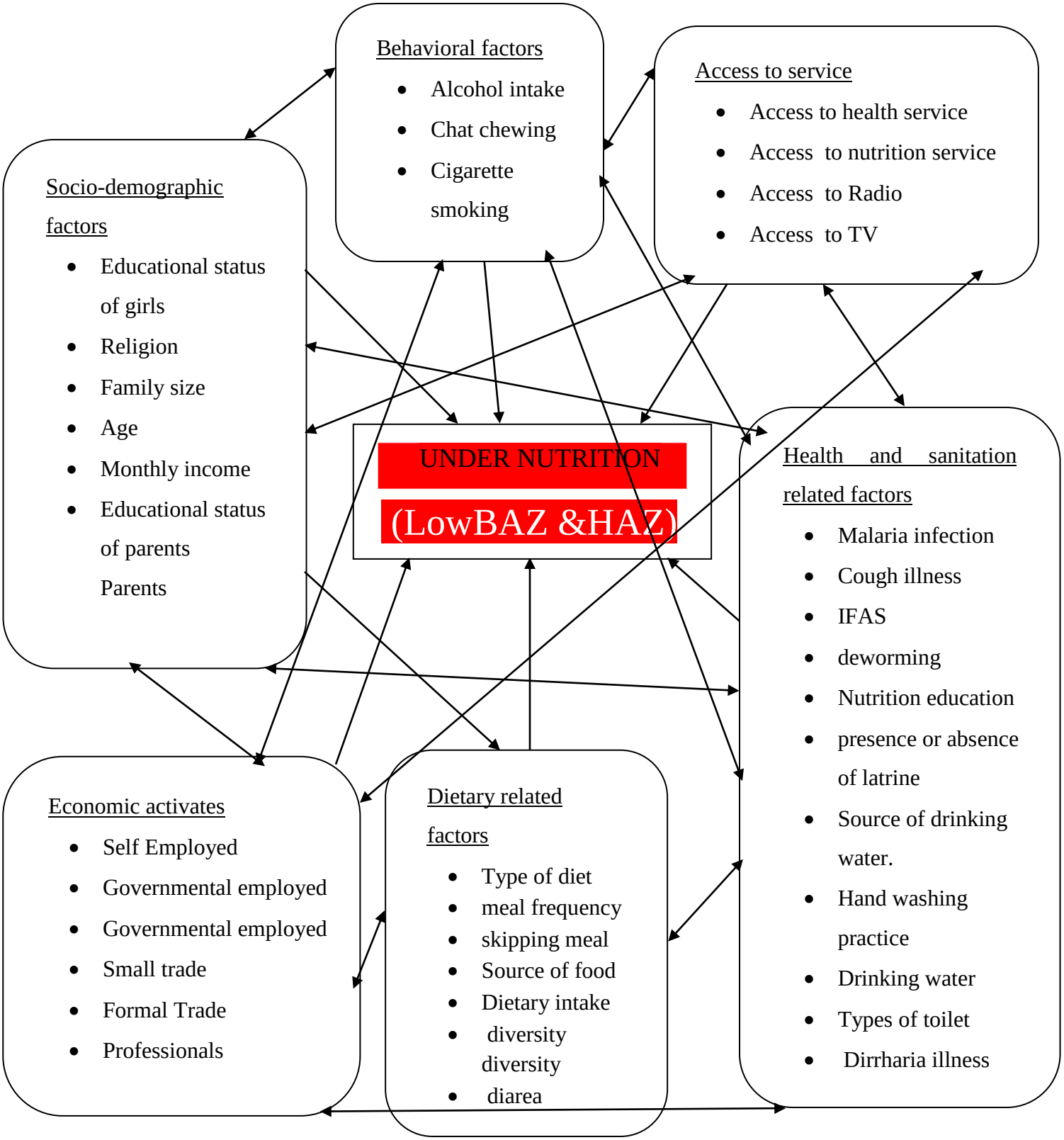

Figure 1. Conceptual Framework for low nutritional status: Reviewed from literatures

2.4 Dietary diversity and its predictors among adolescent girls

Dietary diversity is the number of foods consumed over a reference period. Different studies indicated that it is an indicator of diet quality. It indicates the idea that increasing the diversity of food groups in the diet helps confirm acceptable consumption of important nutrients and encourages good health(Trumbo *et al*., 2001). There are confirmations from both advanced and developing countries show that eating diversified diet is related with nutrient appropriateness and thus is an important element of diet quality (Kurniawan *et al*., 2006).

A study conducted in Ahvaz-Iran indicated that the mean and SD of the dietary diversity score was 6.81±1.75(Vakili *et al*., 2013). Similarly, a study conducted at the University of the Philippines indicated that in the average DDS of the adolescents (3.94) was low which means that their diets were not that much diverse. This may be due to low DDS for dark green leafy vegetables. This is probably due to the typical consumption of fast food items like hamburgers, pizza, etc. among adolescents(Bullecer *et al*., 2012). However, the study used only the age group of 16-19 years old. In addition to this study employed a stratified random sampling method among college students only. Another study conducted in southwestern Nigeria indicated that the mean dietary diversity score (DDS) was 2.6 ± 1.058(Olumakaiye, 2013). However, this study used adolescent girls attending government-owned schools in rural areas only. This study was not inclusive to know the overall practice of dietary diversity in the study area.

A study conducted among adolescent girls in Adama City 4.2(41.2%), (Roba *et al*., 2016), Jimma Town 4.34(61.3%) (Melaku *et al*., 2017) and Gurage Zone 4.69(53.2%) (Meron Worku, 2017) indicated high prevalence of low dietary diversity score. However, studies used only school-based adolescents, which cannot include all adolescent girls.

A study conducted at Ahvaz-Iran among school adolescents indicated that a weak economic situation was a risk for poor dietary diversity score (Vakili *et al*., 2013). Food insecurity and rural residence were negatively associated, and household income was positively associated with a diversified diet. Likewise, dwelling in semi-urban areas and the urban area was positively related with a diversified diet. Girls were less likely to have a diversified diet compared with boys (Belachew *et al*., 2013).

A study from Tanzania indicated that female-headed families have low dietary diversity score compared to those in male-headed families. Most of the time women and adolescent girls access diete which were less diversified.

Production of vegetables helps to improve the quality of diet of women. Gender and education of family head and nutrition training are important factors influencing the dietary diversity of the members of a household(Ochieng *et al*., 2017). Similarly, a study conducted in Rural Burkina Faso indicated that seasonal variation of food availabilities affects dietary diversity(Savy *et al*., 2006). Another study from urban northwest Ethiopia among adolescent girls indicated that eating out of home was positively associated with dietary diversity(Lachat *et al*., 2009).

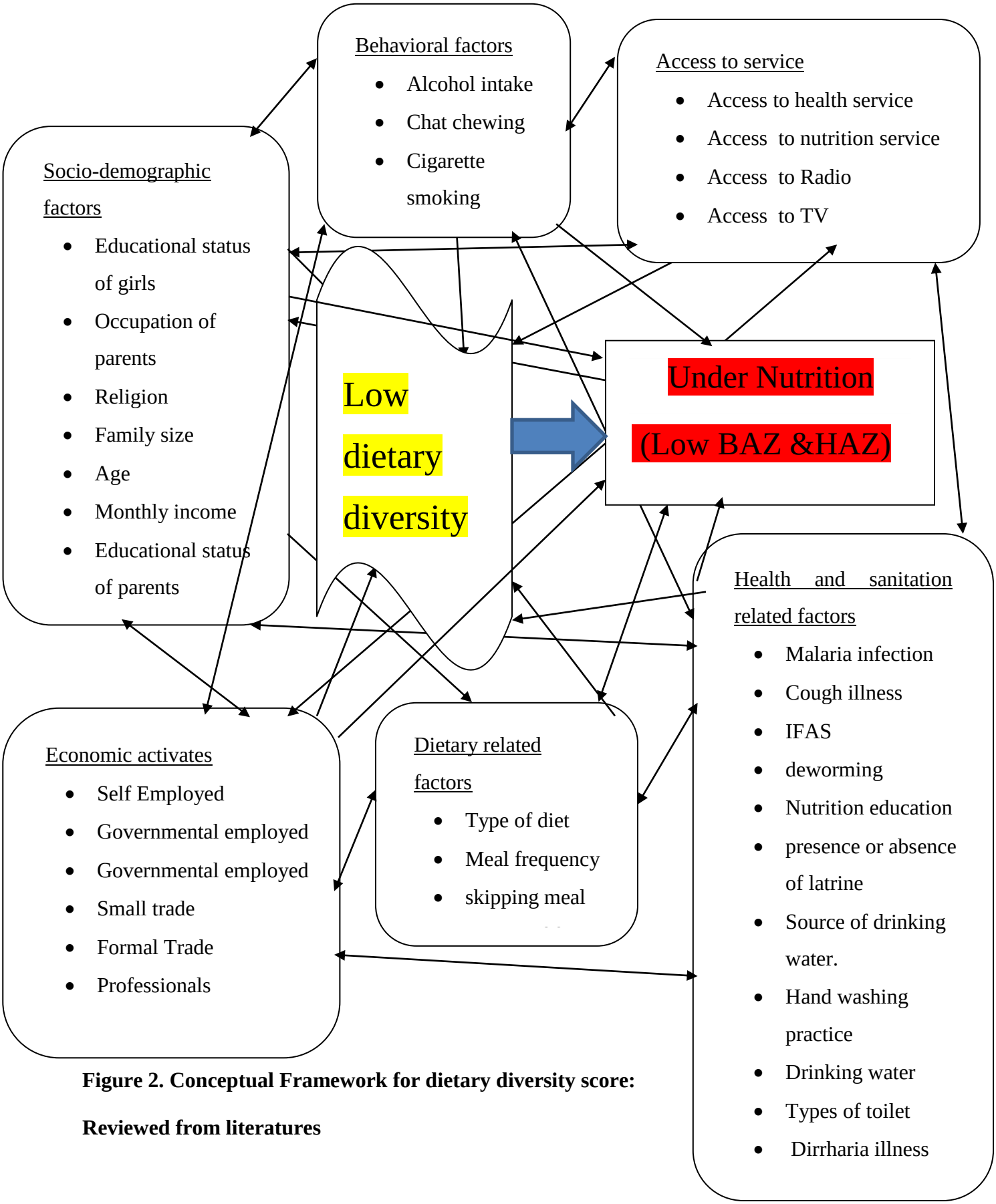

Figure 2. Conceptual Framework for dietary diversity score:

Reviewed from literatures

2.5. Hemoglobin concentration and its predictors among adolescent girls

The public health influence of iron deficiency include reduced work capacity, anemia, mental performance, poor growth and development, weak control of body temperature, impairments in intellectual performance and behavior, and weak resistance to infections (Onabanjo and Balogun, 2014, Bowman and Russell, 2001).

The prevalence of anemia among adolescent girls from developing countries is high (Hung *et al*., 2005). Iron-deficiency anemia is the most common nutritional problem in the world(Lien *et al*., 2006). World Health Organization statistics indicates a worldwide anemia prevalence of about 30% with higher rates in developing countries (Parimalavalli *et al*., 2009). About 80% of the world's population may be an iron deficit, whereas 30% may have iron deficiency anemia (Stoltzfus, 2001). Poor iron status may be caused by inadequate dietary intake, poor absorption, parasitic infection, and medical conditions that cause internal bleeding(Lieu *et al*., 2001).

A study conducted in India indicated that a higher proportion (42.1%) of the anemia were recored among adolescent girls aged between 13-15 years (Srivastava *et al*., 2017). A study conducted in Nepal showed that the magnitude of anemia from iron deficiency among the adolescent populations was 56.3% with the distribution of females and males 29.4% and 26.8%, respectively. Among anemic subjects, the incidence of anemia in female 52.3% and male 47.7% (Sinha *et al*., 2012). However, hospital based retrospective study cannot be representative for all adolescent and also getting reliable data from secondary record was difficult. Another study conducted in Nepal in 2016 indicated that the overall magnitude of anemia was found to be 51.3%. Prevalence was significantly more in pre-menarche age and undernourished girls (Kanodia *et al*., 2016). However, this study has used only school-going adolescents, and which is not inclusive for no-schooling adolescent girls. Likewise, study from India indicated that 36.4% of adolescent girls were found to be anemic. The

percentage of mild, moderate, and severe anemia in the anemic population was respectively 84.9%, 12.9%, and 2.1%. In this study, hemoglobin concentration was significantly associated with the different socioeconomic class, body mass index, and diet pattern of the study subjects (Patel *et al*., 2017). Similarly, a study conducted in India indicated that the majority of adolescent girls were anemic (75%), and of them, 46.75% had mild anemia, 20.75% had moderate, and 4.5% had severe anemia (Baliga *et al*., 2014). Another study conducted in India in 2013 indicated that 63% of adolescent girl students had hemoglobin levels less than 12 g/dL and 37 g/dL had hemoglobin levels above 12 g/dL. Thus, the prevalence of anemia in school going adolescent girls was 63% (More *et al*., 2013). The result of a study conducted in Kenya showed that 26.5% of adolescent girls are anemic (Nelima, 2015). A study conducted in Nigeria the overall prevalence of anemia was 24.4% while that of iron deficiency 15.0% (Onabanjo and Balogun, 2014). Similarly, a study conducted in the eastern part of Ethiopia indicated that 32% of adolescents were anemic and out of which 1.8% had severe anemia (Teji *et al*., 2016).

Iron deficiency can occur when iron intake from food is less than the body requirements. Iron deficiency anemia affected nearly 2 billion people worldwide. In addition to infancy and early childhood, adolescence is considered at a high-risk level for leading iron deficiency, because of a combination of menstrual iron losses of girls and a rapid physical growth, expansion of blood volume, and increases in muscle mass that occurs simultaneously (Beard, 2000). Significant associations of anemia was found among those belonging to the low socioeconomic status, increased family size, and less parents education(Srivastava *et al*., 2017). Similarly, finding among school adolescent girls in Kebena district, Southwest Ethiopia showed that younger age and frequently walking barefoot were significantly associated with anemia(Teni *et al*., 2017). A study conducted in southern Benin among adolescent girls indicated that subjects having low meat

consumption were more than twice as likely to suffer from iron deficiency. Adolescents consuming less fruits also had a higher likelihood of suffering from iron deficiency. Similarly, individuals whose meat intake was low were two times more likely to affected from iron deficiency anemia (Alaofe *et al*., 2008).

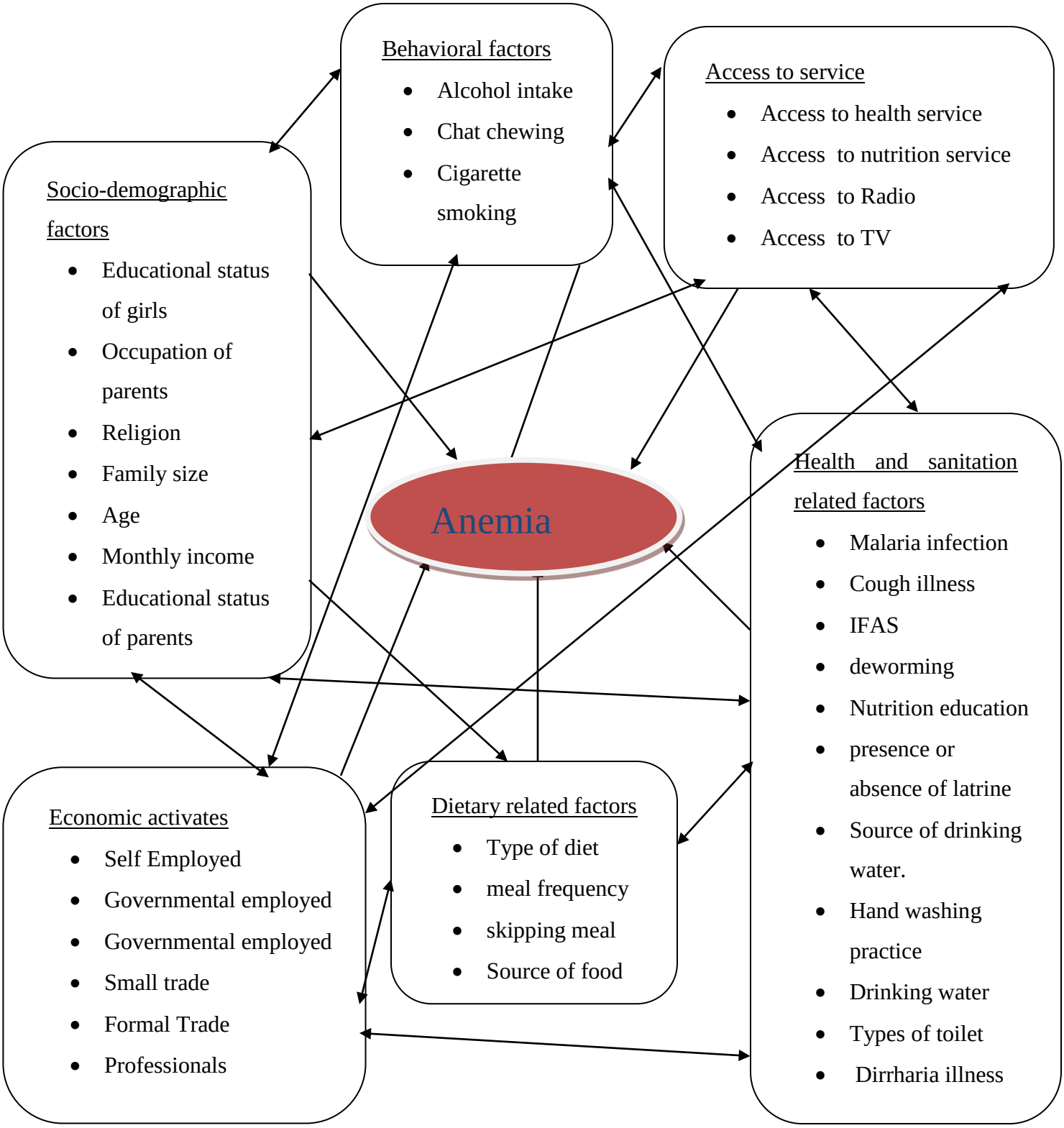

Figure 3. Conceptual framework for low blood hemoglobin level (anemia): Reviewed from literatures

2.6 Nutrition-service utilization among adolescent girls

The nutrient needs of adolescents increase to meet pubertal growth demands, particularly for iron, calcium, zinc, vitamin A, and vitamin D (Calcitriol) in adolescent girls. It was estimated that a moderately active adolescent girl requires a caloric intake of 2,300 kilocalories (kcal) per day(Gidding *et al*., 2005). For this, nutritional care and service are important for adolescents as it is the time for dramatic physical growth and development and changing nutrition due to socio-cultural factors (Nithya and Bhavani, 2018).

Adolescents who are getting nutrition service and well-nourished live healthier lives, with greater resilience to life-threatening diseases. A diet that contains sufficient quantities provides the foundation for the physical growth and cognitive development. Quality diet is important to be succeessful in the workplace and and facilitates economic development (Haddad *et al*., 2015). Promoting adequate nutrition for adolescents is important for their healthy. This means enhancing control of adolescents over their food and food security, and improving their access to appropriate nutrition services, in addition to strengthening food-related skills and encouraging healthy eating and lifestyle(Breinbauer and Maddaleno, 2005). For promoting healthful nutrition practices in adolescents, the challenge is to develop interventions that succeed in increasing motivation, while decreasing barriers to eating a healthful diet and being physically active. In the developed countries, nutrition services reduced the unfavorable consequences of malnutrition and teenage pregnancy. It may be underlined again that nutrition interventions with adolescent girls are more relevant before pregnancy as a means of improving nutritional status at the onset of pregnancy, and that delaying the first pregnancy should be the central goal anywhere (Delisle, 2005). Nutrition education, food security, and access to nutrition services are the three major components of nutrition promotion. The health-care sector should primarily involve in providing nutrition education and services, but health workers have to be aware of

food security issues and link with food security programmers. Food security is a critical environmental determinant of nutritional health. It is only to the extent that people have access to food and some margin for a choice that nutrition education can be meaningful. A study conducted in Nigeria recommended that nutrition education should be intensified among female adolescents to improve their nutritional knowledge and to make them realize the importance of choosing healthy food for healthy living (Olumakaiye, 2013). A study conducted in the Amhara region indicated that only 52.7% of adolescent girls are using community-based nutrition services (Wassie *et al*., 2015). However, these studies did not identify barriers and facilitators of nutrition service utilization and the study areas are not similar to southern Ethiopia. Thus, this study is needed to conduct among adolescent girls in southern Ethiopia.

2.6.1 Barriers to Nutrition-Service utilization among adolescent girls

Studies from developing and developed countries suggests that nutrition services targeting adolescents are poorly coordinated, highly fragmented, and uneven in quality (Chatterjee and Baltag, 2015). In addition to these, health expertise faces several challenges with adolescents as they require specialized skills for consultation, interpersonal communication, and interdisciplinary care (Salam *et al*., 2016a). Another study conducted in Peru indicated that barriers for nutrition service are inadequate program support such as lack of political commitment and financial support, insufficient delivery of services such as lack of supplies, access, training, and motivation of health-care professionals, and participants factors such as misunderstanding of instructions and adverse side effects (Gross *et al*., 2006). Unavailability of the tablets was the most common reason that adolescent girls did not take iron–folate supplements. This was confirmed by a study of iron-supplementation interventions in different countries that found the major reason for the effectiveness of supplementation programs (Galloway *et al*., 2002). Similarly, inadequate counseling of girls, difficult access to nutrition services, and fear of

taking tablets may be factors contributing to the low effectiveness of supplementation programs(Yip, 2002). However, these studies are old and the study areas are not similar to southern Ethiopia. Thus, this study is needed to conduct among adolescent girls in southern Ethiopia.

2.6.2 Facilitators for Nutrition-service utilization among adolescent girls

For the implementation of the nutrition program, federal guidelines on the structure, role, and function of multi-sectoral nutrition coordination mechanisms have been developed in Ethiopia(Health, 2016). The Ethiopian NNP provides a framework for multispectral collaboration to effectively deliver nutrition interventions: both nutrition-specific and nutrition-sensitive(Health, 2016). The national nutrition coordination body and technical committees oversee central level coordination, while similar structures were mandated at regional, district, and community levels. The routine function of the committees is monitored through reporting systems and supportive supervision.

The Ethiopian national nutrition program II (2016-2020) incorporated initiatives to improve the nutritional status of adolescent girls, but which interventions under which circumstances are not effective (Bekele *et al*., 2008). So, this study is needed to know effective facilitators for implementation.

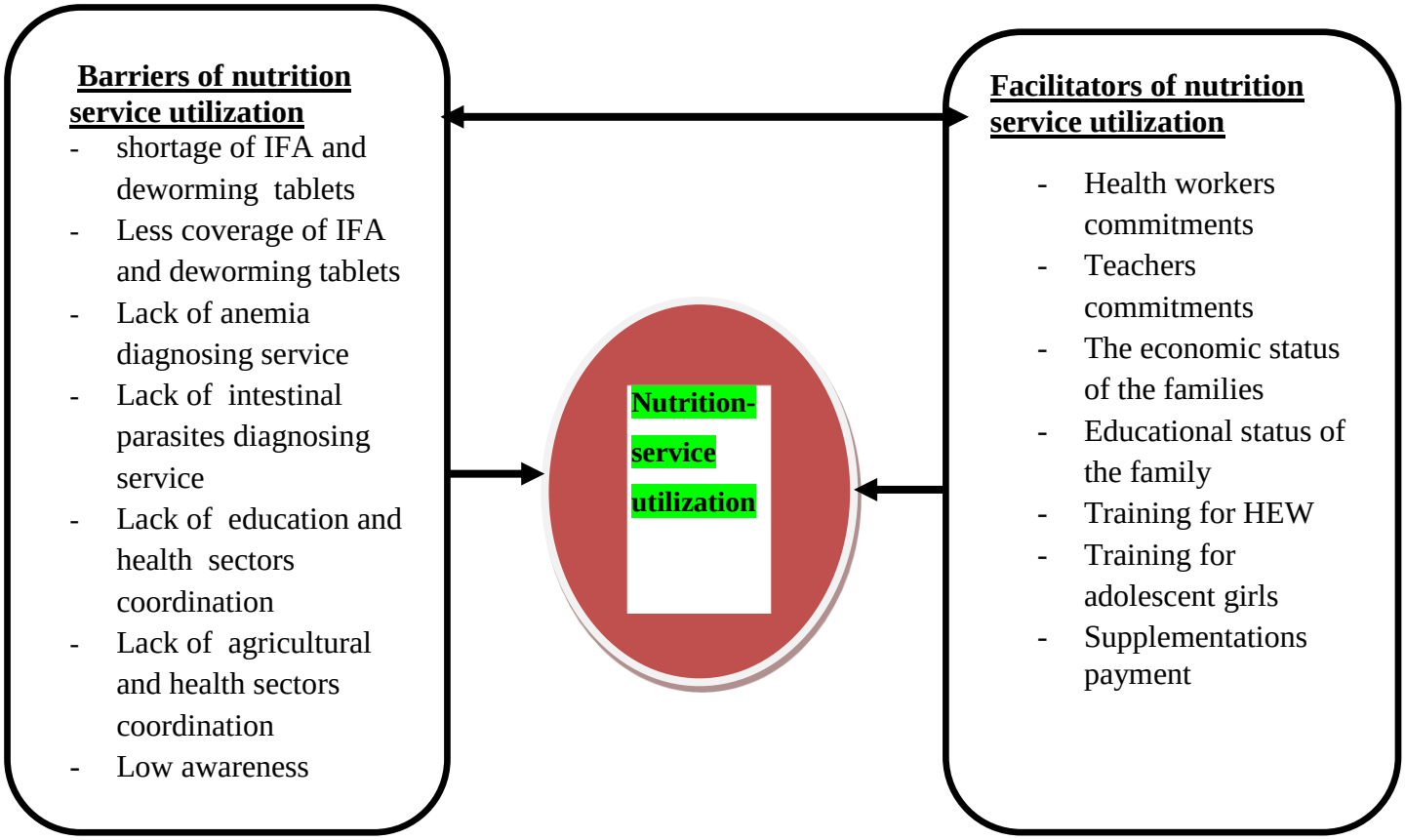

Figure 4. A conceptual framework for barriers and facilitators of nutrition service

2.7 The effect of Iron-Folate supplementation on Hemoglobin concentration, Weight gain, and Inflammation status among adolescent girls

The study conducted in an urban slum area of India indicated that the rise of mean hemoglobin level in the weekly IFA supplementation group was 1.8 gm/dl. That was weekly supplementation IFA showed positive significant results (Gumashta, 2013). There was a significant post-intervention improvement in anemia status among all the study subjects who were moderately anemic and the prevalence of moderate anemia was reduced from 31.66% to 8.33%. This result was hopeful for weekly IFA supplementations as good opportunity regimes for the control and prevention of anemia in adolescent girls(Gumashta, 2013, Bansal *et al*., 2016a). However, this study used only anemic adolescent girls which cannot tell the effect of weekly iron folate supplementation on non-anemic adolescent girls.

Another study conducted in the Uttar Pradesh area of India indicates that after 6 months of weekly iron-folic acid supplementation, the mean hemoglobin value improved significantly from 11 to 11.8 g/dl. In general, the percentage of adolescent girls with anemia decreased from 55.0% to 39.8%. From this the prevalence of severe anemia decreased from 2.3% to 1.0%, the prevalence of moderate anemia decreased from 15.3% to 4.9%, and the prevalence of mild anemia decreased from 37.4% to 33.9%. In addition to this, hemoglobin levels were also measured and showed significant increment (Sheila C. Vir, 2008b). Similarly, another study conducted in western Kenya indicated that school-based weekly iron supplementation in girls aged 12–18 has resulted in substantial increases in hemoglobin concentration(Leenstra, 2009). However, this study included only adolescent girls with mild-to-moderate anemia. Another study conducted in Vadodara-India indicated that the iron-Folic acid supplementation group showed significant higher hemoglobin increment than the control. The mean hemoglobin increment among initially anemic girls in the supplemented group was higher than those among initially non-anemic girls(Kanani, 2009). Another community-based interventional study was

carried out in India, showed that hemoglobin levels were increased after intervention in participants and it was statistically significant. At the baseline, mild anemic girls were 28.6% and moderate anemic girls were 39.2% and after intervention, mild anemic was 48.15% and moderate anemic was 13.17%. Thus, the declining trend was observed in grades of anemia. There was the conversion of moderate anemia to mild anemia and to non-anemia. After intervention mild and moderate anemia was 65% and 10%, respectively. There was a decline of moderate anemia to mild anemia(Bina M. Kuril, 2016). However, this study used only anemic adolescent girls and the study area is different to this study.

The study in India indicated that there was an increase of 19.55 g/L hemoglobin in the group of girls taking IFAS whereas hemoglobin reduced slightly in girls in the control group(MITTAL M. BHANUSHALI, 2011).

A study conducted in Vadodara indicated that each of the intervention groups showed significantly higher hemoglobin increment than the controls, with the mean hemoglobin increment the highest in the IFA weekly group. The mean hemoglobin increments among initially anemic girls in all the supplemented groups were higher than those among initially non-anemic girls (Kanani, 2009).

An experimental placebo control study conducted in India indicated that the effect of Iron-folate supplementation has shown the difference in weight gains compared with the control group. A significant weight gain of 0.83 kg was seen in the experimental group. That was the experimental group had a significantly better BMI response to supplementation than the control group(Poojara, 2000).

Another study conducted in Tanzania indicated that iron supplementation led to a significant increase in weight gain. This might be improved appetite leads to increased dietary intake (N. M. R. Beasley, 2000). Similarly, the study undertaken in 2007, in Mumbai, India, showed that there was an increment of 2.66 kg weight in the group of girls receiving IFA supplements than in the control group. A significant weight gain of 2.66 kg was seen in the intervention group, but girls in the control group

showed only little weight gain. The experimental group also had a significantly better BMI response to supplementation than the control group. This might be the food intake of the girls was increased during the study period in the experimental group (MITTAL M. BHANUSHALI, 2011). However, iron-folate was given with calcium tablets i.e. the effect of iron-folate and calcium on weight gain was not identified separately. A similar experimental-control study done in Vadodara in India among school girls from families with low-income group indicated that high dosing with iron folate resulted in higher hemoglobin levels. In addition to this, adolescent girls with iron folate acid supplementation achieved higher weight gains as suggested in a study on anemic preschool children (Kanani, 2012,). However, this study used a small sample size and school adolescent girls which can be influenced by the interest and cooperation of the school teachers.

The study conducted in an urban slum area of India indicated that abdominal pain was the common adverse effect noted in 11.6% of study subjects. A total of 8.3% of study subjects has an adverse effect on the weekly iron-folate supplementation group. Abdominal pain was the commonest adverse effect seen in 6.6% of the weekly iron-folate supplementation group. In addition to this constipation, nausea, and skin rash were also other adverse effects seen in the iron folate supplementation group(Gumashta, 2013).

Another study conducted in different parts of the world indicated that oral iron therapy has a high incidence of gastiro intestinal(GI) side effects such as epigastric pain and diarrhea that lead to discontinuation of therapy in up to 21% of patients(GASCHE, 2006).

Side effect and non-compliance can be improved if iron-folic acid supplementation is in low dose. Oral iron should be underway at a low dose once daily after meals. If individuals adopted for iron-folic acid, taking in an empty stomach to increase iron absorption. Within 7-14 d of therapy, an increase in reticulocyte count would be expected and within 2 months Hb level should return to normal. Oral iron

replacement should be continued to replenish iron stores, usually for an additional 4 to 6 months after Hb normalization. In addition to its GI side effects, oral iron may worsen inflammatory bowel disease (IBD) as a result of non-absorbed iron-mediated toxic reactive oxygen species (Julie Carrier, 2002). However, this study used only hospitalized patients. A study conducted in Uttar Pradesh, India indicated that twenty-eight girls (18.7%) reported side effects, such as vomiting, nausea, diarrhea, and black stool (Sheila C. Vir, 2008a).

2.8. Summary of the literature reviews: What is known and what is the Gap?

Even though adolescence is a period of vulnerability, most nutrition policies and programs in some developed countries and in many of the Low and Middle Income Countries (LMICs) are not given attention to the impact of diet on their health and wellbeing. This might be due to the understanding that adolescent girls are the healthiest segment of the population(Sichert-Hellert et al., 2011). There is a gap in research, policy and action related to adolescent girls' nutrition and its consequences on health and nutritional status.

Global evidence on adolescent girls' nutrition and health is inconsistent. Even though Promoting health and nutrition services of adolescence girls and protecting young people from health risks is critical to the future of countries' health and social infrastructure, nutrition service utilization effectiveness is often limited without known factors(Van Cauwenberghe et al., 2010). Furthermore some studies conducted have used school-based supplementation which did not include girls that were not following school. In addition to this, most of the studies did not include the side effect of iron-folic acid supplementation and did not adjust for the effects of the inflammatory iron-folate level. Mony studies on the effect of weekly iron-folate supplementation on serum folate, serum ferritin and hemoglobin concentration were mostly from developed or middle income countries and may not equaly generalized

for Ethiopian setting. So, this study is very important to confirm the results of different studies in the Ethiopian context.

In southern Ethiopia, there is no evidence on the adolescent girls' nutrition. A study among adolescent girls in the northern part of the country showed that 26.5% of the girls were stunted and 58.3% were thin(Mulugeta et al., 2009). Another study conducted in Amhara region northern Ethiopia indicated that prevalence of girls with BMI-for-age Z-score < −2 were 13.6 % and height-for-age Z-score < −2 were 31.5 %(Wassie et al., 2015). A national survey also showed that three quarters of all girls were consuming less than three meals per day and one third skipped a meal in the previous two weeks mostly due to reported food shortage (Messele and Kebede, 2010). However, these studies were conducted among school adolescent girls. In addition to this none of these studies explored barriers and facilitates of nutrition service utilization among adolescent girls. Although the Ethiopian government has a National Nutrition Strategy and National Nutrition program I&II guiding all nutrition related actions in the country, adolescent girls nutritional status in not significantly improved. As a result, there is so far no effective nutrition intervention program that addressed adolescent girls in Ethiopia as in most other developing countries. This study aimed to come up with evidences on the effect of community based iron folic acid supplementation on serum ferritin, serum folate and blood hemoglobin concentration. In addition to this, this study aimed to identify nutritional status, dietary diversity, and barriers and facilitators on nutrition service utilization among adolescent girls in Wolaita and Hadiya zons, southern Ethiopia.

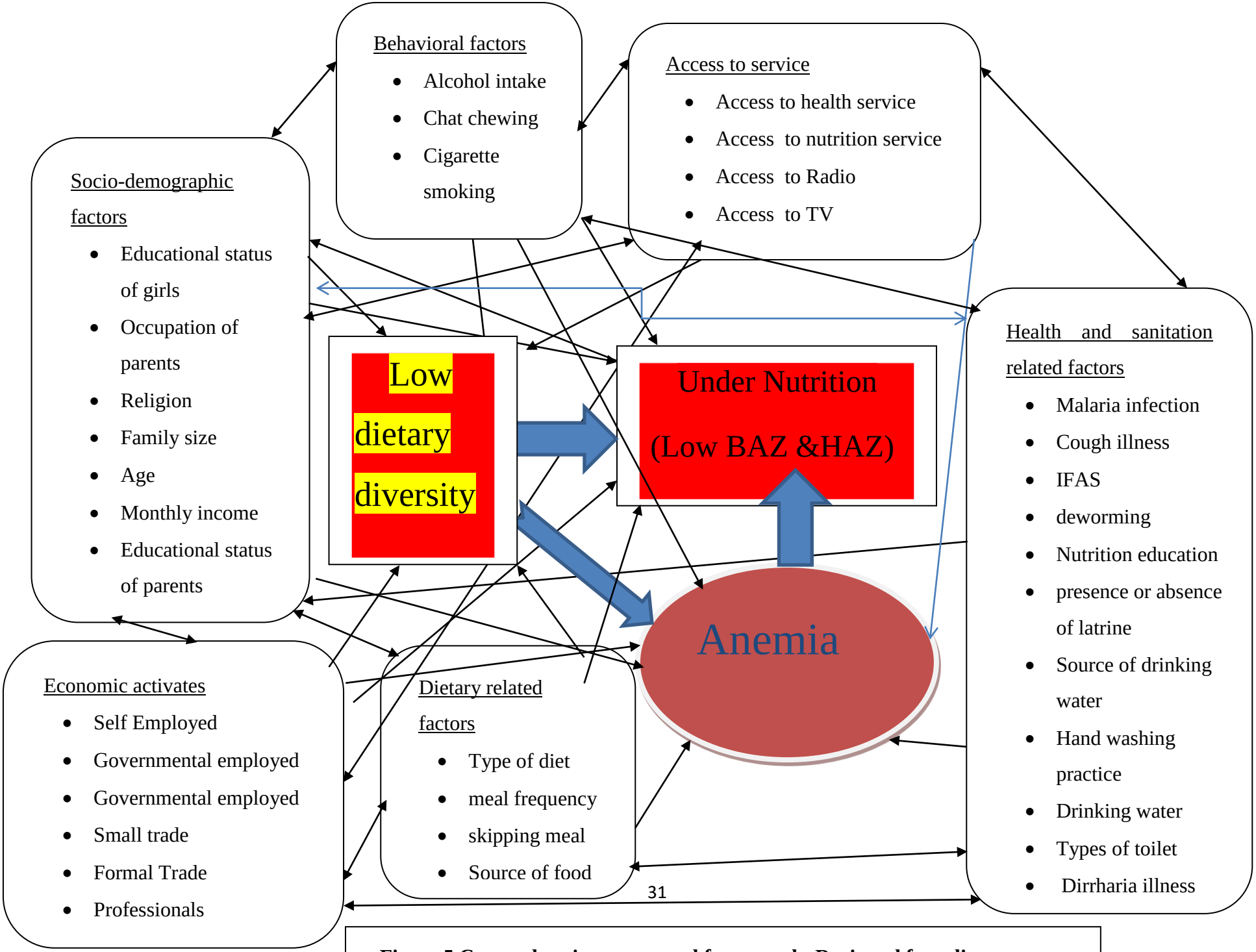

Figure 5.Comprehensive conceptual framework: Reviewed from literatures

Chapter 3-Materials/Subjects & Methods

3. Materials and Methods

The present dissertation had five major parts. The first part has investigated undernutrition and associated factors. The second part has identified blood hemoglobin concentration and associated factors and characterized the findings. The third part of the study has included dietary diversity of adolescent girls which was assessed by using 24h qualitative dietary recall and dietary diversity was determined based on FAO standards(Kennedy *et al.*, 2011). The fourth part of the study has identified barriers and facilitators of nutrition service utilization among adolescent girls. The fifth part of the study has determined the effect of iron-folic acid supplementation on hemoglobin concentration, serum ferrietin, serum folate and CRP.

3.1 Study Setting'

The study was conducted at Humbo District in Wolaita Zone and Misrak Badewacho District in Hadiya Zone of Southern Ethiopia. These zones are predominantly dependent on agriculture, practicing mixed crop-livestock production and living in permanent settlements. Within their landholdings, community members cultivate fruits, vegetables, roots, and tuber crops.

Humbo District is located 1100 meter above sea level, 6° 40'N latitude and 37° 50'E longitude in South Nation Nationalities and People Regional state (SNNPR), 350 km away from capital city of Ethiopia. The mean annual temperature of the study area is 22.0°C and the mean annual rainfall of 1123.15 mm. The major crops grown in the study area were cereals such as teff, maize, sorghum, cotton and root crops like sweet potatoes, ensete, carrot and fruits like mango, avocado and banana. The staple foods of the study area are cereals.

Misrak Badawacho district is located in Hadiya Zone, South Nations Nationalities and Peoples Regional States (SNNPRS). The capital town of the district is shone that is located at a distance of

271 km away from Addis Ababa city on the way towards Wolaita Sodo, about 120km far from SNNP Regional city -Hawassa and about 97km far from Zonal town, Hossana. Geographically, the absolute location of the woreda is between 70 9‟ 00‟‟‟ to 8^0 15‟‟00‟‟‟ North latitude and 370 5‟ 00‟‟‟ to 400 00‟ 00‟‟‟East longitudes. Its annual rain fall amount ranges from 800 mm to 1300 mm. The majority of the population economy depends on traditional agriculture; the main crops produced in the area are teff and maize (Regional Agricultural office, 2017).

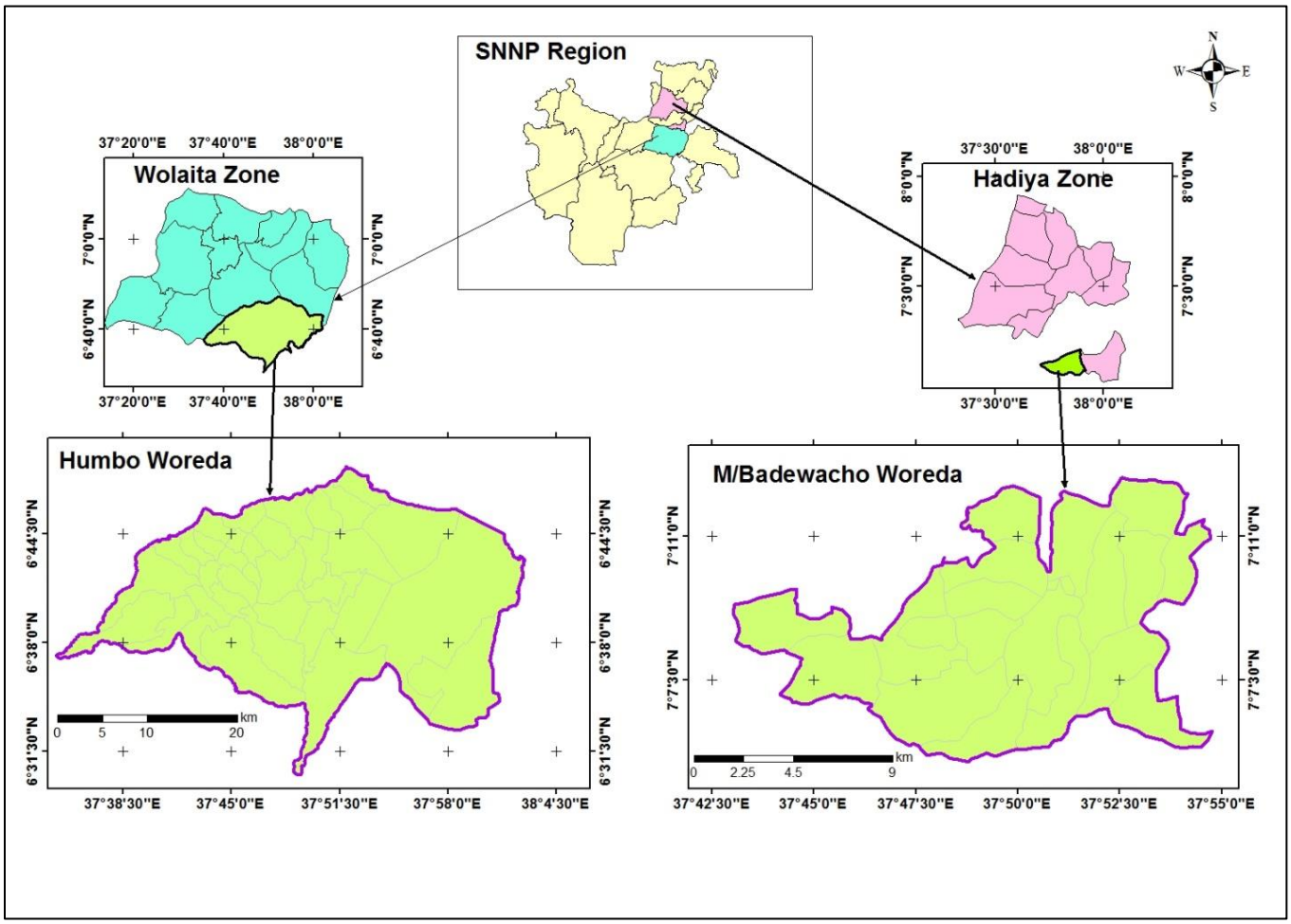

Figure 6. Map of the study area (Wolaita and Hadiya zones) in SNNPR

3.2 Study design and period

This study used a mixed study design (cross-sectional quantitative, qualitative, and randomized control trial). A community-based cross-sectional study was conducted from April 30/2019 to May 30/2019 at two zones in southern Ethiopia.

Table 1. Summary of the studies conducted: study design, population and study period

Paper	Paper Titles	Study design	Study Population/participants	Study period
Manuscript I	Undernutrition and its determinants among adolescent girls in Wolaita and Hadiya Zones, Southern Ethiopia	Cross-sectional	Adolescent girls, age within 10-19 years old	April 30/2019 to May 30/2019
Manuscript-II	Low dietary diversity score and its determinants among adolescent girls in Southern Ethiopia	Cross-sectional	Adolescent girls, age within 10-19 years old	April 30/2019 to May 30/2019
Manuscript-III	Barriers and facilitators of nutrition service utilization among adolescent girls in Southern Ethiopia	A qualitative (FGDs and KII)	1. Adolescent girls 2. HEW, teachers, youths and gender center leaders, and health center expert	April 30/2019 to May 30/2019
Manuscript-IV	Low blood hemoglobin level and its determinant among adolescent girls in Southern Ethiopia	Cross-sectional	Adolescent girls, age within 10-19 years old	April 30/2019 to May 30/2019
Paper -V	Effect of community-based weekly iron-folic acid supplementation on serum ferritin, serum folate and hemoglobin level among adolescent girls	Randomized control trial	Adolescent girls, age within 10-19 years old	April 30/2019 to September 30/2019

3.3. Description of Methods for Nutritional Status, Dietary Diversity and Blood Hemoglobin Concentration

3.3.1 Source population

All adolescent girls (in school and out of school), age within 10-19 years in two zones of Southern Ethiopia were the source population for the study.

3.3.2 Study population

Randomly selected adolescent girls (in school and out of school), age within 10-19 years in two zones of Southern Ethiopia who fulfill the inclusion criteria were the study population.

3.3.3 Inclusion criteria

All adolescent girls, age within 10-19 years in Wolaita and Hadiya zones from southern Ethiopia who have a willingness to give assent/consent as appropriate and whose guardians/parents have a willingness to provide consent to participate in the study (for participants <18 years) and those adolescents of 18-19 ages who provide informed consent were included.

3.3.4 Exclusion criteria

All adolescent girls in the age group 10-19 years in Wolaita and Hadiya zones, Southern Ethiopia who were with physical and mental disability were excluded from the study. In addition to these pregnant adolescent girls were excluded from the study.

3.4.5. Study Variables

3.3.5.1. Outcome Variables /Dependent Variables

Body mass index for age z-score and height for age z-score, blood hemoglobin concentration, and dietary diversity score

3.3.5.2 Independent/Predictor variables

Age, educational status of the adolescent girls, family size, maternal and paternal educational and occupational status, distance from health facilities, access to nutritional counseling services in health facilities, taking the deworming tablet, iron-folic acid supplementation, household monthly income, source of food, number of meals per day, alcohol drinking, smoking, chat chewing, presence or absence of latrine and source of drinking water.

3.3.6 Sample Size Calculation

A single population proportion formula [$n=z\frac{\propto 2}{2}P\ (1-P)/d^2$] was used to estimate the sample size. Fromthe literature review, the prevalence of thinness (24.4%), stunting (29.4%), anemia (32.1%), not using nutrition service (47.3%), and low dietary diversity (46.8%) were used for sample size calculation (Table 2). For this study, to estimate the sample size, considering a 95% confidence interval and d=0.05%, the initial sample size was 383. By adding 10% of non-respondents and design effect 2, the final sample size is **843.**

$$\mathbf{n= \frac{(Z_{\alpha/2})^2 * p\ (1-p)\ DE}{d^2}}$$

Where: - Z = Standard normal distribution value at 95% CI= $(1.96)^2$

DE = design effect, d = 0.05(5% margin of error)

Table 2. Sample size calculation for diferent study designs, 2019

No	Variables	Confidence level	d=desired precision	% of Prevalence in not exposed	Prevalence in Exposed??	Sample Size	DE=2	Non-response rate %	Final sample size	References
1	Stunting	95%	5%	29.4		319	2	10	638	(Berheto *et al*., 2015b)
2	Thinness	95%	5%	24.4		284	2	10	625	(Berheto *et al*., 2015b)
3	Anemia	95%	5%	32		334	2	10	735	(Teji *et al*., 2016)
4	Low DDS	95%	5%	46.8		383	2	10	843	(Melaku *et al*., 2018)
5	Not taking nutrition service	95%	5%	47.3		383	2	10	843	(Wassie *et al*., 2015)

3.3.7. Sampling procedures

This study used multistage sampling techniques. From 13 zones in southern Ethiopia, two zones (Wolaita and Hadiya) were selected by purposive sampling , because there is no community based study conducted among adolescent girls. Then, from these selected two zones, two districts were selected based on a simple random sampling procedure. One district was selected from each zone. These are Humbo District from the Wolaita Zone and Misrak Badawacho district from the Hadiya Zone. Three villages were selected from each district by a simple random method. Listing of adolescent girls was conducted at these selected Villages. Listing of adolescent girls age ranges within 10-19 years was established with the help of the local government administration/woreda in particular and more importantly by health extension workers. During the listing of adolescent girls, if more than one adolescent girl was available in one household one adolescent girl was selected by the lottery method.

Eitht hundred forty six (843) participants were allocated to these selected six villages depending on the number of adolescent girls in each village. Participants were drawn from each village based on proportional to size (PPS) allocation sampling techniques depends on the number of adolescent girls in each village. From these lists, **843** adolescent girls were selected by simple random sampling method. Those adolescent girls who are not eligible for the study were excluded.

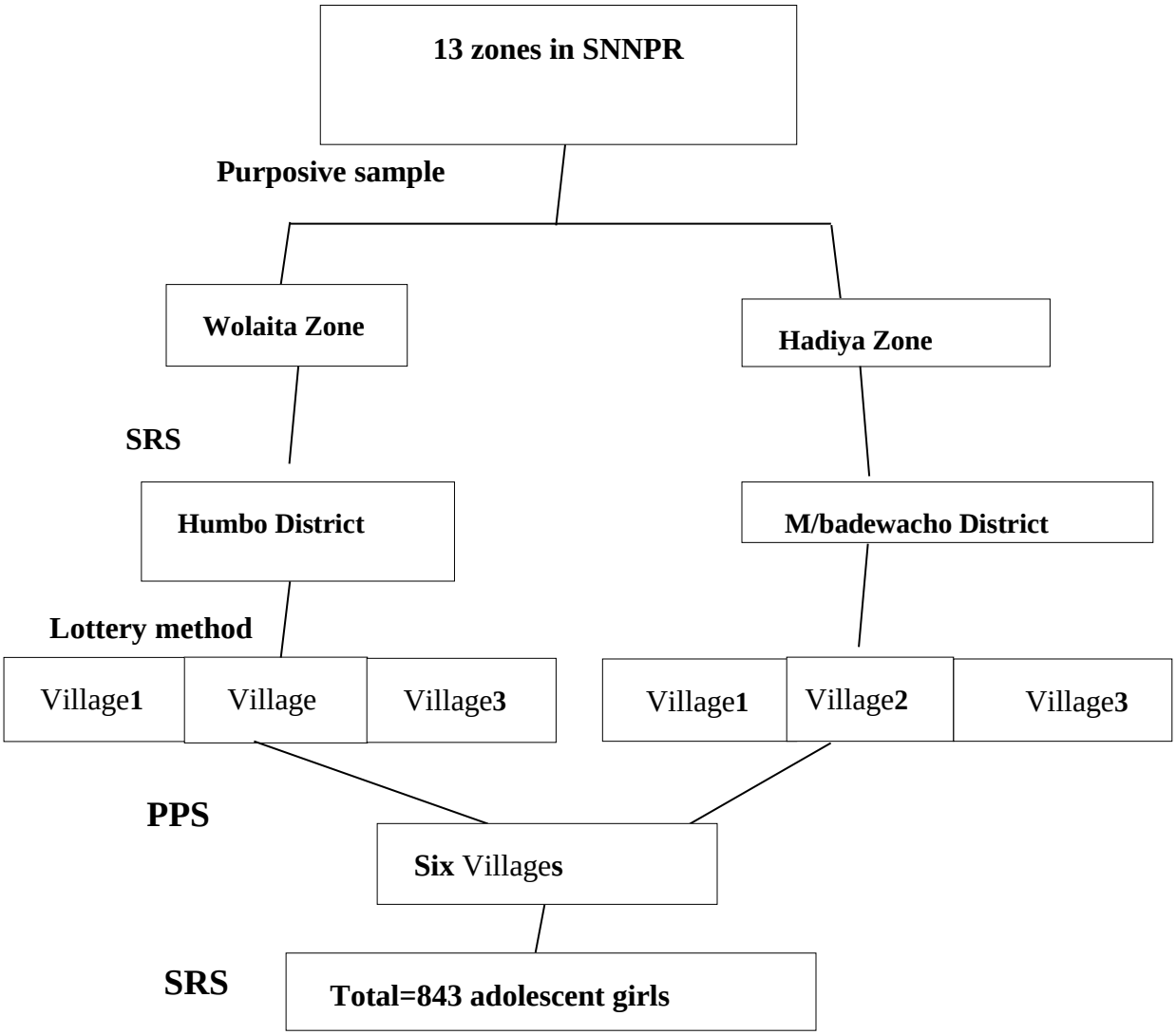

Figure 7. Flow-diagram for sampling technique

3.3.8 Anthropometric measurements

Anthropometrics (height and weight) was measured on all sampled adolescent girls. The weight of sampled adolescent girls was measured with light clothing and without shoes to the nearest 100g using a standard SECA digital scale. The scale was calibrated/ checked for a correction after moving from one participant to the next. The height of sampled adolescent girls was measured in a standing position to the nearest 0.1 cm using a vertical board with a detachable sliding headpiece. Body mass index for age z-score and height for age z-score was calculated out of height, weight, and age of the participants.

3.3.9 Hemoglobin screening using venous blood

Adolescent girls were assessed for hemoglobin concentration. For hemoglobin analysis, 5ml venous blood sample was collected by using clean syringe. The experienced laboratory technician trained on the field blood sample collections procedures and hemoglobin concentration analysis on the field. The prevalence of anemia was calculated based on the hemoglobin concentration / standard cut-off points for hemoglobin concentration measured in venous blood samples using a Hemocue photometer which was processed on the field (Hemocue R, Hb 301+ system). Biological hazards were discarded in hazard boxes and burned in the incinerator at the health centers.

The hemoglobin (Hb) concentration was adjusted for altitude before defining anemia. The adjustment was done to account for a reduction in oxygen saturation of the blood. I used the following formula for adjustment of hemoglobin for altitude. Hb adjustment = -0.032 *(altitude + 0.003280) + 0.022 *(altitude + 0.003280)^2. The average altitude of Misrak Badawacho is 1450 meters above sea level (Worku, 2016) and the average altitude of the data collected area of the Humbo district is 1356 meters above sea level. Where the Hb adjustment was the amount subtracted from each individual's observed hemoglobin concentration.

3.3.10. Dietary Assessment

A structured 24-hour dietary recall (24HR) interview was conducted to capture detailed information about all foods and beverages consumed by the respondents in the past 24 hours, most commonly from sunrise in the previous day to sunrise on the interview day. In addition to this, a food frequency questionnaire was conducted to know the usual frequency of consumption of food over the time period. The food frequency questionnaire contained a finite list of foods and beverages with response categories to indicate the usual frequency of consumption.

The dietary diversity score was calculated by summing the number of food groups consumed by the individual respondent over the 24-hour recall period. First, new food group variable were created for those food groups that need to be aggregated, then a new WDDS variable was formed. Finally, Values for the dietary diversity score were computed by summing all food groups included in the dietary diversity scores.

3.3.11 Data collection

A structured interviewer-administered questionnaire was used to collect data. The questionnaire was developed based on the objective of the study after thoroughly reviewing different literature. A total of eight data collectors comprising BSc holder nurses, with previous experience of data collection and who have knowledge of culture, language, and norms of the community were employed to collect data using a pretested structured questionnaire. In addition to this, two MSc in public health holders were employed to supervise the data collection process. Data were collected on the weekends for adolescent girls who were at school during weekdays. The principal investigator has controlled the overall study activities on daily bases.

3.3.12. Statistical Analysis

First, the data were checked for completeness and consistency for data entry and cleaning. Then, data were entered into the computer using EPI-data version 4.4.2 and exported to SPSS version 21.0 for further analysis. Descriptive statistics such as frequencies, proportions, and cross-tabulation were used to present the data. Before analysis, missing value and outliers were checked by drawing histograms. In addition to this multicollinearity was checked if there was a linear association among explanatory or predictor variables by using variance inflation factor *(*VIF*)* assumptions. Multicollinearity refers to the correlation between two or more independent variables in a multiple regression model. When a variance inflation factor was less than 10, it was taken as tolerable in this analysis. The model was then tested for its goodness of fit by Hosmer and Lemeshow with P values >0.05 taken as fit. In addition, analyses of bivariate logistic regression were done to assess the association between independent and dependent variables. Variables which showed association (p-value ≤ 0.25) in the bivariate analysis were included in the final multivariable logistic regression model. Odds ratio for logistic regression along with 95% confidence interval was estimated. P-value less than 0.05 was used to declare of statistical significance.

3.4 Description of Methods for barriers and facilitators of nutrition service utilization among adolescent girls

3.4.1 Study design

A qualitative cross-sectional study was conducted

3.4.2 Participants

Purposively selected health extension workers, school leaders, gender focal persons, health center experts, and youth center leaders from each village were involved in this study as key informants. In addition to this, a total of 6 FGDs were conducted. Eight adolescent girls were included in each focus group discussion.

3.4.3. Data collection

Key informant interview (KII) - health extension workers, school leader and gender focal person, health center expert, and youth center leader have participated from each village. In total, health

extension workers (n= 6), primary or secondary school leader (n= 6), gender focal person (n= 2), health center expert (n= 2) and youth center leader (n= 2) were involved for key informant interviews (KIIs). Similarly, for focus group discussion- eight adolescent girls in one group have participated in each village. A total of six FGDs were conducted from the two districts. Both FGDs and KIIs were used to triangulate individual and group-level opinions. The KIIs were conducted in an interactive manner, whereby the study participants were encouraged to take an active role in establishing the flow of the interview. FGDs and KIIs were held at the community or nearby health posts or health centers. Qualitative data from FGDS were collected by data collectors who have experience in qualitative data collection procedures. For qualitative data collection, a key informant interviews (KII) were conducted by the participial investigator. All interviews were tape-recorded. Open-ended questions were used to collect relevant information.

3.4.4 Data analysis

Each audiotape interview was professionally transcribed word by word in wolaitegna and Hadiyissa (local language) and then translated to English. The lead author coded all the transcripts followed by conventional content analysis procedure by starting coding categories which derived directly from the text data. The process of analysis was conducted with open coding, identifying concepts, categories, and subcategories. After aggregating and defining the concept, the lead author developed memos that can elaborate on the concepts/categories developed. Finally, the integration of categories was done which was linking categories around a core category. Data were analyzed by using 'Open code software version 3.6.'

3.5 Description of Methods for Randomized Control Trial

3.5.1 Dependent Variables

Blood hemoglobin concentration, serum ferritin level, and serum folate level

3.5.2 Independent variable

Community-based weekly iron-folic acid supplementation

3.5.3 Sample size calculation

The sample size was calculated by using Gpower 3.0. The power calculation was based on a linear regression model with the outcome variable being blood hemoglobin concentration. Assuming power 80% and effect size 0.3 and adding 20% contingency data across the assessments due to attrition and non-response rate, a total of n=226 for a mean hemoglobin concentration, subjects satisfying the inclusion criteria were initially recruited. In the power analyses, effect sizes of interest were associated with the time and intervention group parameters. For the mixed regression analysis, a final sample size of n = 226 provides sufficient power (80%) to detect a 0.3 effect size at a 5% significance level.

Table 3. Sample size calculation by using Gpower 3.0 software on the mean of dependent variables

F tests - ANOVA: Fixed effects, special, main effects and interactions for hemoglobin concentration		
Analysis: A priori: Compute the required sample size		
Input:	Effect size f	0.3
	α err prob	0.05
	Power (1-β err prob)	0.8
	Numerator df	10
	Number of groups	2
Output:	Non-centrality parameter λ	17.100000
	Critical F	1.882176
	Denominator df	185
	Actual power	0.801357
	Total sample size	188

So, by adding 20 % of non-response rate/lost to follow up, the final sample size is 226 [Sample size group1=113 and Control (group2) =113].

3.5.4 Inclusion criteria

All adolescent girls, age within 10-19 years at selected four villages of the Humbo District in Wolaita Zone and Misrak Badawacho District in Hadiya Zone who have a willingness to give consent or whose

guardians/parents have a willingness to provide consent to participate in the study were included.

3.5.5 Exclusion Criteria

All adolescent girls in the age group 10-19 years at selected four villages from Wolaita and Hadiya Zones who were with a known disease like (HIV/ADIS, TB), anemic**,** positive for malaria parasites based on a blood smear, physical and mental disability were excluded from the study. In addition to this individuals who were smoking or alcoholism were excluded. Diagnose of TB, HIV, and malaria was conducted during the recruitment of participants. For the diagnosis of these diseases physicians, laboratory technicians, and Phlebotomist have participated. During recruitment, the biological sample which was collected was tested in the medical laboratory of Wolaita Sodo university referral hospital.

3.5.6 Study Design/ Randomization

A community-based, individually randomized trial (RCT) was conducted at four villages of Wolaita and Hadiya Zones. Randomization was with one intervention group and one control group. The intervention group has taken weekly iron-folic acid supplementation, and the control group has not taken supplementation from each village. The overall study has one treatment arm and one control arm. In the four selected villages, a list of adolescent girls who were eligible for inclusion in the study was established with the help of the health extension worker. From this list, 226 adolescent girls were selected by a simple random selection method. Then, these adolescent girls (226 in total) were randomly assigned to the intervention group (G1= 113) and the control group (G2=113). To assign study participants to the experimental and control groups, two hundred twenty-six pieces of paper with letters marked G1 and G2 to represent the two study arms were rolled into balls and placed in a plastic container. The rolled pieces of paper were mixed thoroughly through the shaking of the container. An independent person then picked the pieces one by one from the container. The unique number-letter became the subject and the group assignment for each participant.

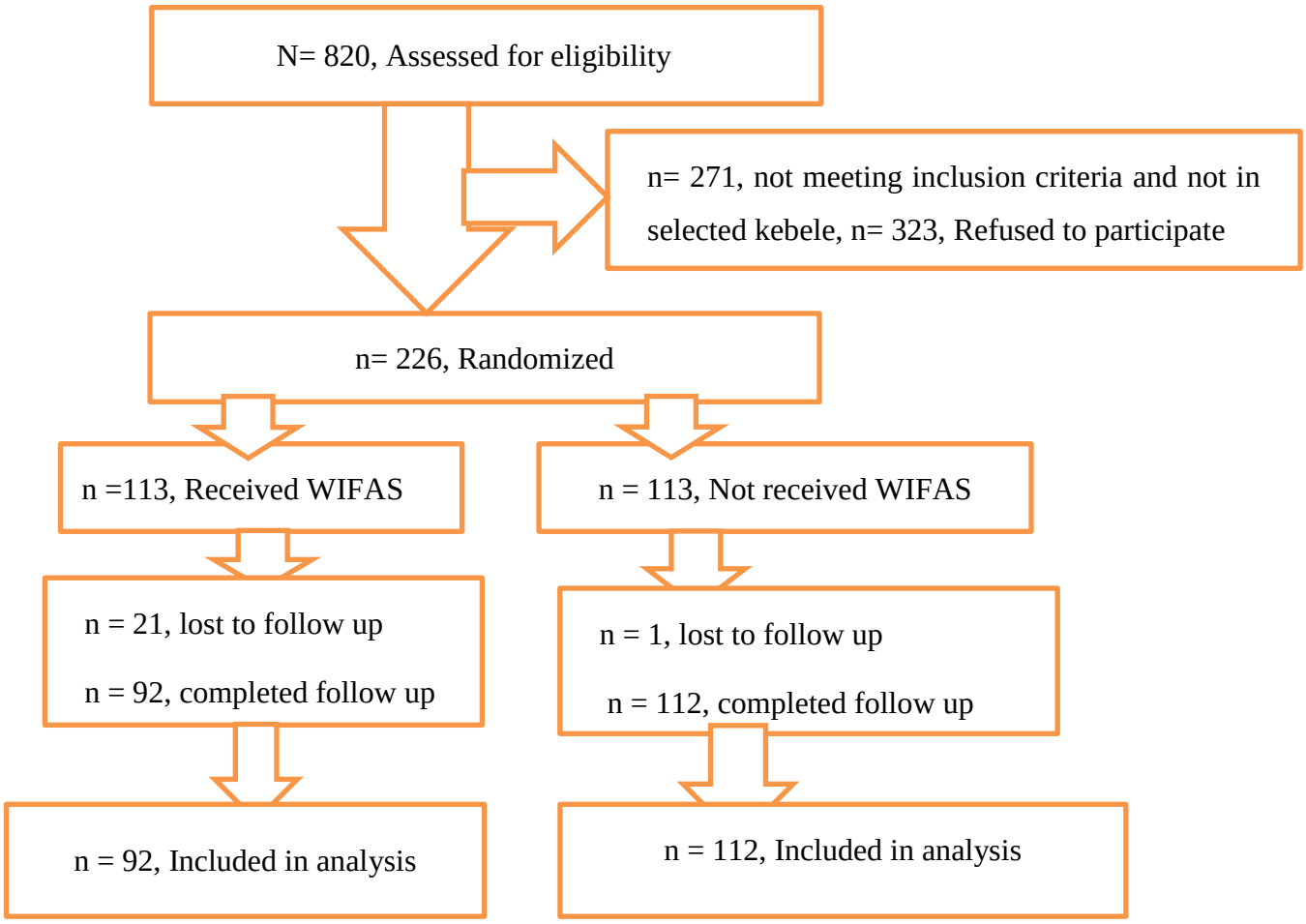

Figure 8. Schematic representation of study participants selection and inclusion

3.5.7. Follow up procedures during the intervention

Community-based weekly IFA supplementation was given to the intervention groups, and nothing was given to control groups. This intervention group was compared to the control group to know the effect of interventions. For the supplementation of iron-folic acid, four clinical nurses and two supervisors were recruited. Then, they have supplied the iron-folic acid tablet every Saturday/Sunday to selected adolescent girls in their households. During the weekly home visits, the subjects were followed up by the nurse/clinical officer to check the general health status, ensure compliance, and answer questions that adolescent girls have. Supplementation of iron-folic acid was on Saturday/Sunday because; this supplementation program was not affected by a class schedule of academic programs for adolescent girls who were following school.

3.5.8 Anthropometric measurements

Anthropometric measures such as height, weight, and mid-upper arm circumference were measured at baseline and end line. Weight was measured to the nearest 100g using a pre-calibrated digital scale (SECA), wearing light closing and without shoes. Height was measured in a standing position to the nearest 0.1 cm using a vertical board with a detachable sliding headpiece. Mid-upper arm circumference (MUAC) was measured using a standard MUAC tape on the upper left arm, after locating the midpoint for measurement between the end of the shoulder (acromion) and the tip of the elbow (olecranon).

3.5.9. Biological/laboratory sample collection and analysis

Adolescent girls were assessed for blood hemoglobin concentration, serum folate, and ferritin level. For these assessments, a 5ml venous blood sample was collected at baseline and at the end of the intervention. The laboratory technician trained biological sample collectors for four days. Phlebotomist/nurse at baseline and at the end of the intervention collected blood samples using clean syringe. Blood tubes were incubated without shaking at room temperature for 45 min before being centrifuged for serum separation. The prevalence of anemia was calculated based on the hemoglobin concentration measured in venous blood samples using a Hemocue photometer which was processed on the field (Hb 301+ system). Every time the analyzer turned on, it automatically verifies the performance of the optronic unit of the analyzer. A serum sample was placed on ice at the home visits and was held in a -20 ^{0}C freezer for an overnight stay at the local health center until transport the next day in the -70 ^{0}C freezer at Wolaita Sodo university referral hospital using an ice-packed vaccine carrier. Specimens were transported on dry ice to the Ethiopian public health institute for further analysis. Serum ferritin was analyzed using a fully automated clinical analyzer electrochemo-iluminescence immunoassay (ECLIA, Elecsys 2010 analyzer Cobas e 411; Roche Diagnostics GmbH, Mannheim, Germany). C-reactive protein (CRP) and folate were determined by Immune turbid metric methods with a clinical

chemistry analyzer (Cobas 6000 system; Roche Diagnostic GmbH) at the Ethiopian Public Health Institute.

3.5.10. Statistical analysis

Primary outcomes were analyzed based on intention to treatment principle. Socio-demographic characteristics were summarized with percentages for categorical variables and mean ± SD (or median and range) for continuous variables. A linear regression model was used to examine the impact of WIFAS on blood hemoglobin, serum ferritin, folate level, and weight gain. All hypothesis tests were two-sided with a 0.05 significance level. Linear regression model:

$$\mathbf{Y} = \beta 0 + \beta 1X1 + \beta 2X2 + \varepsilon.$$

Where Y is termed as the dependent or study variables, X_1 *and* X_2 are termed as independent or explanatory variables. The terms $\beta 0$, $\beta 1$, and $\beta 2$ are the parameters of the model, and ε is the residual error, which is an unmeasured variable. The parameter β0 is termed as an intercept term and the parameter β1 is termed as a slope parameter. Also, $\beta 0$ and $\beta 1$ parameters are regression coefficients.

3.6. Data Quality Assurance

The questionnaire was prepared in English and then translated to Amharic and rendered back to English to keep the consistency of the questions. Data collectors and supervisors were trained for 4 days about the proper filling of the questionnaire, how to measure anthropometry. Data collectors were selected from each zone that can communicated by local language fluently and can understand the socio-cultural practice of the community. Pre-testing of the questionnaire was done on 5% of adolescent girls in a similar area to the study sites to ensure the reliability of the questionnaire. Feedbacks from the pre-test were incorporated into the final questionnaire design. Principal investigators and supervisors have checked on the spot and review all the completed questionnaires to ensure completeness and consistency of the information collected.

Standardization of anthropometric measurements was conducted. To standardize anthropometric measurements, during training an expert has taken two measurements of weight and height of ten adolescent girls and then let each data collector take the measurements of all the ten adolescent girls twice. Then, the averages of the two measurements for each adolescent girl were taken by the data a collector was compared with the average of the expert's measurements. Technical error of measurement

and coefficient of variance (CV) were computed for all data collectors by using ENA for SMART software. Data collators with unacceptable TEM and CV were allowed to repeat the steps again.

For biological sample analysis, Cobas 6000 and Cobas e 411system of the machine was automatically working but checked for accuracy by using a control solution.

3.7 Ethical considerations

Study was approved by Addis Ababa University (AAU), College of Natural Sciences Research Ethics Review Committee. Official letter of cooperation was written to Wolaita and Hadiya Zones, and the district health office. Official letter of cooperation was written to wolaita and Hadiya Zones, and districts of health offices. The nature of the study was fully explained to the study participants and parents/guardians. Informed verbal and written consent was obtained from parents/guardians for adolescent girls' age less than 18 years old and assent was obtained from the participant before the interview. Participants 18 years or older were asked to provide verbal and written consent. The collected data were kept confidential. The code number was given for each participant and the data is stored in secure and password-protected database.

3.8 Operational Definition

Adolescent girls- are girls whose ages within 10-19 years. Early 10-13, Middle 14-16 and late 17-19 years old girls

Thinness: BMI-for- age Z score less than -2 standard deviation from the new WHO 2007 reference population

Stunting: Height-for-age Z score less than -2 standard deviation of new WHO 2007 reference population

Overweight: BMI-for- age Z score between +1 and +2 SD standard deviation for new WHO 2007 reference population

Obesity: BMI-for- age Z score right to +2 SD standard deviations for the new WHO 2007 reference population.

Overall anemia - is low blood hemoglobin concentration (Hb <12 g/dL)

Moderately anemia- is low blood hemoglobin concentration (Hg is 7-12gm/dl)

Severe anemia - is low blood hemoglobin concentration (Hg<7g/dL)

Dietary diversity score – is defined as the number of food groups consumed over a twenty-four hour period. Less than five food groups (DDS<5) is not diversified and greater than or equals to five food groups is diversified diets (DDS≥5)

Iron depletion - Serum ferritin <15.0 μg/L in girls

Iron-deficiency Anemia – Hb < 12.0 g/dL plus serum ferritin <15.0 μg/L in girls

Serum folate level- Adequate (> 6 ng/mL), moderate deficiency (3 to 5.9 ng/mL) and sever deficient level (<3 ng/mL)

CRP- (C-reactive protein) for inflammation. It has elevated C reactive protein (CRP) >5.0 μg/L

Nutrition service for adolescent girls – In this study, if the participants received any of the following services:

Nutrition education- If adolescent girls have taken nutrition education within the last three months.

Iron folic acid tablet supplementation – If adolescent girls have taken iron-folic acid tablets within the last three months or currently taking daily, weekly or monthly.

Deworming tablet supplementation – If adolescent girls are taking a deworming tablet every six months

Chapter 4 – Results

Chapter four: Results

4.1 Undernutrition and its determinants among adolescent girls in Southern Ethiopia

4.1.1 Introduction

Undernutrition is prevalent among adolescents in developing countries. Nutrition status among adolescents is an important determinant of health outcomes; undernutrition affects the health status of adolescent girls. In addition to causing significant mortality, it creates long-lasting effects on the growth, development, and physical fitness of survivors. Physical growth and development during puberty increase requirements for energy, protein, and many vitamins and minerals, and deficiencies can lead to physiological, anatomical, and functional disturbances. Understanding nutritional status and its associated factors are critical to timely address malnutrition in this age group.

However, previous studies have used only school adolescent girls who were not representative of adolescent girls who were not at school. So, a community-based cross-sectional study was conducted, and a multistage sampling method was used to select a sample of adolescent girls. The data were analyzed using EPI-data 4.4.2 and SPSS version 21.0. The odds ratios for logistic regression along with a 95% confidence interval (CI) were estimated. Thinness and stunting were found to be public health problems in the study area. Recommendations that can improve inter-sectoral collaboration, and health and nutrition programs were made.

4.1.2 Undernutrition and its predictors among adolescent girls in Southern Ethiopia

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RESEARCH ARTICLE

Undernutrition and its determinants among adolescent girls in low land area of Southern Ethiopia

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Abstract

Background

Undernutrition is one of the most common causes of morbidity and mortality among adolescent girls worldwide, especially in South-East Asia and Africa. Even though adolescence is a window of opportunity to break the intergenerational cycle of undernutrition, adolescent girls are a neglected group. The objective of this study was to assess the nutritional status and associated factors among adolescent girls in the Wolaita and Hadiya zones of Southern Ethiopia.

Methods

A community-based cross-sectional study was conducted, and a multistage random sampling method was used to select a sample of **843** adolescent girls. Anthropometric measurements were collected from all participants and entered in the WHO Anthro plus software for Z-score analysis. The data was analyzed using EPI-data 4.4.2 and SPSS version 21.0. The odds ratios for logistic regression along with a 95% confidence interval (CI) were generated. A P-value < 0.05 was declared as the level of statistical significance.

Result

Thinness (27.5%) and stunting (8.8%) are found to be public health problems in the study area. Age [AOR(adjusted odds ratio) (95% CI) = 2.91 (2.03–4.173)], large family size [AOR (95% CI) = 1.63(1.105–2.396)], low monthly income [AOR (95% CI) = 2.54(1.66–3.87)], not taking deworming tablets [AOR (95% CI) = 1.56(1.11–21)], low educational status of the father [AOR (95% CI) = 2.45(1.02–5.86)], the source of food for the family only from market [AOR (95% CI) = 5.14(2.1–12.8)], not visited by health extension workers [AOR (95% CI) = 1.72(1.7–2.4)], and not washing hand with soap before eating and after using the toilet

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[AOR (95% CI) = 2.25(1.079–4.675)] were positively associated with poor nutritional status of adolescent girls in the Wolaita and Hadiya zones, Southern Ethiopia.

Conclusion

Thinness and stunting were found to be high in the study area. Age, family size, monthly household income, regularly skipping meals, fathers' educational status, visits by health extension workers, and nutrition services decision-making are the main predictors of thinness. Hand washing practice, visits by health extension workers, and nutrition services decision-making are the main predictors of stunting among adolescent girls. Multisectoral community-based, adolescent health and nutrition programs should be implemented.

Background

Adolescence is defined by WHO as the age range from 10–19 years, and it is a period of transition from childhood to adulthood [1]. The adolescent age group comprises 20% of the global population [2]. Malnutrition, particularly undernutrition, is highly prevalent among adolescents in low and middle-income countries [3, 4]. Nutrition status among adolescents is an important determinant of health outcomes; undernutrition affects the health status of adolescent girls. In addition to causing significant mortality, it creates long lasting effects on the growth, development, and physical fitness of survivors [5]. This, in turn, affects their ability to learn and work at maximal productivity [6]. Undernutrition is an indicator of poor nutrition and has major consequences on human health as well as the social and economic development of the population [7]. Physical growth and development during puberty increase requirements for energy, protein, and many vitamins and minerals, and deficiencies can lead to physiological, anatomical, and functional disturbances [8].

The nutritional status of adolescent girls can have intergenerational effects because adolescent girls with poor nutritional status are more likely to give birth to low birth weight infants [8, 9]. Focus on adolescent girls is important because their health and nutritional status before as well as during pregnancy influences fetal growth and newborn health. Adolescent girls' health and undernutrition is an important determinant of adverse fetal outcomes, including low birth weight, preterm births, stillbirths, and an increased risk of neonatal mortality [10]. Therefore, adequate nutrition is key; it is associated with a better quality of life and has many intergeneration benefits[11].

Most causes of malnutrition are related to poor care, poor economic status, and food insecurity; however, malnutrition can sometimes be inherited genetically [12]. Presence of malaria infections, cigarette smoking, alcohol and drug use, environmental pollution, and domestic violence are predictors of undernutrition [13]. Similarly, age of adolescent girls, occupation of father [14, 15], poor dietary diversity score, meal skipping, not getting nutrition information, living in food in-secured households [16, 17], eating less than 3 meals per day, having family size >5, source of drinking water, monthly income were predictors of under nutrition among adolescent girls [18–22].

In regions of South-East Asia and Africa, a large number of adolescent girls suffer from chronic undernutrition, which adversely impacts their own health and development, as well as that of their offspring, contributing to an intergenerational cycle of malnutrition [23, 24]. More than 10% of girls were underweight in Mauritius, Bangladesh, Maldives, Cambodia, and Vietnam [25]. Body mass index of adolescent girls were less than 20 in South Asia, Southeast

Asia, East Africa, West Africa, and Central Africa [26]. A study from northern Ethiopia reported high levels of stunting (26.5%) and thinness (58.3%) among adolescents [27].

Even though the sustainable development goals (SDGs) include an adolescent nutrition service which is addressing adolescent malnutrition, the nutritional status of adolescent girls is not improving [28]. The government of Ethiopia officially launched the National Nutrition Program (NNP) in 2009, which aimed to reduce malnutrition in Ethiopia by integrating adolescents' nutrition into community-based health and development programs but faced many challenges. The Ethiopian NNP II (2016–2020) incorporated initiatives to improve the nutritional status of adolescent girls, but these interventions are not effective [29, 30]. However, these studies were conducted among school adolescent girls. Thus, the results of these studies cannot be generalized to the whole adolescent girls. In addition to this, there are no community based studies conducted in Southern Ethiopia among adolescent girls. Therefore, understanding nutritional status and its associated factors are critical to timely address malnutrition in this age group.

Materials and methods

Study area

The study was conducted in the Wolaita and Hadiya zones of Southern Ethiopia. These zones are predominantly dependent on agriculture, practicing mixed crop-livestock production and living in permanent settlements. Within their landholdings, community members cultivate fruits, vegetables, roots, and tuber crops.

Fig 1 shows Map of the study sites (Wolaita and Hadiya zones) in southern nation nationality and peoples region (SNNPR), 2019. A community-based cross-sectional study was conducted at two zones in Southern Ethiopia from April 30, 2019 to May 30, 2019. The inclusion criteria were adolescent girls (both attending and not attending school) between the ages of 10–19 years in two Southern Ethiopian zones. Participants who met the inclusion criteria were randomly selected to be the study population. BMI-for-age Body mass index for age z-score and height-for-age z-score were the dependent variables. Age, educational status of the participant, family size, maternal and paternal educational level, access to nutritional counseling services in health facilities, deworming tablets, iron-folic acid supplementation, household monthly income, source of food, and number of meals per day were the independent variables for our study.

Sample size determination

A single population proportion formula, $[n = z\frac{\alpha_2}{2} P (1\text{-}P) / d^2]$ was used to estimate the sample size. From the literature review, the prevalence of thinness (24.4%) and stunting (29.4%) were used for sample size calculations. Sample size calculation by using thinness (24.4%) was $n = (Z_{\alpha/2})^{2*} p (1\text{-}p)/d^2 = 748$ and sample size calculation by using stunting (29.4%) was $n = n = (Z_{\alpha/2})^{2*} p (1\text{-}p)/d^2 = 843$. So that for this study, stunting (29.4%) was selected to estimate the sample size as it gives a larger sample; considering a 95% confidence interval (CI) and d = 0.05%, the initial sample size was 383. By adding 10% for non-response and a design effect of 2.4, the final sample size was **843**. $n = (Z_{\alpha/2})^{2*} p (1\text{-}p) DE / d^2$. Where: Z = Standard normal distribution value at 95% CI = $(1.96)^2$, DE = design effect, and d = 0.05 (5% margin of error).

Sampling procedures

This study used multistage sampling techniques and was conducted in the Wolaita and Hadiya zones. From these two selected zones, two districts were selected based on a simple random sampling procedure, the Humbo district from Wolaita zone and the Misrak Badawacho district from the Hadiya zone. Three kebeles (villages) were selected from each district using a simple random

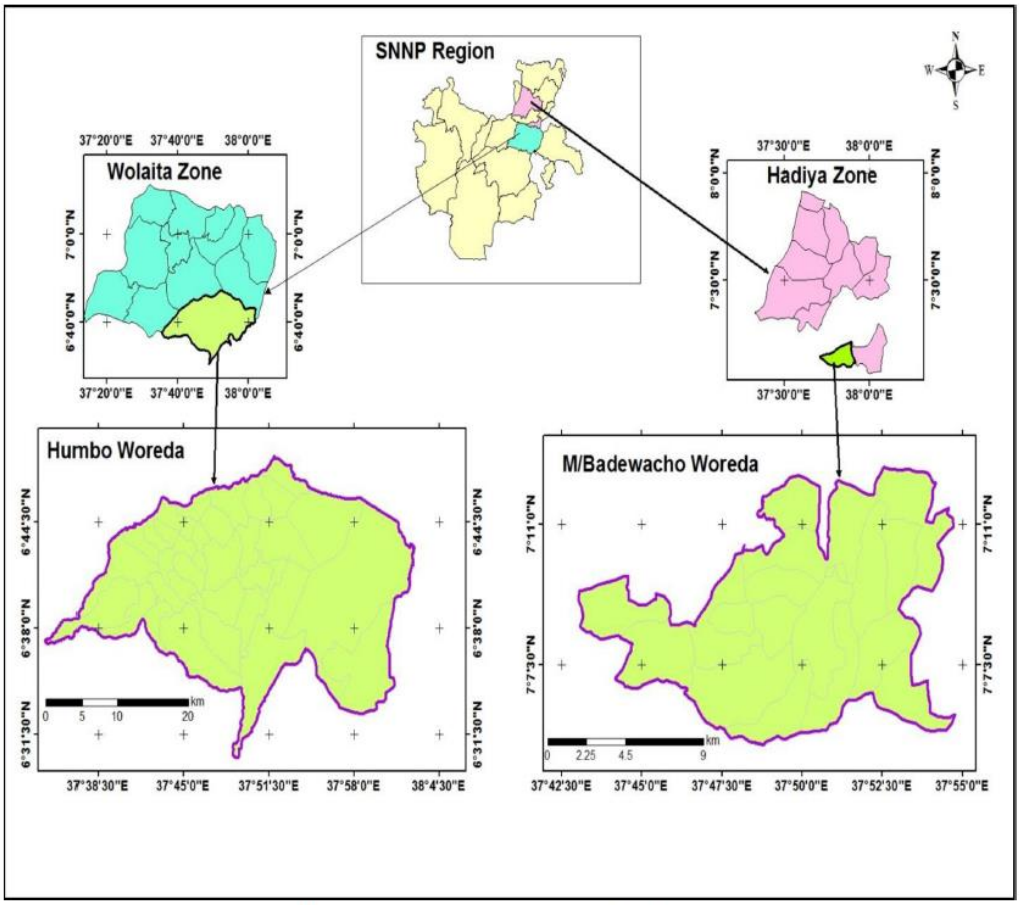

Fig 1. Map of the study sites (Wolaita and Hadiya zones) in southern nation nationality and peoples region.

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sampling method. A listing of adolescent girls was conducted at these selected kebeles. This listing was developed with the help of both the local government administration, woreda in particular, and health extension workers. During the development of the list, if there were more than one adolescent girl in a household, one adolescent girl was selected by simple random sampling (lottery method). From the selected six kebeles, 843 participants were chosen by simple random sampling method depending on the number of adolescent girls in each kebele. Participants were drawn from each kebele based on probability proportional to size (PPS) sampling techniques. The sampling techniques depended on the number of adolescent girls in each kebele. Adolescent girls with pregnancy, physical and mental disability were excluded from the study.

Data collection

Anthropometric measurements. Anthropometrics (i.e., height and weight) were measured on all sampled adolescent girls. Weight was measured to the nearest 100 g using a standard SECA

digital scale while the participants wore light clothing and no shoes. The scale was calibrated after weighing each participant. Height was measured in a standing position to the nearest 0.1 cm using a vertical board with a detachable sliding headpiece. Measuring tape was attached to it. BMI-for- age z-scores and height-for-age z-scores were calculated using the height, weight, and age of the participants. WHO Anthro plus software was used to calculate Z-score.

A structured interviewer-administered questionnaire was used to collect data. The questionnaire was developed based on a thorough review of the current literature [31–34]. A total of eight nurses with B.Sc. degrees; previous experience in collecting data; and knowledge of the culture, language, and norms of the community were employed to collect data using a pre-tested structured questionnaire. In addition to this, two supervisors with M.Sc. in public health were employed to supervise the data collection process. Data were collected on weekends for adolescent girls who attended school during the weekdays. The principal investigator controlled the daily overall study activities.

Statistical analysis. First, the data were checked for completeness and consistency for data entry and cleaning. Then, data were entered into the computer using EPI-data version 4.4.2 and exported to SPSS version 21.0 for further analysis. Descriptive statistics such as frequencies, proportions, and cross-tabulation were used to present the data. In addition, bivariate logistic regression analysis was performed to assess the association between independent and dependent variables. Variables that showed an association (p-value ≤ 0.25) in the bivariate analysis were included in the final multivariate logistic regression model. Odds ratios for logistic regression along with a 95% CI were estimated. A p-value less than 0.05 was declared statistically significant.

Data quality assurance. The questionnaire was prepared in English, translated to Amharic, and back translation to English to maintain consistency of the questions. Data collectors and supervisors were trained for 4 days to properly fill out the questionnaire and measure anthropometry. Data collectors were selected from each zone so they could communicate fluently in the local language and understand the socio-cultural practices of the community. The questionnaire was pre-tested on 5% adolescent girls in a similar area to the study sites to ensure reliability. Feedbacks from the pre-test were incorporated into the final questionnaire design. Principal investigator and supervisors performed checks on the spot and reviewed all the completed questionnaires to ensure completeness and consistency of the information collected.

Standardization of anthropometric measurements was conducted. To standardize anthropometric measurements, during training an expert took two heights and weight measurements for ten adolescent girls and then let each data collector take the measurements for all ten girls twice. Then, the averages of the two measurements for each adolescent girl taken by the data collector were compared with the average of the expert's measurements. The technical error of measurement (TEM) and coefficient of variance (CV) were computed for all data collectors using Emergency Nutrition Assessment (ENA) for SMART software. Data collators with unacceptable TEM and CV were asked to repeat the steps again.

Ethical considerations. The study was approved by Addis Ababa University (AAU), College of Natural Sciences Research Ethics Review Committee. The official letter of cooperation was written to the Wolaita and Hadiya zones, and the district of health offices. The nature of the study was fully explained to the study participants and parents/guardians. Informed verbal and written consents were obtained from the parents/guardians for adolescent girls aged < 18 years old and assent was obtained from the participant before the interview. Participants ≥ 18 years aged were asked to provide verbal and written consent. The collected data were kept confidential. Each participant was given a code number, and the data were stored in a secure and password-protected database.

Results

Socio-demographic characteristics of adolescent girls in Southern Ethiopia

Eight hundred and twenty adolescent girls participated with a response rate of 97.3%.

As shown in Table 1, the mean age of the study participants was 14.6 (±1.9) years, the mean family size was 6.56 (±1.83) persons, while 69.3% of the households had ≥ 5 family members and 30.7% had < 5 family members. Most of the study participants (93.3%) were in grades 1–8 and only 0.2% had college and University education. Most of the study participants were Protestant (65.0%), but 34.3% were Orthodox Christian, and only 0.7% were Muslims. About one third (33.4%) of the study participants were from households that have less than 1000 ETB (31.25 USD) monthly income and 30.3% are from households that have greater than 2000 ETB (62.5USD) monthly income.

Nutrition service and health-related factors of adolescent girls in Southern Ethiopia

As indicated in Table 2, 70.4% of the study participants did not receive nutrition education. Only 29.6% of the study participants had nutrition education. Similarly, 54.9% of the study participants never received deworming tablets. Out of the participants who took deworming tablets (45.1%), 65.6% have taken two tablets (albendazole,400 mg) and 34.4% have taken one tablet every six months. When considering iron and folate supplementation, only 0.4% of the study participants have taken iron-folate supplement. Of the total study participants with access to nutrition services, only 60.4% received friendly nutrition service. In 66.1% of the households, the fathers were the primary decision-makers regarding nutrition service. 27.8% of the study participants had a cough in the two weeks before data collection.

Table 1. Socio-demographic characteristics of adolescent girls in Southern Ethiopia, 2019.

Variables		Frequency(n)	Percent (%)
Age	10–14	393	47.9
	15–19	427	52.1
Median age	14.6 ±1.9 years		
Educational status	No formal education	4	0.5
	1–8 grade	765	93.3
	9–12 grade	49	6.0
	College and University	2	0.2
Religion	Orthodox	281	34.3
	Protestant	533	65.0
	Muslim	6	0.7
Family size	<5 family members	252	30.7
	≥5 family members	568	69.3
Median family size	6.56 ±1.83		
Monthly household income	< 1000 ETB (31.25 USD)	274	33.4
	1000 ETB(31.25 USD)– 2000 ETB (62.5USD)	298	36.3
	> 2000 ETB (62.5USD)	248	30.3

Source: Field survey, 2019; ETB, Ethiopian Birr

https://doi.org/10.1371/journal.pone.0240677.t001

Table 2. Nutrition service and health-related factors of adolescent girls in Southern Ethiopia, 2019.

Variables		Frequency(n)	Percent (%)
Received nutrition education within the last three months	Yes	243	29.6
	No	577	70.4
Received deworming tablets every six months	Yes	450	54.9
	No	370	45.1
Number of deworming tablet received	One	155	34.4
	Two	295	65.6
Received iron folic acid supplementation (IFAS)	Yes	3	0.4
	No	817	99.6
Friendly nutrition service received	Yes	495	60.4
	No	324	39.5
Decision maker for nutrition service	Father	542	66.1
	Mother	78	9.5
	Jointly(Mother & Father)	200	24.4
Presence of cough within 2 weeks before data collection	Yes	228	27.8
	No	592	72.2

Source: Field survey, 2019; IFAS, = Iron- folic acid supplementation

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Health and sanitation-related factors of adolescent girls in Southern Ethiopia

Table 3 describes the health and sanitation related conditions of the adolescent girls. Of the total 820 subjects, 53.0% of the adolescent girls lived in houses with mud floors, and 58.5% of the adolescent girls lived with domestic animals in the same house. Similarly, 53.3% washed their hands sometimes before eating their food, 41.7% usually washed their hands before eating, 3.4% did not wash their hands at all, 93.2% washed their hands after using the toilet, and 6.8% did not wash their hands at all after using the toilet. When washing their hands, 90.1% of the study participants reported using soap. Out of the total participants who used soap when washing their hands, only 42% usually used soap and 58% sometime used soap.

Meal patterns of adolescent girls in Southern Ethiopia

As indicated in Table 4, 39.5% of the study participants ate $\geq$ four times per day and 59.8% of the study participants ate three times per day. This indicates only 0.7% of the study participants skipped regular meals. Similarly, 41.6% of the study participants ate smaller meals that do not satisfy their needs. Maize was the primary staple food for 40.6% of the study participants, and 38.8% consumed both teff and maize as a staple food. Participants purchased food from the market (40.4%) or produced their own food (50.6%).

Nutritional status of adolescent girls in Southern Ethiopia

As shown in Table 5 and Fig 2, 69.5% of the adolescent girls have a normal body mass index, i.e. body mass index-for-age z-score is between -2 and +2. From the total adolescent girls, 19.5% were moderately thin as defined by a body mass index-for-age z-score is $-3 \leq BAZ < -2$ and 8% were severely thin as defined by a BMI-for-age z-score is $BAZ < -3$. Only 3% of the adolescent girls were overweight ($BAZ \geq +2$).

As shown in Table 5 and Fig 3, 91.2% of adolescent girls had a normal height-for-age z-score is $HAZ > -2$, 7.8% were moderately stunted ($-3 \leq HAZ < -2$), and 1% were severely

Table 3. Health and sanitation-related factors of adolescent girls in Southern Ethiopia, 2019.

Variables		Frequency(n)	Percent (%)
Type of floor adolescent girls are living on	Cement	385	47.0
	Muddy	435	53.0
Living with animals in the same house.	Yes	480	58.5
	No	340	41.5
Number of windows in the entire house	0	3	0.4
	1	43	5.2
	2	231	28.2
	3	297	36.2
	4	235	28.7
	5	11	1.3
Frequency of teeth brushing (times per day)	0	29	3.5
	1	401	48.9
	2	267	32.6
	3	123	15.0
Hand washing before eating	Not at all	32	3.9
	sometimes	442	53.9
	Usually	346	42.2
Hand washing after using the toilet	Yes	764	93.2
	No	56	6.8
Using soap when washing hands	Yes	739	90.1
	No	81	9.9
Frequency of using soap when washing hands	Sometimes	429	58.0
	Usually	310	42.0

Source: Field survey, 2019

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stunted(HAZ <-3) [35]. As indicated in Figs 4 and 5, nutritional status of adolescent girls was lower than the reference population according to WHO-2007 growth chart.

Association between variables and nutritional status of adolescent girls in Southern Ethiopia

The present study showed an association between some variables with nutritional status, as defined by BMI for age z-score (BAZ), of the study participants. Low BAZ was statistically and

Table 4. Meal patterns of adolescent girls in Southern Ethiopia, 2019.

Variables		Frequency(n)	Percent (%)
Number of meals per day	Two times	6	0.7
	Three times	490	59.8
	Four times and above	324	39.5
Skip regular meals	Yes	6	0.7
	No	814	99.3
Staple food	Teff	169	20.6
	Maize	333	40.6
	Teff & Maize	318	38.8
Source of food for the family	Produce your own	415	50.6
	Market purchase	336	41.0
	Produce your own and market purchase	69	8.4
Eat small meals	Yes	341	41.6
	No	479	58.4

Source: Field survey, 2019

https://doi.org/10.1371/journal.pone.0240677.t004

Table 5. Nutritional status of adolescent girls in Southern Ethiopia, 2019.

Variables	Level	Frequency(N)	Percent (%)
Normal	-2< BAZ <+2	569	69.5
Moderate thinness	-3 ≤ BAZ < -2	160	19.5
Severe thinness	BAZ < -3	66	8.0
Overweight	BAZ ≥+2	25	3.0
Normal height	HAZ > -2	748	91.2
Moderately stunted	-3 ≤ HAZ ≤ -2	64	7.8
Severely stunted	HAZ <-3	8	1.0

Source: Field survey, 2019; BAZ, BMI-for-age z-score; HAZ, height-for-age z-score

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positively associated with younger age, large family size, low monthly household income, not receiving deworming tablet(s), low educational status of the participant's fathers, separate decision making for nutrition service, source of food for family from market and not being visited by health extension workers at home (Table 6).

There was also an association between some variables with nutritional status, as defined by height-for-age z-scores (HAZ), of the study participants. Low HAZ of the study participants was statistically and positively associated with separate decision making for nutrition service, not washing hands before eating and after using the toilet, and not visited by health extension worker (Table 7).

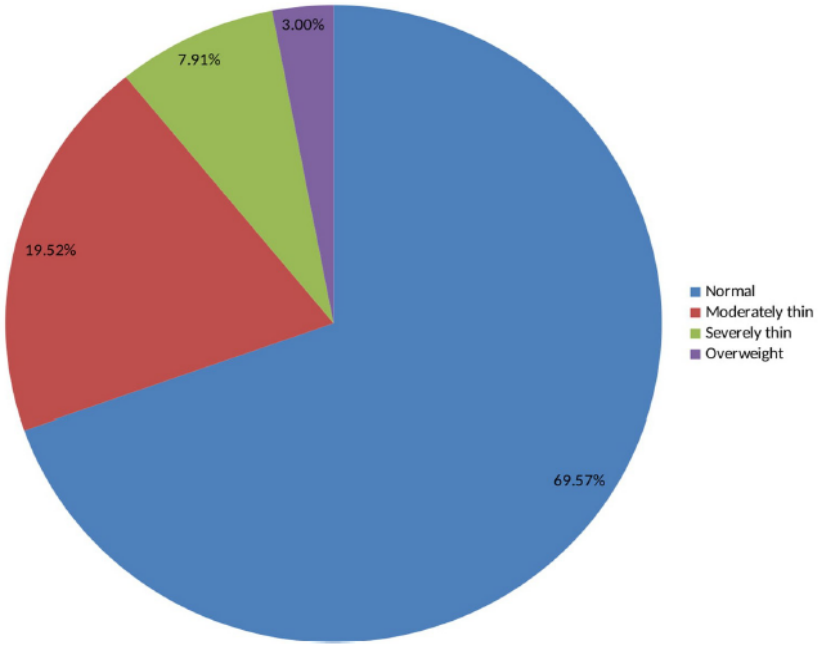

Fig 2. BMI for age z-scores (BAZ) among adolescent girls in Southern Ethiopia, 2019.

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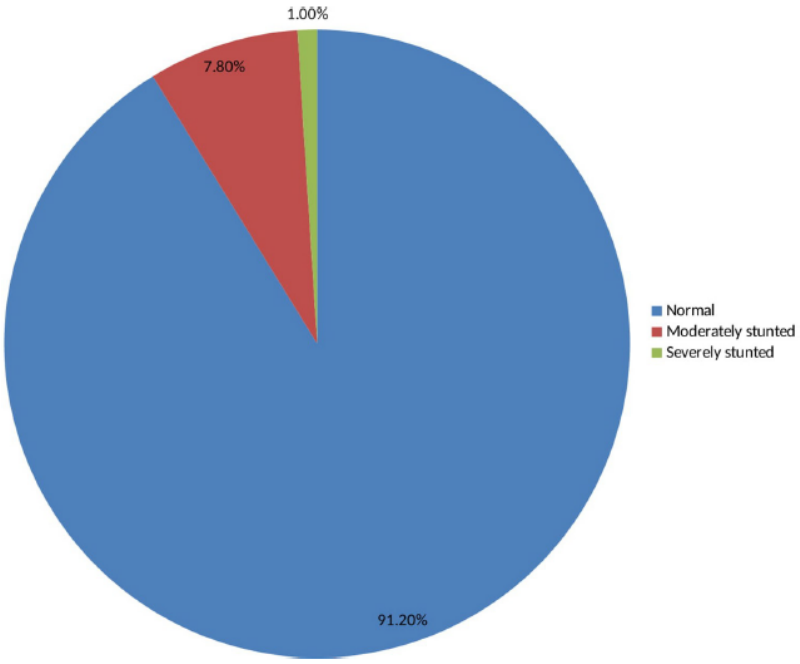

Fig 3. Height for age z-scores (HAZ) among adolescent girls in Southern Ethiopia, 2019.

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Discussion

Health and nutritional status of adolescent girls in Southern Ethiopia

The BAZs revealed that 19.5% of the adolescent girls were moderately thin and 8% were severely thin. Similarly, 7.8% of adolescent girls are moderately stunted and 1% are severely stunted. The prevalence of thinness is higher in this study than in a study conducted in the Amhara Region [36]. Similarly, the prevalence of stunting in the current study was lower than in the study conducted at the Amhara Region [17] and in Adwa, northern Ethiopia [20]. The prevalence in this study were also lower than those reported from a study conducted in Bangladesh [19].

The reasons for the observed undernutrition among the current study participants might be due to their low monthly household income, large family size, low educational status of fathers' of the adolescent girls and poor hand-washing practice with soap before eating food. Our finding is supported by a study conducted in the Somali Region of Ethiopia, which indicated that hand washing with soap after using the toilet and before eating affects the nutritional status of adolescent girls [18]. This might be due to the association between diarrheal disease with not washing hands, which can also affect the nutritional status of adolescent girls [37]. Moreover, 40.4% of the study participants purchased their food from the market, whose amounts and quality can depend on their income, distance to markets, and price fluctuations [38].

The decision-making power of the family might also affect the nutritional status of adolescent girls. Decision-making for receiving nutrition services was found to be under the control of fathers' in 66.1% of the study participants. As indicated by a study conducted in

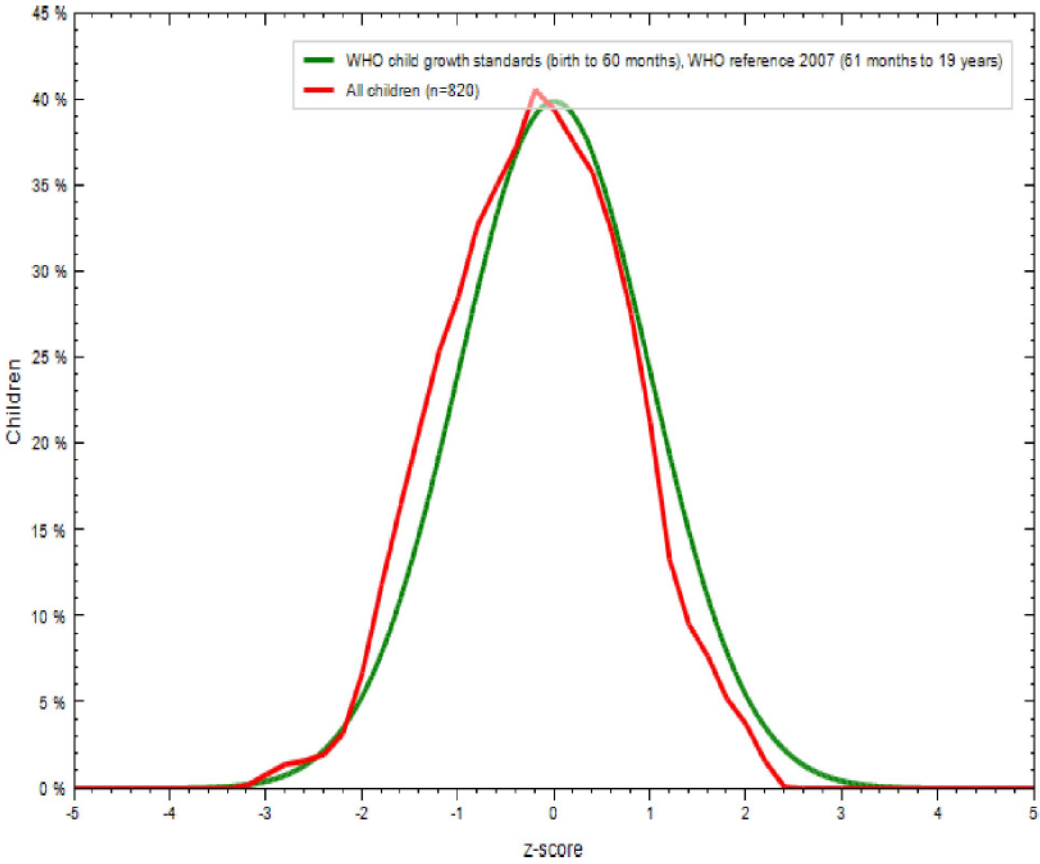

Fig 4. Comparison of BMI-for-age z-scores (BAZ) of the study population (N = 820) with the 2007 WHO growth reference populations.

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Jimma Zone, Southwest of Ethiopia, women autonomy in decision-making is important to improve nutritional status women and their children [39, 40]. Similarly, 45.1% of the study participants did not receive a deworming tablet. As indicated by a study conducted in Angolela, Ethiopia, stunting of study participants was associated with intestinal parasite [41]. Therefore, this might further aggravate the low nutritional status of the study subjects [42].

Factors associated with the nutritional status (BAZ) and HAZ of adolescent girls in Southern Ethiopia

Adolescent girls between the ages of 10–14 years were 2.9 times more likely to be thin than adolescent girls ≥ 15 years old. This finding is in line with the study conducted in the Amhara Region [17]. This might be due to the rapid growth and reproductive maturation during adolescence(10–14 years age), which increases energy and nutrient requirements and hence the need for quality diets [43, 44].

Adolescent girls with a family size > 5 were 1.6 times more likely to be thin than those from a family with ≤ 5 people. This finding is supported by studies conducted in the city of Arar

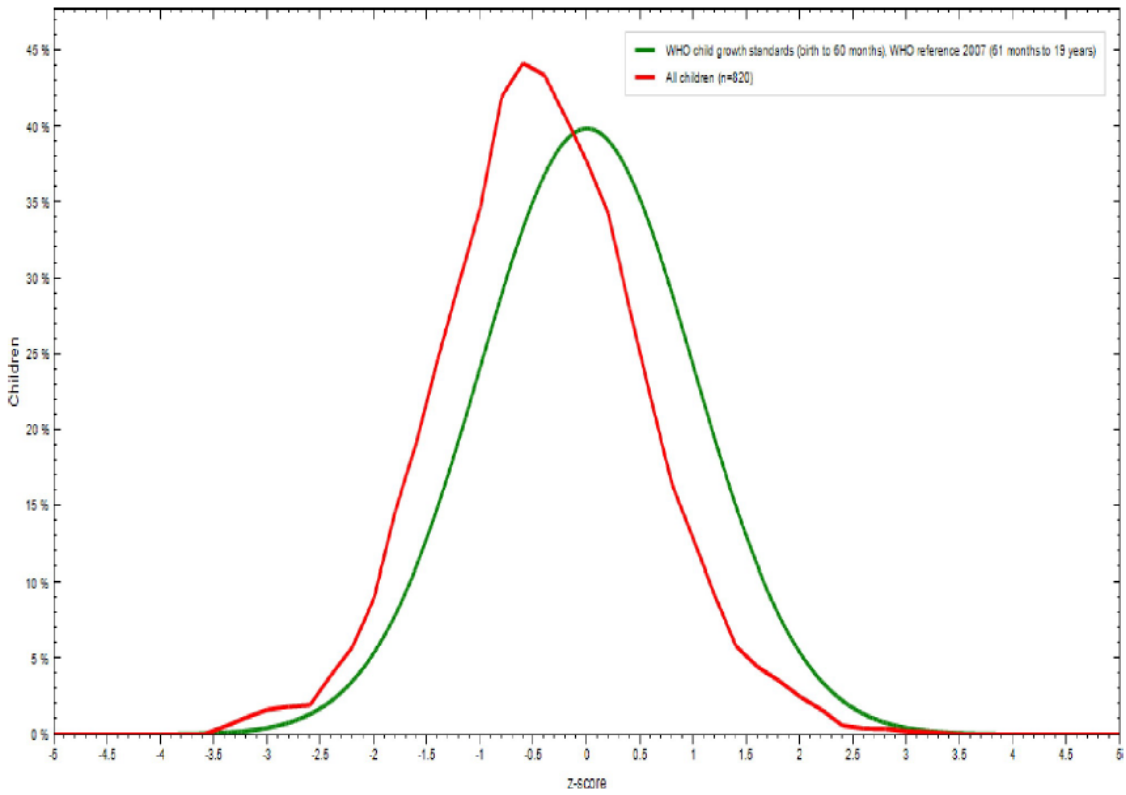

Fig 5. Comparison of height-for-age z-scores (HAZ) of the study population (N = 820) with the 2007 WHO growth reference populations.

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[45], Nigeria [46], and the Amhara Region [17]. Large families may share food among family members [20], constraining the availability of adequate amount of quality food [47].

Adolescent girls from families whose monthly income was < 1000 ETB (31.25 USD) were 2.5 times more likely to be thinner than those from families who have monthly incomes > 2000ETB (62.5 USD). This finding is in line with studies conducted in Bangladesh [48, 49] and Nigeria [22]. This might be because the household's low monthly income, which affects the purchasing power leading to the consumption of suboptimal quantity and quality food. Consequently, adolescent girls from low monthly income were more likely to be thinner [50].

Study participants who did not take deworming tablets every six months were 1.56 times more likely to be thinner than those who took a deworming tablet every six months. According to the WHO preventive deworming recommendations, a biannual single-dose of albendazole (400 mg) is recommended as a public health intervention for all non-pregnant adolescent girls and women of reproductive age in order to reduce the burden of soil-transmitted helminthes which can affect nutritional status of adolescent girls [51]. Indeed, a systematic review and meta-analysis indicated that taking deworming tablets improves the nutritional status of adolescent girls [52], by causing diarrhea and reducing absorption of nutrients. The odds of stunting were also lower among adolescents that washed their hands prior to eating meals ($P < 0.05$).

Table 6. Factors associated with nutritional status (BAZ) of adolescent girls in Southern Ethiopia, 2019.

Variables		BAZ (≤ -2) N(%)	BAZ (> -2) N(%)	Crude OR (CI)	Adjusted OR (CI)
Age (years)	10–14	144(17.6)	249(30.3)	2.397 (1.75–3.28)***	2.91 (2.03–4.17)***
	> 15	83(10.1)	344(42.0)	1	1
Family size	≤ 5	57(6.9)	195(23.8)	1	1
	> 5	170(20.7)	398(48.6)	1.46 (1.034–2.064)*	1.63 (1.105–2.39)*
Monthly income ETB (USD)	< 31.25	126(15.4)	148(18.1)	3.37 (2.28–4.98)***	2.54 (1.66–3.87)***
	1000(31.25) -2000(62.5)	49(6.0)	249(30.3)	0.779 (0.504–1.205)	0.74 (0.475–1.158)
	> 2000(62.5)	52(6.3)	196(23.9)	1	1
		Nutritional status			
Variables		BAZ(≤ -2)N(%)	BAZ(> -2)N(%)	Crude OR (CI)	Adjusted OR (CI)
Receiving deworming tablets	Yes	101(12.3)	349(42.6)	1	1
	No	126(15.4)	244(29.7)	1.8 (1.3–2.4)***	1.56 (1.1–21)*
Father's educational status	No formal education	30(3.6)	51(6.3)	1.94 (1.1–3.4)*	2.3 (1.1–4.8)*
	1–8 grade	73(8.8)	190(23.2)	1.28 (0.82–1.96)	1.7 (0.96–2.87)
	9–12 grade	81(9.9)	210 (25.6)	1.27 (0.83–1.95)	1.78 (0.86–3.01)
	College and University	43(5.3)	142(17.3)	1	1
Decision-maker for nutrition service	Father	168(20.5)	374(45.6)	2.05 (1.37–3.07)**	1.89 (1.22–2.94)**
	Mother	23(2.8)	55(6.7)	1.905 (1.37–3.07)*	2.022 (1.016–4.024)*
	Jointly	36(4.4)	164(20)	1	1
		Nutritional status, N(%)			
Variables		BAZ (≤ -2)	BAZ (> -2)	Crude OR (CI)	Adjusted OR (CI)
Visited by health extension worker regularly	Yes	83(10.1)	303(37.0)	1	1
	No	144(17.5)	290(35.4)	1.81 (1.32–2.48)***	1.72 (1.7–2.4)**
Source of family food	Produce own	109(13.3)	306(37.3)	3.74 (1.57–8.89)**	3.288 (1.3–8.1)*
	Market purchase	112(13.6)	224(27.3)	5.25 (2.21–12.5)***	5.14 (2.1–12.8)***
	Produce own and market purchase	6(0.73)	63(7.7)	1	1

*p-value < 0.05
**p-value < 0.01
***p-value<0.001
BAZ, BMI- for- age z-score

https://doi.org/10.1371/journal.pone.0240677.t006

Table 7. Factors associated with nutritional status (HAZ) of adolescent girls in Southern Ethiopia, 2019.

		Nutritional status			
Variables		**HAZ (≤ -2)**	**HAZ (> -2)**	**Crude OR (CI)**	**Adjusted OR (CI)**
Decision-maker for nutrition service	Father	54(6.6)	488(59.5)	2.65 (1.241–5.68)**	2.53 (1.106–6.087)*
	Mother	10(1.2)	68(8.3)	3.529 (1.4–9.310)**	2.58 (0.89–7.45)
	Jointly	8(1.0)	192(23.4)	1	1
Hand washing before eating and after toilet	Yes	61(7.4)	703(85.7)	1	1
	No	11(1.4)	45(5.5)	2.82 (1.39–5.73)**	2.25 (1.079–4.675)*
Visited by a health extension worker	Yes	15(1.8)	237(28.9)	1	1
	No	57(7.0)	511(62.3)	2.13 (1.14–3.93)*	2.036 (1.059–3.914)*

*p-value < 0.05
**p-value < 0.01
***p-value<0.001
HAZ, height-for-age z-score

https://doi.org/10.1371/journal.pone.0240677.t007

Study participants whose fathers had no formal education were 2.3 times more likely to be thinner than those whose fathers completed college and university level education. This finding is in line with a study conducted in the cities of Tehran [53] and in Adama in Central Ethiopia [54]. This might be due to educated families having better access to information, nutrition education, and quality diets [55].

Decision-making power for nutrition services was statistically associated with the nutritional status of the study participants. Adolescent girls that had both parents jointly making decisions on access to nutrition services were significantly less likely to be thin and stunted than adolescents whose decision to access to nutrition services were solely made by the father or the mother. Other studies have shown that women's participation in decision making is important for improving the nutritional status of women and children [56].

Adolescent girls acquiring their food from their household production or from purchases form the market were 3.28 and 5.14 times, respectively, more likely to be thinner than those who were getting their food from both home production and market purchases.

Visits by health extension workers were statistically associated with the nutritional status of adolescent girls. Adolescent girls who were not visited by health extension workers in their homes were 1.72 times more likely to be thinner than those who were visited by health extension workers at their homes within the past three months. This might be due to nutritional counseling that can result in the improvement of nutritional knowledge and behavioral change for improved nutrition [57]. Similarly, adolescents visited by health extension workers in the last three months had lower odds of being stunted.

Conclusions

Thinness and stunting were found to be high in the study area. Age, family size, monthly household income, fathers' educational status, visits by health extension workers, and nutrition services decision-making power are the main predictors of thinness. Hand washing practice, visits by health extension workers, and nutrition services decision-making power are the main predictors of stunting among adolescent girls in Southern Ethiopia.

Recommendation

- Income-generating activities should be implemented to improve the income of the families as it affects the nutritional status of adolescent girls.
- Health extension workers should visit and give nutrition education regularly for adolescent girls at their homes and at community meetings.
- Hand washing practice before meals and after visiting toilets should be improved
- Joint decision-making on household resources by both parents should be promoted
- Health extension workers should give counseling that discourages adolescent girls from skipping regular meals.

Strength of the study

This study tried to include large sample size and relatively wider geographic area of the region which can be an input for the design and implementation of adolescent nutrition interventions.

Weaknesses of the study

Using cross-sectional study design might not allow causal inferences. So, this study cannot tell cause and effect relationship.

Supporting information

S1 Checklist. STROBE statement.
(DOCX)

S1 File.
(DOCX)

S1 Data.
(XLS)

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4.2 Dietary diversity score and its predictors among adolescent girls in Southern Ethiopia

4.2.1 Introduction

Understanding nutrition status of adolescents is important to implement improving starategy for undernutrition that affects the health status of adolescent girls. Section 4.1 identified the nutritional status and determinants of undernutrition among adolescent girls. However, understanding only nutritional status and its determinants is not enough to understand adolescent nutrition.

In section 4.2, dietary diversity and its determinants were identified among adolescent girls. Failure to consume an adequate diet during adolescent period can result in delayed sexual maturation and can arrest or slow linear growth. Thus understanding dietary diversity score is critical to timely address malnutrition in this age group. A community-based cross-sectional study was conducted and 24hr dietary recall sample was collected from all adolescent girls. In this study, mean dietary diversity score of the study participants was identified. Factors associated with low dietary diversity were identified. Recommendations that are important to improve low dietary diversity were made.

4.2.2 Low dietary diversity score and its determinants among adolescent girls in Southern Ethiopia

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Low dietary diversity and its determinants among adolescent girls in Southern Ethiopia

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Abstract: Normal growth and development of adolescent girls need a healthy diet which includes a variety of foods from different food groups. The dietary practice of adolescent girls in the study area was not assessed. The objective of this study was to assess the dietary diversity score and associated factors among adolescent girls. A community-based cross-sectional study was conducted from 30 April 2019 to 30 May 2019 in Wolaita Zone Southern Ethiopia. A multistage sampling method was used to select 843 adolescent girls. A structured 24-h dietary recall (24 HR) interview was conducted to capture detailed information about all foods and beverages consumed by the respondent in the past 24 hours, most commonly, from "sun raise on the day before interview to sunrise on the date of interview". Dietary diversity scores were calculated by summing the number of food groups consumed by the adolescent girl over the 24-h recall period. Socio-demographic, health, and sanitation-related data were collected using a structured interviewer-administered questionnaire which was developed based on a thorough reviewing of different literature. Data were entered into EPI-data version 4.4.2 and exported to SPSS for windows version 21.0 for further analysis. Multivariable logistic regression model was used to isolate independent predictors of adequate dietary diversity. P-value of less than 0.05 was considered as the

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PUBLIC INTEREST STATEMENT

Diversified diet is an indicator of a healthy diet and adequate micronutrient intake. Dietary diversity score is a proxy indicator of nutrient adequacy. So, conducting a community-based study to explore evidence on dietary diversity and its determinants among adolescent girls in all settings is very important to solve malnutrition problems and improve nutrition intervention programs among adolescent girls in southern Ethiopia.

The mean dietary diversity score of the study participants is 3.56 (±1.2). Overall 72.4% of the study participants had a low dietary diversity score. A low dietary diversity score is found to be a public health problem in the study area. Family monthly income, fathers and mothers' educational status, not taking nutrition education and decision-making power were the main predictors of low dietary diversity among adolescent girls in southern Ethiopia. The results imply the need for promoting maternal education, nutrition education, and empowering women to have decision-making power to improve the dietary diversity of girls in the study area.

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level of statistical significance. The mean dietary diversity score of the study participants is 3.56 (±1.2). Overall 72.4% of the study participants had a low dietary diversity score. A low dietary diversity score is found to be a public health problem in the study area. Family monthly income [AOR (95%CI) = 15.5 (8.6–28.1)], fathers [AOR (95% CI) = 4.3 (1.8–10.6)] and mothers' educational status [AOR (95%CI) = 3.2 (1.5–6.8)], not taking nutrition education [AOR (95%CI) = 2.1 (1.4–3.1)] and decision-making power [AOR (95%CI) = 2.2 (1.5–3.3)], were the main predictors of low dietary diversity among adolescent girls in southern Ethiopia. Family monthly income and education, providing nutrition education, and decision-making power should be improved. The results imply the need for promoting maternal education, nutrition education, and empowering women to have decision-making power to improve the dietary diversity of girls in the study area. *[AOR (95% CI) = 2.45(1.02–5.86)].*

Subjects: Nutrition and Dietetics; Health Conditions; Community and Public Health Nursing

Keywords: adolescent girls; dietary diversity score and determinants

1. Background

Adolescence is defined as the age range of 10–19 years and it is a period of transition from childhood to adulthood (WHO, 2015). Adolescence is the most important period of life where growth and development are accompanied by various physical, physiological, behavioral, and social changes (Vashist & Goel, 2009).

It presents a second window of opportunity and is characterized by a rapid growth that needs adequate quantity and quality food to meet the nutrient requirement for their physical and mental development in addition to reproductive maturity (Stang & Story, 2008). Different studies indicated adolescence as a determining point for nutritional status, physical activity, and cognitive behaviors. Thus, adolescence is a life-stage offering significant potential for shaping the transgenerational effects of nutrition through the prevention of non communicable diseases (Todd et al., 2015).

Diversified diet is an indicator of a healthy diet and adequate micronutrient intake (G.L. Kennedy et al., 2007). Dietary diversity score (DDS) is a proxy indicator of nutrient adequacy and is calculated by summing the number of food groups consumed by the adolescent girl over the 24-h recall period (Rathnayake et al., 2012).

A diverse diet that contains at least five food groups is necessary for achieving nutrient adequacy and optimal growth and development (Vakili et al., 2013). The adequate nutrient is key and is associated with better lives and with potential intergenerational benefits (Bay et al., 2016). Physical growth and development during puberty increase requirements for energy, protein, and many vitamins and minerals, and deficiencies can lead to physiological, anatomical, and functional disturbances (Salam et al., 2016). A focus on young girls is also crucial because their health and nutritional status before as well as during pregnancy also influences fetal growth and newborn health. Adolescent health and undernutrition is an important determinant of adverse fetal/neonatal outcomes, including low births weight, preterm births, stillbirths, and excess risk of neonatal mortality (Cnattingius & Villamor, 2016).

In South-East Asia and Africa, a large number of adolescent girls suffer from chronic undernutrition and anemia, which adversely impacts their health and development, as well as their offsprings contributing to an intergenerational cycle of malnutrition (Wasnik & Rao, 2012).

A study conducted by the University of the Philippines indicated that the average DDS of the adolescents was 3.94 (Bullecer et al., 2012). Another study conducted in Adama City, Central Ethiopia indicated that from the 24-h dietary recall data the mean DDS was 4.2. In this study, from total adolescent girls, 58.8% of them did meet the minimum DDS of 5 out of 10 food groups (Roba et al., 2016). Another study conducted in Jimma Town, South West Ethiopia among school adolescent girls indicated that the DDS of adolescent girls was 4.34. From the total, 61.3% of students had dietary diversity scores of less than five (Melaku et al., 2017a). A study conducted among high school adolescent girls in Gurage Zone, Southwest Ethiopia indicated the mean dietary diversity score was 4.69. In this study, the prevalence of adolescents who consumed less than or equal to three food groups was 20% and those who consumed 3–4 food groups, 53.2% and those consumed greater than or equal to six food groups were 26.8% (Meron Worku & Wondmu, 2017).

Even though the sustainable development goals included an adolescent nutrition service which is addressing adolescent malnutrition (Assembly, 2015), the nutritional status of adolescent girls is not improving in many parts of the country. The government of Ethiopia officially launched the National Nutrition Program (NNP) in 2009, which aimed to reduce malnutrition in Ethiopia by integrating adolescents' nutrition into community-based health and development programs. The Ethiopian national nutrition program II (2016–2020) incorporated initiatives to improve the nutritional status of adolescent girls, but effectiveness of this and other interventions is unknown (Ethiopia, 2016). Additionally, the deferent studies referred to previously have focused on only school adolescent girls and none of them was conducted in southern Ethiopia. So, conducting a community-based study to explore evidence on dietary diversity and its determinants among adolescent girls in all settings is very important to solve malnutrition problems and improve nutrition intervention programs among adolescent girls in southern Ethiopia. The objective of the study was to assess community-based dietary diversity and associated factors among adolescent girls in southern Ethiopia. Figure 1, indicates the interaction of socio-demographic factors, health, and sanitation-related factors to determine the nutritional status of a community.

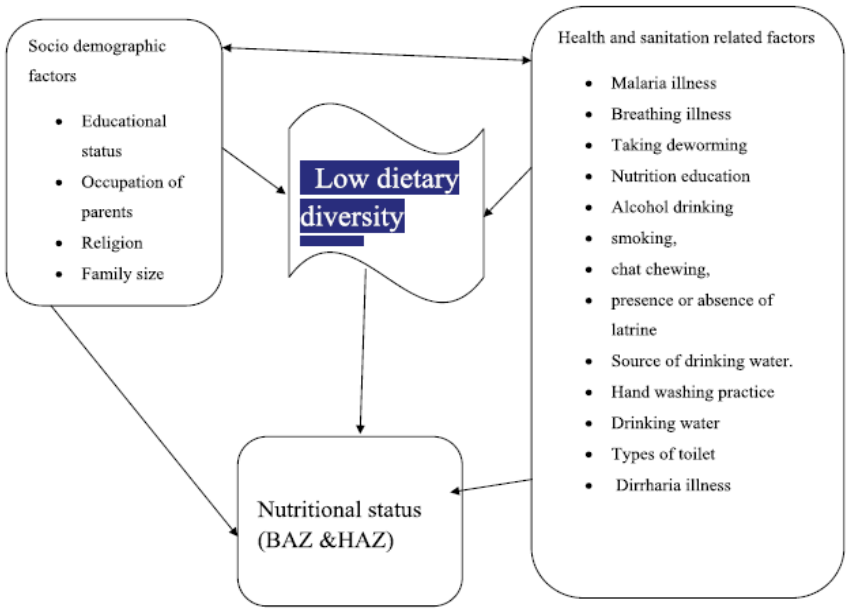

Figure 1. Conceptual Framework for dietary diversity: Reviewed from works of literature.

NB. BAZ = Body mass index—for-age z-score and
HAZ = Height—for-age z-score

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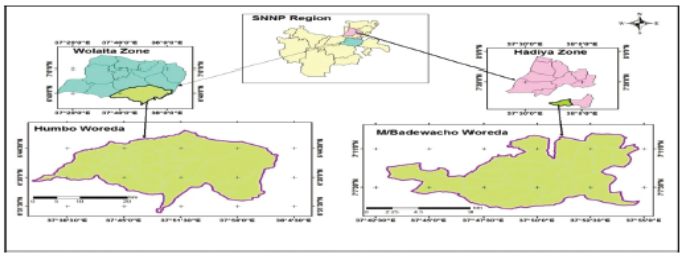

Figure 2. Map of the study area, 2019.

2. Materials and methods

2.1. Study area and design

A community-based cross-sectional study was conducted from April 30/2019 to May 30/2019 in Southern Nations, Nationalities, and Peoples' Region (SNNPR); one of the regional states of Ethiopia.

Its capital city is Hawassa and is located 278 km away from Addis Ababa. The SNNPR borders Kenya to the south, South Sudan to the west, the Gambela to the northwest, and Oromia to the north and east. There are 13 zones in SNNPR with a total population of 17,887,000.

As indicated by Figure 2, Wolaita and Hadiya Zones were selected purposefully for the study. There is no community-based research previously conducted in the study area. These zones are predominantly dependent on agriculture, practicing mixed crop-livestock production, and inhabitants live in permanent settlements. Within their landholdings, community members cultivate fruits, vegetables, roots, and tuber crops (Regional health office, 2017).

3. Sampling procedures

This study used multistage sampling techniques. From 13 zones in southern Ethiopia, two zones (Wolaita and Hadiya) were selected by purposive sampling. Then, from these selected zones, two districts were selected based on a simple random sampling procedure. One district was selected from each zone. These are Humbo District from Wolaita and the Misrak Badawacho District from the Hadiya. Three villages were selected from each district by a simple random method. A census of adolescent girls was conducted at these selected Villages. Listing (census) of adolescent girls age ranges within 10–19 years was established with the help of the local government administration/woreda in particular, and more importantly from health extension workers. During the listing of adolescent girls, if more than one adolescent girl is available in one household, one of them was selected by a lottery method. Eight hundred forty-three participants were allocated to these selected six villages depending on the number of adolescent girls in each village. Participants were drawn from each village-based proportional to size (PPS) sampling techniques depending on the number of adolescent girls in each village. From these lists, 843 adolescent girls were selected by the simple random sampling method. Those adolescent girls who are not eligible for the study were excluded.

4. Sample size and sampling technique

A single population proportion formula, [$n = z\frac{\alpha}{2}^2 P\ (1\text{-}P)\ /d^2$] was used to estimate the sample size. Low prevalence of dietary diversity score (46.8%) (Melaku et al., 2017b) was used to estimate the sample size as it gives a larger sample and which can be inclusive for associated factors for dietary diversity score (second objective). Considering a 95% confidence interval (CI) and d = 0.05%, the initial sample size was 383. By adding 10% for non-respondents and a design effect of 2, the final sample size was **843**. The formula for estimation of a single population was used as follows: $n = (Z_{\alpha/2})^2 * p\ (1\text{-}p)\ DE\ /d^2$. Where: Z = Standard normal distribution value at 95% CI = $(1.96)^2$, DE = design effect, and d = 0.05 (5% margin of error).

All adolescent girls (in school and out of school), age within 10–19 years in Wolaita and Hadiya zones of southern Ethiopia were source population for the study. The study population was randomly selected 843 adolescent girls, age within 10–19 years in two zones of Southern Ethiopia who can fulfill the inclusion criteria. All adolescent girls, age within 10–19 years in Wolaita and Hadiya zones from southern Ethiopia who have a willingness to give assent and whose guardians/parents have a willingness to provide consent to participate in the study (for participants <18 years) and those adolescents of 19 ages provided informed consent were included.

All adolescent girls age within 10–19 years in southern Ethiopia who were with a physical disability for anthropometric measurement, mental disability who are not correctly responding for an interview were excluded from the study. In addition to these pregnant adolescent girls were excluded from the study.

5. Measurement

Dietary diversity score (DDS) was used as dependent variable while the following variables were used as independent variables:

Age, educational status of the adolescents girls, family size, religion, maternal and paternal educational and occupational status, distance from health facilities, access to nutritional counseling services in health facilities, household monthly income, source of food, shortage of food, number of meals per day, alcohol drinking, smoking, khat chewing, presence or absence of latrine, source of drinking water, malaria illness, diarrhea illness, decision-making power and breathing illness.

6. Data collection

A structured 24-h dietary recall (24 HR) interview was conducted to capture detailed information about all foods and beverages consumed by the respondent in the past 24 hours, most commonly, from early morning to the early morning of the previous day. In addition to this, a food frequency questionnaire was administered to know the usual frequency of consumption of food over 24-h time period. The food frequency questionnaire contained a finite list of foods and beverages with response categories to indicate the usual frequency of consumption. According to FAO guidelines, to reflect a better quality diet, the number of different food groups consumed was calculated and used as a proxy measure of the nutritional quality of an individual dietary diversity score (IDDS)(G. Kennedy et al., 2011).

A structured interviewer-administered questionnaire was used to collect data. The questionnaire was developed based on a thorough review of different literature.

A total of eight data collectors comprising BSc holder nurses, with previous experience of data collection and who have knowledge of culture, language, and norms of the community were employed to collect data by using a pretested structured questionnaire. In addition to these two MSc in public health holder supervisors were employed to supervise the data collection process. The collection of data was at weekends for adolescent girls who are at school during weekdays. The principal investigator controlled the overall study activities on a daily basis.

7. Data processing and analysis

First, the data were checked for completeness and consistency prior to data entry and cleaning. Then, data were entered into the computer using EP-data version 4.4.2 and exported to SPSS version 21.0 for further analysis. Descriptive statistics such as frequencies, proportions, and cross-tabulation were used to present the information. Before actual data analysis, missing value and outliers were checked by drawing histograms. In addition to this, multicollinearity was checked to find out a linear association among explanatory or predictor variables by using the variance inflation factor (VIF) assumptions. Multicollinearity refers to a situation in which two or more explanatory variables in a multiple regression model are highly linearly related. Multicollinearity

effect was assessed with a cutoff point of variance inflation factor (VIF) less than 10 and model robustness was also assessed using Hosmer and Lemeshow techniques.

Also, bivariate logistic was done to assess the association between independent and dependent variables. Variables that showed association (p-value ≤0.25) in the bivariate analysis were included in the final multivariable logistic regression model. We used the enter method during regression analysis. The odds ratio for logistic regression along with a 95% confidence interval was estimated. A P-value of less than 0.05 was considered as a level of statistical significance.

8. Data quality assurance

The questionnaire was prepared in English and then translated to Amharic and rendered back to English to keep the consistency of the questions. Data collectors and supervisors were trained for 4 days about the proper filling of the questionnaire. Data collectors were selected from each zone that can communicate by local language fluently and can understand the socio-cultural practice of the community. Pre-testing of the questionnaire was done on 5% adolescent girls in a similar area to the study sites to ensure the reliability of the data. Feedbacks from the pre-test were incorporated into the final questionnaire design. Principal investigators and supervisors checked on the spot and review all the completed questionnaires to ensure completeness and consistency of the information collected.

9. Ethical considerations

The study was approved by Addis Ababa University (AAU), College of Natural Sciences Research Ethics Review Committee. Official letter of cooperation was written to Wolaita and Hadiya zones, and districts of health offices. The nature of the study was fully explained to the study participants and parents/guardians. Informed verbal and written consent was obtained from parents/guardians for adolescent girls aged less than 18 years old and assent was obtained from the participant before the interview. Participants 18 years or older were asked to provide verbal and written consent. The collected data were kept confidential. The code number was given for each participant and the data were stored in a secured and password-protected database.

10. Operational definition

Adolescent girls- are girls whose ages within 10–19 years. Early adolescence (10–13 years), middle adolescence (14–16 years), and late adolescence (17–19 years)

Dietary diversity score—is defined as the number of food groups consumed over a 24-h period. Less than five food groups (DDS<5) are not diversified and greater than or equals to five food groups is diversified diets (DDS≥5) (Kennedy et al., 2010; G. Kennedy et al., 2011).

Individual dietary diversity score:—is defined as the average number of different food groups consumed by adolescent girls in the previous day and night. Less than five food groups (DDS<5) are not diversified and greater than or equals to five food groups is diversified diets (DDS≥5) (Kennedy et al., 2010; G. Kennedy et al., 2011).

11. Results

Eight hundred and twenty adolescent girls participated in the study (a response rate of 97.3%). The study participants included in this study were adolescent girls with age ranging from 10 to 19 years.

Socio-demographic characteristics of the study participants are shown in Table 1. The average age of the study participants was 14.6 ± 1.9 years and their average family size, 6.56 ± 1.83 persons, while 69.3% of the households had more than 5 family members. About three-fourth (70%) of the study participants are in 5–8 grade. Most of the study participants are protestant (77.2%). About 33.4% of the study participants are from households that have less than USD 31.25 monthly income (Table1).

The mean dietary diversity score of the study participants is 3.56 (±1.2). In this study,72.4% of the study participants had low dietary diversity scores. Also, Figure 3 indicates that 20.1% of the study participants

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Table 1. Socio-demographic characteristics of adolescent girls in southern Ethiopia, 2019

Variable	Level	n (%)
Age of participants	10–13	228(27.8)
	14–16	497(60.6)
	17–19	95(11.6)
Educational status of participants	No formal education	4(0.5)
	1–4 grade	191(23.3)
	5–8 grade	574(70.0)
	9–10 grade	45(5.5)
	11–12 grade	4(0.5)
	College and University	2(0.2)
Religion of participants	Orthodox	281(34.3)
	Protestant	533(65.0)
	Muslim	6(0.7)
Family size	<5 family member	252(30.7)
	>5 family member	568(69.3)
Monthly income of the households	<31.25USD	274(33.4)
	31.25–62.5 USD	298(36.3)
	>62.5 USD	248(30.3)
Taking nutrition education	Yes	243(29.6)
	No	577(70.4)
Decision maker for nutrition service	Father	542(66.1)
	Mother	78(9.5)
	Mother and father	200(24.4)
Educational status of the father	No formal education	81(9.9)
	1–4 grade	61(7.4)
	5–8 grade	202(24.6)
	9–10 grade	220(26.8)
	11–12 grade	71(8.7)
	College & above	185(22.6)
Educational status of the mother	No formal education	117(14.3)
	1–4 grade	81(9.9)
	5–8 grade	346(42.2)
	9–10 grade	132(16.1)
	11–12 grade	36(4.4)
	College & above	108(13.1)

are eating only from two food groups and 36.6% are eating only from 3 food groups. Only 4.8% of the study participants are consuming from six and above food groups (Figure 3).

12. Food frequency pattern of adolescent girls

All adolescent girls (100%) in the study area were consuming foods prepared with cereals, grain, and white roots and tubers more than once times per day. Only 16.0% of the participants were consuming pulses once per day. Meat, poultry, and fish are the least frequently consumed food items as only 13.4% of adolescent girls reported having consumed those two to four times per week. Dark green leafy vegetable foods were consumed less frequently in this study group as only 19.1% of the study participants consumed from this group once per day (Table 2).

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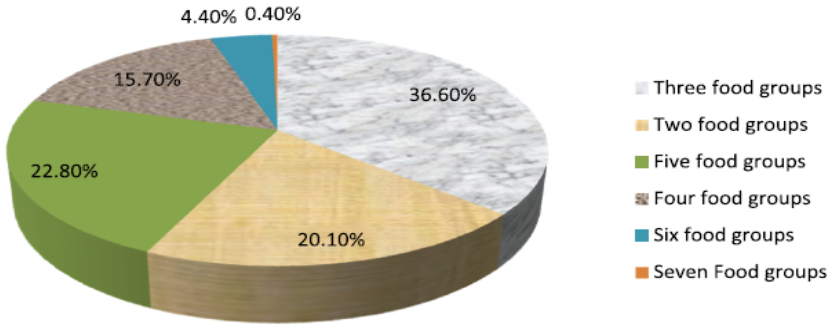

Figure 3. Distribution of dietary diversity score of the study participants.

13. Factors associated with dietary diversity

Table 3 shows association between some variables with dietary diversity score of the study participants. Dietary diversity scores of the study participants were statistically associated with families' monthly income less than USD 31.25 [AOR (95% CI) = 15.5 (8.6–28.1)] and monthly income USD 31.25–62.5 [AOR (95% CI) = 4.3 (2.9–6.5)], educational status of participant's fathers [AOR (95%CI) = 4.3 (1.8–10.6)] and mothers [AOR (95%CI) = 2.6 (1.2–5.6)], taking nutrition education [AOR (95% CI) = 2.2 (1.5–3.3)] and decision-making power of the father [AOR (95% CI) = 2.2 (1.5–3.3)] and decision-making power of the mother [AOR (95% CI) = 2.0 (1.0–3.6)].

14. Discussion

The dietary diversity score indicates the quality and adequacy of the diet that an individual consumed (Oldewage-Theron & Kruger, 2011). The present study identified the prevalence of low dietary diversity scores among adolescent girls aged 10–19 years old. About 72.4% of the study participants were not getting diversified diets. This study is almost in line with a study conducted among adolescent girls in Eastern Arsi Zone, which indicated that most of the study participants frequently consumed foods prepared from cereals and grains (Yemaneh et al., 2012).

The mean dietary diversity score of the study participants is 3.56 (±1.2), which is lower than that estimated by other studies in Bangladesh, Ethiopia, Iran, and Nigeria (Birru et al., 2018; Melaku et al., 2018; Organization, 2006; Vakili et al., 2013; Worku et al., 2017; Yemaneh et al., 2012). This is possible because our study was community-based which most likely included all adolescent girls.

In this study, the dietary diversity scores of the study participants' are significantly associated with family monthly income ($p < 0.001$). Adolescent girls who were from families who had less than 31.25 USD monthly incomes are 15.5 times more likely to have low dietary diversity scores than those who are from families whose monthly income is more than 62.5 USD. This implies that low income can affect the purchasing power of the family and this can lead to less access to food choice (Fisher, 2006; Kaufman et al., 1997). Similar findings were reported from the study conducted at Somali Regional State-Ethiopia (Engidaw et al., 2018), Ahvaz-Iran (Vakili et al., 2013), Nigeria (Ogechi & Chilezie, 2017), and Gurage Zone-Southwest Ethiopia (Worku et al., 2017) which indicated that poor economic status of the family was statistically associated with a low dietary diversity score of adolescent girls.

Low educational status of the participant's fathers is significantly associated with a low dietary diversity score of adolescent girls. Adolescent girls who are from a family whose fathers have no formal education are 4.3 times more likely to have low dietary diversity score and adolescent girls who are from families whose fathers have completed only 1–4 grades are 2.14 times more likely to have low dietary diversity scores than adolescent girls whose fathers have completed college and university. Similarly, in this study, the low educational status of the participant mothers is significantly associated with a low

Table 2. Food frequency pattern of adolescent girls in southern Ethiopia, 2019

%	Grains, white roots, and tubers	Pulses	Nuts and seeds	Dairy products	Meat, poultry, and fish	Eggs	Dark green leafy vegetables	Vitamin A-rich fruits and vegetables	Other vegetables	Other fruits	Fats and oils	Sweets and soft drinks
More than once per day	100	1.7	0.2	3.3	0.2	0.2	5.1	1.2	2.9	2.4	16.7	0.7
Once per day		16.0	6.2	10.5	3.4	3.8	19.4	13.0	17.6	12.9	19.9	7.9
5–6 times per week		27.0	9.9	20.2	3.5	5.9	31.2	23.4	34.8	25.1	15.4	12.4
2–4 times per week		31.2	18.8	29.4	13.4	25.6	30.9	37.0	28.8	41.0	14.4	22.0
Once per week		22.6	28.8	30.2	55.6	50.2	11.0	21.5	15.4	17.7	31.2	64.9
Never		1.6	36.1	6.3	23.8	14.3	2.4	3.9	0.6	0.9	2.4	0.7
Total	100	100	100	100	100	100	100	100	100	100	100	100

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Table 3. Association between some variables with dietary diversity score of adolescent girls in Southern Ethiopia, 2019

Variables	Level	<5DDS N (%)	≤5 DDS N (%)	Crude OR (CI)	Adjusted OR (CI)
Monthly income in USD	<31.25	256(31.2)	18(2.2)	19.4(11.3–33.3)**	15.5(8.6–28.1)***
	31.25–62.5	233(28.4)	65(7.9)	4.9(3.4–7.1)***	4.3(2.9–6.5)***
	>62.5	105(12.8)	143(17.4)	1	1
Educational status of the father	No formal education	72(8.8)	9(1.1)	6.8(3.2–14.4)***	4.3(1.8–10.6)**
	1–4 grade	49(6)	12(1.5)	3.5(1.7–6.9)***	2.14(1.97–4.73)**
	5–8 grade	166(2.0)	36(4.4)	3.9(2.5–6.2)***	3.0(1.74–5.2)***
	9–10 grade	157(19.1)	63(7.7)	2.2(1.4–3.2)***	1.5(0.91–2.44)
	11–12 grade	50(6.1)	21(2.6)	2.0(1.1–3.6)***	1.52(0.79–2.92)
	College & above	100(12.2)	85(10.4)	1	1
Educationalstatus of Mother	No formal education	98(12.0)	19(2.3)	6.7(3.6–12.5)***	3.2(1.5–6.8)**
	1–4 grade	63(7.7)	18(2.2)	4.5(2.4–8.7)***	2.6(1.2–5.6)*
	5–8 grade	255(31.2)	91(11.1)	3.6(2.3–5.7)***	2.3(1.3–3.9)**
	9–10 grade	100(12.2)	32(3.9)	4.1(2.3–7.0)***	2.6(1.4–4.8)**
	11–12 grade	31(3.8)	5(0.6)	8.1(2.9–22.3)***	5.3(1.8–15.4)*
	College & above	47(5.7)	61(7.4)	1	1
Taken nutrition Education	Yes	150(18.3)	93(11.3)	1	1
	No	444(54.1)	133(16.2)	2.1(1.5–2.9)***	2.1(1.4–3.1)***
Decision maker for nutrition service	Father	417(50.8)	125(15.2)	2.3(1.6–3.2)***	2.2(1.5–3.3)***
	Mother	58(7.1)	20(2.5)	2.0(1.1–3.5)*	2.0(1.0–3.6)*
	Mother and father	119(14.5)	81(9.9)	1	1
Family size	less than 5	172	80	1	1
	Greater than 5	422	146	1.34(0.97–1.86)	1.36(0.94–1.97)
Age of participants	10–13 years	175	53	0.83(0. 46–1.49)	0.63(0.33–1.203)
	14–16 years	343	154	0.56(0.33–1.95)	0.53(0.293–0.95)
	17–19 years	76	19	1	1

1 = reference category, **p-value* < 0.05, ***p-value* < 0.001 and ****p-value* < 0.0001, CI = confidence interval, OR = odds ratio

dietary diversity score of adolescent girls. Adolescent girls who are from families whose mothers have no formal education are 3.2 times more likely have low dietary diversity score and adolescent girls who are from a family whose fathers have completed only 1–4 grades are 2.6 times more likely to have low dietary diversity scores than adolescent girls whose fathers have completed college and university. Awareness and knowledge that can improve food selection and eating behavior. In addition to this educated family has a better economic status which can lead to a quality diet. Similar findings were reported by studies conducted in Iran, Nigeria, northern Ethiopia, and Gurage-Ethiopia (Desta et al., 2019; Jemal & Awol, 2019; Nachvak et al., 2017; Ogechi & Chilezie, 2017; Wachs et al., 2005; Worku et al., 2017).

Not taking nutrition education is significantly associated with a low dietary diversity score of adolescent girls in southern Ethiopia. Adolescent girls who are not taking nutrition education are 2.1 times more likely to have a low dietary diversity score than those who are taking nutrition education. The decision-making power for nutrition service is statistically associated with a dietary diversity score of the study participants. Adolescent girls from the family whose decision-maker is a father were 2.2 and mother are 2.0 times more likely to have a low dietary diversity score than the adolescent girls who are from the family in which nutrition decisions are made by both father and mother.

Improving the awareness level towards nutrition improves dietary diversity scores. This finding is supported by studies conducted previously in different parts of Africa and Ethiopia (Kuchenbecker et al., 2017; Murendo et al., 2018; Negash et al., 2014; Tamiru et al., 2016; Yoon et al., 2000).

15. Conclusions

Low dietary diversity score is found to be a public health problem in the study area. Low family monthly income, low fathers' educational status, low mothers' educational status, not taking nutrition education and reliance on single parent decision on nutrition are the main predictors of low dietary diversity scores among adolescent girls in southern Ethiopia.

Recommendation: At all levels, adolescent girls' nutrition education should be given due emphasis to improve the dietary diversity of adolescent girls as they are tomorrow's mothers who are very important to break the intergenerational cycle of malnutrition. In addition to this, income-generating activities should be implemented to improve the economic status of the household as it affects the dietary diversity score of adolescent girls. Decision-making within the household should be implemented jointly (by both mother and father) to improve the ability to efficiently utilize resources among the household member.

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YH did project administration, manuscript writing.
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All relevant data are within the paper and its Supporting information file. English Version Questionnaire and information sheet.docx

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4.3 Barriers and facilitators of nutrition service utilization among adolescent girls

4.3.1 Introduction

In the previous sections 4.1 & 4.2 the nutritional status, dietary diversity and their determinants were studied among adolescent girls. The Ethiopian NNP provides a framework for multispectral collaboration to effectively deliver nutrition interventions: both nutrition-specific and nutrition-sensitivity. In addition to this national nutrition program II incorporated initiatives to improve the nutritional status of adolescent girls. However, these studies (sections 4.1 & 4.2) have identified that nutritional status and dietary diversity score were low in the study area among adolescent girls. So, understanding barriers and facilitators for nutrition service utilization is critical to timely address malnutrition problem and effective implementation of nutrition program in this age group.

Section 4.3 identified barriers and facilitator of nutrition service utlization among adolescent girls.

Promoting healthy practices of adolescent girls, and protecting young people from health risks is critical to the future of countries' health and social infrastructure. A qualitative cross-sectional study was conducted. For key informant interview: Health extension workers, school leader and gender focal person, health center expert and youth center leader from each village were involved in this study. For focus group discussion: Eight adolescent girls in one group have participated from each village. For the selection of the participants, the purposive sampling method was applied to get the best information. In this paper, barriers and facilitators for nutrition service utilization among adolescent girls were identified. Similarly recommendations based on the finding were made.

4.3.2 Barriers and facilitators of nutrition service utilization among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia

(Qualitative cross-sectional study)

(Paper ready for submission)

Barriers and facilitators of nutrition service utilization among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia: a qualitative cross-sectional study

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Abstract

Background: *Health and nutrition service for adolescents will serve as a future investment for breaking the cycle of intergenerational poor health. Promoting healthy practices of adolescent girls and protecting young people from health risks is critical to the future of countries' health and social infrastructure. Thus, understanding barriers and facilitators for nutrition service utilization is critical to timely address malnutrition problem in this age group.*

Methods*: This study was conducted in Wolaita and Hadiya zones, Southern Ethiopia. A qualitative cross-sectional study was conducted from April 30/2019 to May 30/2019. For an in-depth interview: Health extension workers, school leader and gender focal person, health center expert and youth center leader from each village were involved in this study. For Focus group discussion: Eight adolescent girls in one group have participated from each villagess. For the selection of the participant, the purposive sampling method was applied to get the best information. Each audiotape interview was professionally transcribed word by word in wolaitegna and Hadyagna (local language) and then translated to English. The lead author coded all the transcripts. The process of analysis was conducted with open coding, identifying concepts, categories and properties/subcategories. The study was approved by Addis Ababa University (AAU), College of Natural Sciences Research Ethics Review Committee. Official letter of cooperation was written to Wolaita and Hadiya zones, and districts of health offices. The nature of the study was fully explained to the study participants. Informed verbal and written consent was obtained from each participant. The collected data has been kept confidential.*

Result: *Barriers for nutrition service utilization among adolescent girls were lack of awareness for study participants and their families, shortage of iron-folate and deworming tablets, lack of trained experts who were responsible for the nutrition service implementation, low economic status of the family, lack of coordination among different sectors for nutrition service, low educational status of the adolescent girls' family. Facilitators for nutrition service utilization among adolescent girls were supplementation of iron-folate and deworming tablets was without payment. In addition to this utilization of social and community networks motivates the utilization of nutrition services among* adolescent girls. *Awareness creation training should be given for adolescent girls and their families, and male adolescent before the implementation of nutrition service provision.*

Keywords*: adolescent girls, facilitators, barriers, nutrition service*

Introduction

Investment on adolescent girls is very important to break the cycle of intergenerational malnutrition. Promoting health and nutrition services of adolescence girls and protecting young people from health risks is critical to the future of countries' health and social infrastructure (Nandan *et al*., 2007). Because adolescent health and nutrition service has an intergenerational effect, hence it is one of the important stages of the life cycle in terms of health interventions. Nutrition intervention during adolescent has a positive outcome for future generations and improves the life of society (Staff, 2011). The adverse effect of malnutrition during this period can persist into adulthood and influence future health. Thus, adolescence is a life-stage offering significant potential for shaping the trans-generational effects of nutrition through the prevention of non-communicable diseases (Todd *et al*., 2015).

Nutrition service utilization effectiveness is often limited because of low adherence by the target population. The reasons for noncompliance were inadequate program support, insufficient delivery of services and patient factors (Dubik *et al*., 2019, Bhatt *et al*., 2011b). In the case of iron supplementation, low adherence was due to the unavailability of the tablets was the most common reason that participants did not take iron–folate supplements(Sendeku *et al*., 2020). Lack of nutrition communication efforts must be solved to increase understanding of the importance of taking supplements and to address any fears or misconceptions related to supplementation(Zoellner *et al*., 2009).

Nutrition services in high-income countries, as well as low- and middle-income countries that targeting adolescents, are highly fragmented, poorly coordinated, and uneven in quality (Chatterjee and Baltag, 2015). In addition to these, health expertise faces several challenges with adolescents as they require specialized skills for consultation, interpersonal communication, and interdisciplinary

care (Salam *et al*., 2016a). Study at Peru indicated that barriers for nutrition service are inadequate program support such as lack of political commitment and financial support, insufficient delivery of services such as lack of supplies, access, training, and motivation of health-care professionals, and participants factors such as misunderstanding of instructions and adverse side effects(Gross *et al*., 2006).

Understanding prevailing adolescent nutrition problems and their consequences, the Ethiopian government considered adolescence as a second window of opportunity in the life cycle approach for addressing nutrition problems(Kennedy *et al*., 2015). Even though recently increased interest in adolescent nutrition has been shown as reflected by the inclusion of the term adolescent nutrition in the sustainable development goals (SDGs),there is no information on barriers and facilitators of nutrition service utilization of adolescent girls (Klapper *et al*., 2016). Similarly, government of Ethiopia officially launched the National Nutrition Program (NNP) in 2009, which aimed to reduce all forms of malnutrition in Ethiopia by integrating adolescents' nutrition into community-based health and development programs but it is not effective. The Ethiopian national nutrition program II (2016-2020) incorporated initiatives to improve the nutritional status of adolescent girls (Bekele *et al*., 2008). But a community-based cross-sectional study conducted in the northwestern part of the Amhara region of Ethiopia indicated that only 52.7% of adolescent girls are using community-based nutrition services (Wassie *et al*., 2015).

A good understanding of barriers and facilitators of nutrition service utilization among adolescent girls will have many important public health and policy implications to shape and consolidate healthy eating and lifestyle behaviors, thereby preventing or postponing the onset of nutrition-related chronic disease in adulthood(Delisle *et al*., 2001). There was no study documented in the study area regarding barriers and facilitators of nutrition service utilization among adolescent girls. Therefore, this study will fill the

information gap on barriers and facilitators of nutrition service utilization among adolescent girls in Wolaita and Hadiya zones. The results of this study will give information to community health workers, ministry of health, ministry of agriculture and non-governmental organizations that are interested in the safe and effective implementation of nutrition programs to improve the nutritional status of adolescent girls. The findings can be used to improve existing policies and programs targeting adolescent girls' nutrition, particularly the prevention and management of stunting and underweight in Wolaita and Hadiya zones, southern Ethiopia.

Thus, understanding barriers and facilitators for nutrition service utilization is critical to timely address malnutrition problem in this age group. The objective of the study was to explore barriers and facilitators of nutrition service utilization among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia

Methods and Materials

Study area and period

A qualitative cross-sectional study was conducted in Wolaita and Hadiya zones, southern Ethiopia. These zones are predominantly dependent on agriculture, practicing mixed crop-livestock production and living in permanent settlements. Within their landholdings, community members cultivate fruits, vegetables, roots, and tuber crops. The study period was from April 30/2019 to May 30/2019.

Participants

Purposively selected health extension workers, school leaders, gender focal persons, health center expert and youth center leaders from each village were involved in this study as key informants. In addition to this, data was collected from a total of six FGDs which included eight adolescent girls in each focus group discussion.

Data collection

Key informant interview (KII) - health extension workers, school leader and gender focal person, health center expert and youth center leader have participated from each village. In total, health extension workers (6), primary or secondary school leader (6), gender focal person (2), health center expert (2) and youth center leader (2) were involved for key informant interviews (KIIs). Similarly, for focus group discussion- eight adolescent girls in one group have participated from each village. A total of 6 FGDs were conducted from the two districts. Both FGDs and KIIs were used to triangulate individual and group-level opinions. The KIIs were conducted in an interactive manner, whereby the study participants were encouraged to take an active role in establishing the flow of the interview. FGDs and KIIs were held at the community or nearby health posts or health centers. Qualitative data from FGDS were collected by data collectors who have experience in qualitative data collection procedures. Key informant interview (KII) was conducted by the participial investigator. All interviews were tape-recorded. Open-ended questions were used to collect relevant information.

Data analysis

Each audiotape interview was professionally transcribed word by word in wolaitegna and Hadyissa (local language) and then translated to English. The lead author coded all the transcripts followed by conventional content analysis procedure by starting coding categories which derived directly from the text data. The process of analysis was conducted with open coding, identifying concepts, categories, and subcategories. After aggregating and defining concept lead author developed memos that can elaborate on the concepts/categories developed. Finally, the integration of categories was done which was linking categories around a core category. Data were analyzed using Open code software version 4.02.

Ethical considerations

The study was approved by Addis Ababa University (AAU), College of Natural Sciences Research Ethics Review Committee. Official letter of cooperation was written to Wolaita and Hadiya Zones, and Districts of Health Offices. The nature of the study was fully explained to the study participants. Informed verbal and written consent was obtained from each participant. The collected data has been kept confidential.

Results of the study

Socio-demographic characteristics of qualitative study participants in southern Ethiopia

The study was conducted among 18 KIIs and six FGDs in two districts of southern Ethiopia. As indicated in Table1, Twelve of the key informants were female and six were male. The participants represented a wide age range (24–36 years).

Table 1. Demographic characteristics of qualitative study participants in southern Ethiopia, 2019

Demographic characteristics of KIIs	Level	Number (N)	Percentile (%)
Age in year	24-30	11	61.1
	30-36	7	38.9
Sex	Male	6	33.3
	Female	12	66.7
Occupation	Health extension worker	6	33.3
	School leader	6	33.3
	Gender focal person	2	11.1
	Health center expert	2	11.1
	Youth center leader	2	11.1
Age of adolescent girls in the FGD in year	11-13	13	27.1
	14-16	18	37.5
	17-19	17	35.4

Nutrition service provided/ implemented in the study area

Nutrition services that were given for the adolescent girls in the study area were iron-folic acid supplementation, school-based nutrition education and deworming tablet supplementation every six months. In addition to this, community-based nutrition education was given for adolescent girls in the study area. This is indicated in Table2 with thematic categories. In both zones, school-based deworming tablet supplementation takes place every six months. Deworming tablets were freely supplied by the ministry of health for schooling adolescent girls. Community and school-based

nutrition educations were given for adolescent girls in both zones. Health extension workers, woredas health experts, and school teachers gave nutrition education during outreach programs, at school during orientation time, community mobilization and house to house visits by health extension workers. All nutrition services except community-based nutrition education, provided/ implemented at schools. Iron-folate supplementation and deworming tablet were only given for schooling adolescent girls. This indicates that adolescent girls who have no chance to go to school cannot get fully nutrition service.

Table 2.Thematic categories with themes, representative quotes from a qualitative study on barriers and facilitators for nutrition service utilization among adolescent girls in southern Ethiopia, 2019

Category	Categories for barriers	Exemplifying Quotes for barriers
Awareness	Low awareness for participants about the importance of nutrition service utilization	‘‘Sometimes we (adolescent girls) have fear to take an iron-folate and deworming tablet as they believe it may be a contraceptive method and affect reproduction.’’
	Low awareness for participants' families about the importance of nutrition service utilization	‘‘We (HEWs) were asked many times by participants' families as iron-folic acid and deworming tablets affect the reproduction of adolescent girls in the future. ’’
Supplements	Shortage of IFA and deworming tablets	‘‘Supplements were not enough to supply at the community level for all adolescents girls.’’ By HEW
	Less coverage of IFA and deworming tablets	‘‘We (HEW) supplement iron-folate and deworming table for only schooling adolescent girls at school.’’
Diagnosing	Lack of anemia diagnosing service	‘‘We (HEW) supplement iron-folate tablet for adolescent girls without a diagnosis for specific nutrient and deficiency diseases.’’
	Lack of intestinal parasites diagnosing	‘‘We (HEW) supplement deworming tablet for adolescent girls without a diagnosis for specific intestinal

	service	parasites.''
Coordination	Lack of education and health sectors coordination	''We (HEW) implement nutrition service without enough support from education sectors.''
	Lack of agricultural and health sectors coordination	''We (HEW) implement nutrition service without enough support from agricultural sectors.''
Commitment	Health workers commitments	''Health extension workers were not visiting every household frequently and not giving nutrition education at a community level.'' by adolescent girls
	Teachers commitments	''During implementation of nutrition service at the school level, many teachers and school directors were not effectively supporting the implementation process.'' By HEW.
Economy	The economic status of the families	''We (adolescent girls) eat what we get at home.'' by adolescent girls
Education	Educational status of the family	''Uneducated and less educated families were not permitting their adolescent girls for the utilization of nutrition service.''
Training	Training for HEW	''We (HEW) did not get enough training about supplementation.''
	Training for adolescent girls	''We (adolescent girls) did not get enough training about supplementation.'' by adolescent girls
Category	**Category of facilitators**	**Exemplifying Quotes for facilitators**
Payment	Supplementations payment	''Supplementation of iron folate and deworming tablet without payment facilitates nutrition service utilization among adolescent girls.''

Barriers for nutrition service utilization of adolescent girls in the study area

Nutrition services are a nutritional problem identification and intervention for individuals who are identified as being at nutritional risk, and indicating appropriate means of nutrition intervention.

Nutrition services that were given for the adolescent girls in the study area were iron-folic acid supplementation, school-based nutrition education, community-based nutrition education and deworming tablet supplementation every six months.

Barriers for nutrition service utilization of adolescent girls in the study area were lack of awareness of study participants and their families, shortage of IFA and deworming tablets, lack of diagnosing service for anemia and intestinal parasites, lack of coordination among different sectors, low educational status of participants' families, low commitments of health extension workers to visit each households and low economic status of the families to implement the knowledge of nutrition education.

When iron-folic acid supplementation was given for adolescent girls, participant's families were considering the supplementation of iron-folate as a contraceptive method. This affects the utilization of iron-folic acid among adolescent girls in the study area. Similarly, the supplementation of deworming tablets for adolescent girls was considered as the tablet which causes adolescent girls sterile.

''...we feel fear to take iron-folate and deworming table when our family says as it is contraceptive method because awareness creation training was not given for our family. So, they are not volunteering for utilization of iron-folic acid tablet.''

14-year-old adolescent girl from shochora ogodama villages

''...we were asked many times by participants' families as iron-folic acid and deworming tablets affect the reproduction of adolescent girls in the future.''

32-year-old health extension worker from Kanchera villages

Shortage of iron-folate, deworming tablets and less coverage of nutrition service supplementation were barriers for utilization of nutrition service among adolescent girls in the study area. The supply of iron-folate and deworming tablets was not enough with the demand of the adolescent girls. In addition to this, supplementation was school-based. So, adolescent girls who were not at school

cannot get any supplementation. The school-based nutrition education and supplementation program cannot reach out-of-school adolescent girls.

''...we supplement iron-folate and deworming table for only schooling adolescent girls at school. Supplements were not enough to supply at the community level for all adolescents girls. ''

34-year-old health extension worker from Ampo koysha villages

Lack of diagnostic service for specific nutrient and deficiency diseases among adolescent girls was the barrier to the utilization of nutrition. In the study area supplementation of iron-folic was implemented without the diagnosis of blood hemoglobin level for iron and folate status. Without the knowledge of blood nutrient status, participants were not interested to take supplementation. Similarly, supplementation of a deworming tablet was implemented without the diagnosis of a gut parasitic load. So, the universal supplementation of a deworming tablet was not effective due to the interest of participants was low.

''...we supplement iron-folate and deworming tablet for adolescent girls without a diagnosis for specific nutrient and deficiency diseases. *We supplement as told from the district health office without knowing the status of adolescent girls.''*

32-year-old health expert from Humbo woreda health center

Lack of trained experts who were responsible for the nutrition service implementation was the barrier to the utilization of nutrition service. There were no responsible experts for the supplementation of iron-folic acid and deworming tablets in the study area for adolescent girls. Health experts and health extension workers were implementing the supplementation process with other duets without getting enough training. Sometimes school teachers were directly involving in supplementation of tablets and this was affected by class schedules. In addition to this, when students were on semester break or at the end of the class, there was no supplementation program. Some teachers were not volunteers for the supplementation of any tablets.

''...We did not get enough training for supplementation of an iron-folate and deworming tablets for adolescent girls. In addition to this, we did not get training for nutrition education to give nutrition education services for adolescent girls. Sometimes we are too busy to supplement tablets.''

28-year-old female school director from Humbo woreda

The low economic status of the family affects nutrition service utilization among adolescent girls in the study area. When nutrition educating was given for adolescent girls, the utilization of nutrition education was high among adolescent girls who were from economically well family. From FGDs most adolescent girls have reported that taking nutrition education to eat a diversified diet was not important without having enough food and food choice. Similarly, adolescent girls who were from economically well family can attend school and can get nutrition services that were given only at school. Participation in the nutrition education session itself as well as practicing what has been thought by nutrition education can be affected. So, economical status of the adolescent girls' families was barriers to nutrition service utilization.

''…We (adolescent girls) eat what we get at home. We eat kita, injera, Shiro, potato, kale, etc. Even if health extension workers and health experts give nutrition education to eat fruits and vegetables as well as different foods groups, this does not work for adolescent girls who were from poor households…a poor household cannot implement the knowledge of nutrition education….sometimes we were not attending nutrition education session as it was not important for us.''

16-year-old adolescent girl from woyira mazoriya villages

''...Most of the adolescent girls were not volunteer to participate in nutrition education sessions by reporting as 'we don't have different food to eat and choice at home to.' We have asked them what types of food they were frequently consuming.''

30-year-old health extension worker from Shochora Ogodama villages

Lack of coordination among different sectors for nutrition service was a barrier for nutrition service utilization among adolescent girls in the study area. Health sector experts were implanting nutrition services for adolescent girls at school and community level. During the implementation of nutrition service at the school level, many teachers and school directors were not effectively supporting the implementation process. They were not considering themselves as responsible for the provision of nutrition service. In addition to this, agricultural extension workers were not supporting nutrition service work.

''...We (health extension workers) implement nutrition service without enough support from another sector. Teachers, school directors, and agricultural extension workers were not effectively supporting the implementation process. ''

30-year-old health extension worker from Ampo koysha Villages, Humbo woreda

Lack of commitment of health extension workers and health experts was a barrier to the utilization of nutrition services among adolescent girls in the study area. Some of the health experts were not giving attention to nutrition service provision.

''...Health extension workers were not visiting every household frequently and not giving nutrition education at the community level. Health extension workers and health experts did not give attention to visit all households that have adolescent girls at the community level. Most of the time, they waste their time at their office and sometimes at school.''

15 years old adolescent girl from Kanchera villages, Misrak badawacho worada

The low educational status of the adolescent girls' family was barriers to the utilization of nutrition services among adolescent girls in the study area. Uneducated families were not volunteers enough for the utilization of the nutrition service of their adolescent girls.

''...Uneducated and less educated families were not permitting their adolescent girls for the utilization of nutrition service. They deny permission to their adolescent girls for the utilization of iron-folate and deworming tablet supplements.''

32-year-old health extension worker from Ampo koysha Villages, Humbo woreda

Facilitator for nutrition service in the study area

Supplementation of iron folate without payment facilitates nutrition service utilization among adolescent girls. Similarly, deworming tablet supplementation was implemented without payments for adolescent girls to encourage the utilization of nutrition services. In addition to this utilization of social and community networks motivates the utilization of nutrition services among adolescent girls.

''... Supplementation of iron folate and deworming tablet without payment facilitates nutrition service utilization among adolescent girls.''

Health extension workers and health experts from all villages and health centers

''...health extension workers were not asking payment for supplementation of iron folate and deworming tablet. This encourages us to take supplementation every time. ''

Adolescent girls from all villages

DISCUSSION

Barriers for nutrition service utilization of adolescent girls in the study area

The present KIIs and FGDs conducted in two zones have identified barriers and facilitators of nutrition service utilization among adolescent girls in southern Ethiopia.

Barriers to nutrition service utilization of adolescent girls in the study area were lack of awareness of study participants and their families about nutrition service. This finding is similar with the studies conducted in India and Bangladesh among adolescent girls which indicated that awareness creation increases nutrition service utilization (Singh, 2013; Alam *et al*., 2010; Bhatt *et al*., 2011a). This might be due to awareness creation about the importance of nutrition service improves the utilization status of nutrition service among adolescent girls. The adolescent girls and the family who have awareness about the importance of nutrition service have used nutrition service more effectively(Canavan and Fawzi, 2019). Similarly, a study conducted among Latino adolescent girls indicated that misunderstanding of nutrition service for adolescent girls affects nutrition service utilization (Beck *et al*., 2019).

Sometimes a shortage of iron-folate and deworming tablets were barriers for full utilization of nutrition services. Iron-folate and deworming tablets supplementation were implemented only school community. So, adolescent girls who were out of school were no using these supplementations. In addition to this, sometimes Iron-folate and deworming tablets were not enough for all adolescent girls in the school. This was due to the supplementation of tablets from stockholders was not proportional to the number of adolescent girls in the area. Similarly, the lack of diagnosis service for specific nutrient and deficiency diseases among adolescent girls was the barrier to the utilization of nutrition. Adolescent girls were supplemented with the iron-folic acid tablet without a diagnosis for blood iron level and hemoglobin status. Similarly, adolescent girls supplemented deworming tablets without a diagnosis for a gut parasitic load. Lack of knowledge for specific nutrient deficiency and gut parasite/microbial load was a barrier to the utilization of supplements. Studies conducted in the deferent area indicated that diagnosis for a microbial load is very important for effective prevention and utilization of deworming tablets (Albonico *et al*., 2006).

Lack of trained experts who were responsible for the nutrition service implementation was the barrier to the utilization of nutrition service. Health extension workers expend their time on other health

packages other than nutrition service provision. Guidelines for adolescent preventive services written by the world health organization recommends that health and nutrition work and service provision should be implemented by trained experts (WHO, 2017). Lack of trained nutrition experts might leads to low nutrition service utilization among adolescent girls in the study area. A study conducted in Nigeria recommended that nutrition education should be intensified among female adolescents to improve their nutritional knowledge and to make them realize the importance of choosing healthy food for healthy living (Olumakaiye, 2013).

The low economic status of the family was the barrier to nutrition service utilization among adolescent girls in the study areas. When nutrition education was given for adolescent girls, the utilization of nutrition education was high among adolescent girls who were from economically well family. The study conducted in rural Vietnam indicated that individuals from better economic status were using health and nutrition services more than that of low economic status(Thoa *et al*., 2013). Increases in the cost of food lead to changes in the quantity and type of foods that are purchased. This may result in a reduction in the amounts of foods consumed and the substitution of higher-priced foods for less expensive foods which are often less nutritious. So, educating poor adolescent girls to eat healthy and diversified food does not works (Darmon and Drewnowski, 2015; Endevelt *et al*., 2009). This might be due to the availability and accessibility of quality food and food groups affect the utilization of nutrition service among adolescent girls.

Lack of coordination among different sectors for nutrition service was a barrier for nutrition service utilization among adolescent girls in the study area. Health extension workers were providing nutrition services without full support from agricultural and school leaders in the study area. Formative research conducted by Ethiopian public health institution indicated that lack of coordination among different sectors were barriers for nutrition service and program provision(Ayana *et al*., 2017).

Low educational status of the adolescent girls' family was barriers to the utilization of nutrition services among adolescent girls in the study area. Low/not educated families were preventing their adolescent girls from nutrition service utilization. Low educated families did not volunteer for their adolescent girls to take nutrition education, iron-folate and deworming tablet supplementation. A review of the deferent study conducted in selected South-East Asian countries indicated that the

educational status of the family affects nutrition service utilization among adolescent girls(WHO, 2006b).

Supplementation of iron folate and deworming tablet supplementation was implemented without payments for adolescent girls to encourage the utilization of nutrition services. In addition to this utilization of social and community networks motivates the utilization of nutrition services among adolescent girls. The availability of drinking water in the community and school compound was a facilitator for the utilization of iron folate and deworming tablet supplementation. Adolescent girls swallow supplemented iron folate and deworming tablets during supplementation by using potable water in the study area.

Conclusion

Barriers for nutrition service utilization among adolescent girls in the study area were lack of awareness for study participants and family, shortage of iron-folate and deworming tablets, lack of trained experts who were responsible for the nutrition service implementation, low economic status of the family, lack of coordination among different sectors for nutrition service, low educational status of the adolescent girls' family.

Facilitators for nutrition service utilization among adolescent girls in the study area were supplements were free from payment. Supplementation of iron folate and the deworming tablet was implemented without payments from adolescent girls to encourage the utilization of nutrition services. In addition to this utilization of communitys' networks motivate the utilization of nutrition services among adolescent girls.

Recommendation

- Awareness creation training should be given for adolescent girls and their families, and male adolescents before the implementation of nutrition service provision
- Nutrition training should be given for health extension workers, health experts, school directors, agricultural extension workers, and other stockholders experts about nutrition service
- Different sectors and stockholders should be coordinated to implement nutrition service for adolescent girls
- Trained nutrition experts who are responsible for the nutrition service implementation should be recruited at each villages

- The economic status of the family should be improved by participating in poor households in income-generating activities
- Iron-folate and deworming tablet supplementation should be proportional to the number of adolescent girls in each village to cover supplementation for adolescent girls at school and community level.
- Supplementation program of an iron-folate and deworming tablet should be both school and community level to address all adolescent girls

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- **Authors' contributions**
- YH, TB, CA, AW and KB conceptualized the study, looked for funding, contributed to data analyses, and thoroughly edited the manuscript
- YH administered the project and wrote the first draft of the manuscript
- All authors reviewed and approved the manuscript

Competing interests: None of the authors' have potential conflict of interests' to disclose

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4.4 Low blood hemoglobin concentration and its determinants among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia

4.4.1 Introduction

In the previous sections, the nutritional status, dietary diversity and their determinants among adolescent girls were studied. In addition to these barriers and facilitators of nutrition service utlization were identified. These studies (section 4.1, 4.2 & 4.3) have identified that nutritional status and dietary diversity score were low in the study area. Similarly, there were many bariers and facilitetors of nutrition service utlization. But, these studies did not identify blood hemoglobin concentration by taking biological sample of adolescent girls. To improve adolescent girls' nutritional status effectively, the biological sample should also be studied. Therefore, it is important to examine the blood hemoglobin concentration and its determinants among adolescent girls.

In the present section (4.4) hemoglobin concentration was measured in venous blood samples using a Hemocue photometer. The mean (± SD) blood hemoglobin level of the study participants was identified. Similarly, prevalence of anemia was identified. From the total study participants, 37% were moderately anemic (Hg 7-12gm/dl) and 0.2% of the study participants were severely anemic (Hg<7g/dL). Overall prevalence of anemia was 37.2% among adolescent girls in the study area. Associated factors of anemia among adolescent girls were identified. Based on the finding, recommendations that are important to improve blood hemoglobin concentration were made. The study findings were presented in the form of a manuscript ready for submission.

4.4.2 Low blood hemoglobin level and its predictors among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia

(Manuscript under preparation)

Low blood hemoglobin level and its predictors among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia

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Abstract

Background*: Adolescence is defined as the age range of 10-19 years and it is a transition period from childhood to adulthood. Adolescence is the most important period of life for growth and development, and a determining point for nutritional status, physical activity and cognitive behaviors. The aim of this study is to assess anemia status and its determinants among adolescent girls in Southern Ethiopia.*

Methods*: This research was done in Southern Nations, Nationalities, and Peoples' Region (SNNPR). Community-based cross-sectional study was conducted from* April 30/2019 to May 30/2019*. A multistage sampling method was used to select a sample of* ***843*** *adolescent girls. Pre-testing of the questionnaire was done on 5% adolescent girls to ensure the reliability of the questionnaire. Venous blood sample was collected from all adolescent girls. Hemoglobin level was measured in venous blood samples using a Hemocue photometer which was processed in the field (Hemocue R, Hb 301+ system). Data was entered in the computer using EPI-data version 4.4.2 and exported to SPSS version 21.0 for further analysis. Variables which showed association (p-value ≤ 0.25) in the bivariate logistic analysis was included in the final multivariable logistic regression model. Odds ratios for logistic regression along with 95% confidence interval were estimated. P-value less than 0.05 were declared as level of statistical significance.*

Result: *In this study 820 adolescent girls were participated with a response rate of 97.3%. The mean (± SD) blood hemoglobin level of the study participants was 12.23±1.16 g/dL and 37% of the study participants are moderately anemic (Hg 7-12gm/dl) and 0.2% of the study participants were severely anemic (Hg<7g/dL). Overall prevalence of anemia was 37.2% among adolescent girls in the study area. Family monthly income, illness with malaria in the past two weeks, taking deworming tablet, fathers' educational status and BMI-for-age were the main predictors of low blood hemoglobin level among adolescent girls in southern Ethiopia. Thus, community-based Iron folic acid supplementation and deworming tablet intervention program should be implemented to help adolescent girls who are at risk of anemia. In addition to this malaria prevention mechanism and improving family monthly income program should be implemented.*

Keywords*: adolescent girls, anemia and nutrition status*

Background

Adolescence is defined as the age range of 10-19 years and it is a period of transition from childhood to adulthood. Adolescence is the most important period of life where growth and development are accompanied by various physical, physiological, behavioral and social changes. This leads to increased demand for nutrients that in turn could pose high risk of malnutrition (Vashist and Goel, 2009).

Anemia is a worldwide public health problem, with global prevalence estimated at 24.8%. The majority of the burden of anemia is in developing world, with highest prevalence in Africa and Southeast Asia(WHO, 2008, Central Statistical Agency, 2011). Even though anemia has multiple causes, iron and folate deficiencies are the most common causes of anemia. Approximately, 50% of cases of anemia are considered to be due to iron deficiency but this can vary depending on context of living environment (Balarajan *et al*., 2011).

Adolescent girls are vulnerable especially to iron deficiency due to accelerated increase in requirements for iron, poor dietary intake of iron, menstrual losses, infection, norm of early marriage and adolescent pregnancy(Balarajan *et al*., 2011).

High prevalence of anemia reported from Nepal (56.3%) (Sinha *et al*., 2012), from India(60%) (Deshpande *et al*., 2013), western Kenya (30.5%) (Leenstra *et al*., 2009). Study conducted in Babile district, Eastern Ethiopia among adolescent girls indicated that prevalence of anemia was 32%(Teji *et al*., 2016). In general, the prevalence of anemia in Ethiopia among the age group of 15–19-year-old females ranged from 9.3% to 34.8% (Central Statistical Agency, 2011).

Intervention to prevent iron deficiency anemia should include measures to increase iron intake through food-based approaches(WHO, 2006a). The Ethiopian national nutrition program II (2016-2020) incorporated initiatives to improve nutritional status of adolescent girls, but prevalence of anemia is not decreasing significantly in Ethiopia (Gebreyesus *et al*., 2019). Thus, understanding blood hemoglobin concentration and associated factors is critical to timely address malnutrition in this age group. The objective of the study is to assess hemoglobin concentration and its determinants among adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia. A good understanding of nutritional status of adolescent girls will have many important public health and policy implications. So, this study will give information to community health workers, ministry of

health, ministry of agriculture and non-governmental organizations that are interested on the safe and effective implementation to improve the hemoglobin concentration of adolescent girls.

Materials and methods

Study area and period

A cross-sectional study was conducted at six Villages of Wolaita and Hadiya Zones. Wolaita and Hadiya zones are two zonal administrates in Southern Nations, Nationalities, and Peoples' Region (SNNPR). These zones are predominantly dependent on agriculture, practicing mixed crop-livestock production and living in permanent settlements. Within their landholdings, community members cultivate fruits, vegetables, roots, tuber crops, and cereals. The study period was from April 30/2019 to May 30/2019.

Source population for the study

All adolescent girls (in school and out of school), age within 10-19 years in two zones of Southern Ethiopia were source population for the study.

Study population for the study

Randomly selected adolescent girls, age within 10-19 years in two zones of Southern Ethiopia who can fulfill the inclusion criteria were the study population.

Inclusion criteria

All adolescent girls, age within 10-19 years in two zones from southern Ethiopia who have a willingness to give assent/consent as appropriate and whose guardians/parents have a willingness to provide consent to participate in the study (for participants <18 years) and those adolescents of 19 ages provided informed consent were included.

Exclusion criteria

All adolescent girls age within 10-19 years in southern Ethiopia who were with a physical disability for anthropometric measurement, mental disability who were not correctly responding for an interview were excluded from the study. In addition to these pregnant adolescent girls were excluded from the study.

Outcome Variables: Anemia status/hemoglobin concentration

Independent/Predictor variables

Age, educational status of the adolescents girls, family size, maternal and paternal educational and occupational status, distance from health facilities, access to nutritional counseling services in health facilities, deworming tablet, iron-folic acid supplementation, household monthly income, source of food, shortage of food, number of meals per day, alcohol drinking, smoking, chat chewing, presence or absence of latrine and source of drinking water.

Sampling procedures

This study used multistage sampling techniques. From 13 zones in Southern Ethiopia, two zones were selected by purposive sampling because of no previously study was conducted. These are Wolaita and Hadiya Zones. Then, from these selected two zones, two districts were selected using simple random sampling procedure. One district was selected from each zone. These are Humbo District from Wolaita Zone and Misrak Badawacho District from Hadiya Zone. Three villages were selected from each district by simple random method. Listing of adolescent girls was conducted at these selected Villages. Listing of adolescent girls age ranges within 10-19 years was established with the help of the local government administration and health extension workers. During the listing of adolescent girls, if more than one adolescent girls were available in one household, one adolescent girl was selected by lottery method. Then, 843 participants were allocated to these selected six villages depending on the number of adolescent girls in each village. Participants were drawn from each villages based on probability proportional to size (PPS) sampling techniques depends on number of adolescent girls in each villages. From these lists, **843** adolescent girls were selected by simple random sampling method. The adolescent girls who are not eligible for the study were excluded.

Hemoglobin Screening Using Venous Blood

Adolescent girls were assessed for hemoglobin level. For hemoglobin analysis, venous blood sample was collected by using clean syringe. The experienced laboratory technician was trained on the field blood sample collections procedures and hemoglobin analysis at the field level. The prevalence of anemia was calculated based on the hemoglobin concentration / standard cut-off points for hemoglobin concentration measured in venous blood samples using a Hemocue photometer which

was processed in the field (Hemocue R, Hb 301+ system). Biological hazards were discarded in hazard box and burned in incinerator at health center.

Adjustment for hemoglobin (Hb) concentration for altitude was done before defining anemia. The adjustment was done to account for a reduction in oxygen saturation of blood. The following formula was used for adjustment of hemoglobin for high altitude. Hb adjustment =-0.032 *(altitude + 0:003280) + 0.02 *(altitude + 0:003280)$^{2.}$ Hemoglobin is the amount subtracted from each individual's observed hemoglobin concentration.

Data collection

A structured questionnaire was used to collect data. The questionnaire was interviewer-administered and developed based on a thorough reviewing different literature.

A total of eight data collectors comprising BSc holder nurses, with previous experience of data collection and who have knowledge of culture, language and norms of the community were employed to collect data by using pretested structured questionnaire. In addition to this, two MSc in public health holder supervisors were employed to supervise data collection process. The data were collected at weekends for adolescent girls who were at school during weekdays. The principal investigator has controlled the overall study activities in a daily bases.

Statistical Analysis

First, the data were checked for completeness and consistency for data entry and cleaning. Then, data were entered into the computer using EP-data version 4.4.2 and exported to SPSS version 21.0 for further analysis. Frequencies, proportions, and cross-tabulation were used to present the descriptive data. Before analysis, missing value and outliers were checked by drawing histograms. In addition to this Multicollinearity was checked if there was a linear association among explanatory or predictor variables by using *variance inflation factor* (*VIF*) assumptions. Multicollinearity refers to the association or relation between two or more independent variables in a multiple regression model. When a variance inflation factor was less than 10, it was taken as tolerable in this analysis. The model was then tested for its goodness of fit by Hosmer and Lemeshow p-value and a p-value >0.05 were being best fit. In addition, analyses of bivariate

logistic regression were done to assess the association between independent and dependent variables. Variables which showed association (p-value ≤ 0.25) in the bivariate analysis were included in the final multivariable logistic regression model. Odds ratio for logistic regression along with 95% confidence interval was estimated. P-value less than 0.05 was declared as level of statistical significance.

Data quality assurance

The questionnaire was prepared in English and then translated to Amharic and rendered back to English to keep the consistency of the questions. Data collectors and supervisors were trained for 4 days about the proper filling of questionnaire and how to collect blood sample. Data collectors were selected from each zone that can communicate by local language fluently and can understand socio-cultural practice of the community. The questionnaire was pre-testedon on 5% the sample in similar area to the study sites to ensure the reliability of the questionnaire. Feedbacks from the pre-test were incorporated into the final questionnaire design. Principal investigator and supervisors have checked on the spot and review all the completed questionnaires to ensure completeness and consistency of the information collected.

Ethical Considerations

Study was approved by Addis Ababa University (AAU), College of Natural Sciences Research Ethics Review Committee. Official letter of cooperation was written to Wolaita and Hadiya Zones, and districts of health offices. The nature of the study was fully explained to the study participants and parents/guardians. Informed verbal and written consent was obtained from parents/guardian for adolescent girls ages less than 18 years old and assent was obtained from participant before interview. Participants age 18 years or older were asked to provide verbal and written consent. Participants with a low hemoglobin level (Hb <12 g/dL) and severe malnutrition were linked to the nearest health facility. The collected data was kept confidential. Code number was given for each participant and the data was stored in secured and password-protected database.

Results of the study

Socio-demographic characteristics of adolescent girls in Wolaita and Hadiya zones, Southern Ethiopia

Eight hundred and twenty adolescent girls were participated with a response rate of 97.3%. The study participants included in this study were adolescent girls with age ranging from 10-19 years.

As shown on the table 4.1, the socio-demographic characteristics of the study participants include age, occupation and education status, family size, religion and so on. The average age of the study participants was (mean ± SD) 14.6±1.9 years and their average family size was (mean ± SD) 6.56±1.83 persons, while 69.3 % of the households had more than 5 family members. About three fourth (70%) of the adolescent girls were in 5-8 grade. Most of the adolescent girls were protestant (77.2%). About 33.4% of the adolescent girls were from the households who have less than 1000 ETBirr monthly income.

Table 4.Socio-demographic characteristics of the study participants in Wolaita and Hadiya zones, Southern Ethiopia, 2019

Variable	Level	Frequency(n)	Percent (%)
Age of participants	10-13	393	47.9
	14-16	373	45.5
	17-19	54	6.6
Educational status of participants	No formal education	4	0.5
	1-8 grade	765	93.3
	9-12 grade	49	6.0
	College and University	2	0.2
Religion of participants	Orthodox	281	34.3
	Protestant	533	65.0
	Muslim	6	0.7
Family size	≤5 family member	252	30.7
	>5 family member	568	69.3
Monthly income of the households	<1000 ETB	274	33.4
	1001-2000 ETB	298	36.3
	>2000 ETB	248	30.3
Taking deworming tablet	Yes	450	54.9
	No	370	45.1
Ill with cough	Yes	228	27.8
	No	592	72.2

Malaria illness in the past two weeks	Yes	291	35.5
	No	529	64.5

Blood Hemoglobin concentration of study participants in Wolaita and Hadiya zones, Southern Ethiopia

Mean hemoglobin concentration was 12.23g/dl and standard division is 1.16 among study participants. The average blood hemoglobin level of the adolescent girls was (mean ± SD) 12.23±1.16 g/dL.

Table 4.2 below indicated that 62.8% of the adolescent girls were normal i.e. blood hemoglobin level is greater than 12 gm/dl (Hg>12gm/dl), 37% of the adolescent girls were moderately anemic (Hg is 7-12gm/dl) and 0.2% of the adolescent girls were severely anemic (Hg<7g/dL) according to the world health organization, hemoglobin cut-off points for the detection of anemia among study participants(WHO, 2011).

Table 5.Hemoglobin concentration of study participants in Wolaita and Hadiya zones, Southern Ethiopia, 2019

Variable	Level	Frequency	Percent (%)
Hemoglobin	Sever anemic (Hg<7g/dL)	2	0.2
	Moderately anemic (Hg is 7-12gm/dl)	303	37.0
	Normal (Hg>=12gm/dl)	515	62.8

Source: Field Survey, 2019.

Association between some variables with hemoglobin concentration of study participants in Southern Ethiopia

Table.4.3 below shows that association between some variables with blood hemoglobin concentration of the adolescent girls. Blood hemoglobin level was statistically associated with families' monthly income, taking deworming tablet, educational status of participant's fathers, ill with malaria illness and BMI for age.

Table 6.Association between some variables with hemoglobin level of adolescent girls in Southern Ethiopia, 2019

Variables	Level	Hg<12g/dl	Hg >12 g/dl	Crude OR(CI)	Adjusted OR (CI)
Age in years	10-13	136	92	1	1
	14-16	319	178	0.83(0.59-1.14)	0.85(0.51-1.44)
	16-19	60	35	0.86(0.53-1.41)	0.91(0.57-1.46)
Monthly income in ETBirr	<1000	135	139	2.62(1.82--3.8)***	1.703(1.086-2.67)*
	1000-2000	103	195	1.43(0.98--2.06)	1.042(0.69-1.57)
	>2000	67	181	1	1
Taking deworming tablet	Yes	150	300	1	1
	No	155	215	1.4(1.06--1.92)**	1.42(1.06-1.93)**
Educational status of father	No formal education	33	48	2.3(1.3--4.0)**	2.7(2.9—3.1)**
	1-8 grade	119	144	0.7(0.8—4.2)	0.2(0.4—3.4)
	9-12 grade	110	181	2.0(0.3--3.0)	0.7(0.1--2.6)
	College and University	43	142	1	1
Ill with cough	Yes	111	117	0.1(0.56-2.83)	0.65(0.78--2.32)
	No	194	398	1	1
Malaria illness in the past two weeks	Yes	135	156	1.83(1.36-2.45)**	1.85(1.33--2.58)**
	No	170	359	1	1
BMI for age	Not thin	188	405	1	1
	Thin	117	110	2.29(1.68-3.13)**	2.09(1.47-2.98)**
Family size	≤5 family members	173	79	1	1
	>5 family members	342	226	1.45(1.06-0.98)	0.75(0.54-1.05)
DDS	≥ 5 Food groups	169	57	1	1
	< 5 Food groups	346	248	0.13(0.51-2.99)	0.65(0.11- 2.44)

*p-value < 0.05, **p-value < 0.001, ***p value<0.0001, CI=confidence interval, OR= odds ratio.

DISCUSSION

Prevalence of anemia among adolescent girls in southern Ethiopia

The present study conducted in Wolaita and Hadiya zones identified the prevalence of anemia among adolescent girls aged 10-19 years old. The blood hemoglobin concentration of the adolescent girls revealed that 37.0% of the study participants are moderately anemic and 0.2% of study participants were severely anemic. The prevalence of anemia among adolescent girls in the study area was moderately high, because according to world health organization, within 20–39.9 % cut-off point is moderately public health problem (WHO, 2005a). This study was supported by the study conducted in three districts of Ethiopia which indicated that anemia prevalence was ranged from 24 to 38% (Gebreyesus *et al*., 2019) and study conducted in Eastern Ethiopia indicated that 32% of adolescent girls were anemic(Teji *et al*., 2016). But low prevalence of anemia (11.1%) was reported from the study conducted in Bahir Dar city administration(Mengistu *et al*., 2019) and southwest Ethiopia(15.2%) (Tesfaye *et al*., 2015). This low prevalence of anemia might be adolescent girls were from schools and some were from city administration who have relatively high economic status. Likewise, low prevalence of anemia was reported from study conducted in Dembia, Northwest Ethiopia(25.5%)(Gonete *et al*., 2018) and from Siaya district of Kenya (26.5%)(Nelima, 2015). These low anemia prevalences might be adolescent girls were from only schools and these adolescent girls might be from high-income family(Gonete *et al*., 2018, Nelima, 2015).

High prevalence of anemia was reported from study conducted at Nepal in 2018 among school adolescent girls (42.5%) and this difference might be due to the study participants were from deferent socioeconomic and cultural environment(Hamal *et al*., 2018).

In this study, blood hemoglobin level of the adolescent girls is significantly associated with family monthly income ($p < 0.05$). Adolescent girls from family having monthly income less than 1000

ETBirr were 1.7 times more likely to be anemic than families having monthly income more than 2000 EBirr. The monthly income may affect purchasing power of the family and this leads to less access to nutrient-dense food for adolescents to consume. This finding is supported by different studies conducted at south India (Koushik *et al*., 2014), Korea (Kim *et al*., 2014), refugee camp of Somale regional state(Engidaw *et al*., 2018), Bahr dar city administration (Mengistu *et al*., 2019) and Berahle district of Afar region (Adem *et al*., 2015) which indicated that income was positively associated with anemia status. Similarly, review on anemia indicated that anemia was positively associated with economic status of the family(Balarajan *et al*., 2011, Kim *et al*., 2014). This might be due to low family income to obtain variety of foods rich in iron can be affected.

In this adolescent girls who were not taking deworming tablet every six months were 1.42 times more likely to be anemic than those who were taking deworming tablet every six months. This might be due to parasites/worm in the small intestine of the adolescents girls may share the nutrient that adolescent girls are using(WHO, 2017). This study is in line with the study conducted in 2018 among school adolescent girls at Nepal which indicated that the blood hemoglobin concentration was significantly associated with taking of deworming tablets(Hamal *et al*., 2018). Similarly, systematic review and meta-analysis indicated that deworming tablet supplementation decrease prevalence of soil-transmitted helminthic infections (Ghogomu *et al*., 2018). In many studies deworming tablet supplementation decreases anemia prevalence and improves blood iron status (Vir *et al*., 2008, Casey *et al*., 2009, Watthanakulpanich *et al*., 2011).

Adolescent girls who are from family whose fathers have no formal education are 2.7 times more likely anemic than adolescent girls whose fathers have completed college and university. This study is supported by study conducted at Nepal (Hamal *et al*., 2018), at kenya (Nelima, 2015) and at southwest Ethiopia which indicated that educational status of participants' fathers is associated with

anemia status of adolescent girls (Tesfaye *et al*., 2015). Possible reason for this association might be educated fathers have good knowledge about nutrition and have awareness to implement nutrition practice. Better educated people may get better information for healthy and nutritious diets(McKay *et al*., 2006, Choi *et al*., 2011). In addition to this, most of educated fathers have good monthly income to have purchasing power for healthy food(Sullivan, 2017).

Malaria illness can affect hemoglobin level of the study participants. Illness with malaria in the past 2 weeks is significantly associated with blood hemoglobin level of adolescent girls. Adolescent girls who have ill with malaria in the past 2 weeks are 1.85 times more likely anemic than those who have no malaria illness in the past two weeks. Malaria infection was significantly associated with anemia (Nelima, 2015, Haidar, 2010, Asobayire *et al*., 2001, Sowunmi *et al*., 2017). This might be the malaria parasites entering the blood after an infective mosquito bite, infect red blood cells. At the end of that infection cycle, red blood cell ruptures. This process lowers the amount of red blood cells and can cause anemia(Quintero *et al*., 2011).

Body mass index for age is associated with anemia status of adolescent girls. Adolescent girls who have low body mass index for age (thin) are 2.1 times more likely anemic than those who have normal body mass index for age (not thin). This finding is in line with the study conducted among adolescent girls at Serbia (Djokic *et al*., 2010) and Bahr dar city administration (Mengistu *et al*., 2019) which indicated that low body mass index for age (thinness) was significantly associated with anemia status of adolescent girls. This might be anemia impairs the physical development (Xiaoliang *et al*., 2009, Chandrakumari *et al*., 2019, Akramipour *et al*., 2008).

Conclusions

Anemia was found to be moderately a public health problem in the study area. Family monthly income, illness with malaria in the past two weeks, not taking deworming tablet, fathers education and BMI for age are the main predictors of anemia among adolescent girls in Wolaita and Hadiya Zone, Southern Ethiopia.

Recommendation

Community based deworming tablet supplementation program should be implemented for adolescent girls. Inter-sectorial collaboration should be there to implement community-based health and nutrition programs i.e. schools and agricultural experts should work together with health experts to improve meal pattern of adolescent girls. Inaddition to these rural nutrition-sensitive agriculture programs should be promoted through rural agricultural extension programs to improve dietary diversity status. Malaria prevention mechanism should be implemented in the study area to improve anemia status. Longitudinal study should be conducted to know case-effect relationship.

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Declarations

Authors' contributions

YH, TB, CA, AW and KB conceptualized the study, looked for funding, contributed to data analyses, and thoroughly edited the manuscript

YH administered the project and wrote the first draft of the manuscript

All authors reviewed and approved the manuscript

Availability of data and materials: All relevant data are within the paper and its Supporting information file. English version questionnar.docx

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Funders role: Funders had no role in study design and study procedure. They only provided financial support for the study.

Ethics approval and consent to participate: Ethical approval was obtained from Addis Ababa University, College of Natural Sciences Research Ethics Review Committee and written consent was obtained from each participants before study begin.

Competing interests: The authors have declared that no competing interests exist.

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4.5. **Effect of community-based weekly iron-folic acid supplementation on serum ferritin, folate and hemoglobin concentration among adolescent girls: Randomized control trial**

4.5.1 Introduction

In the previous section (section 4.4) blood hemoglobin concentration and its determinant were studied through venous blood sample collection. However, using cross-sectional study design might not allow causal inferences. So, this study cannot tell cause and effect relationship.

In this section (section 5.5) the effect of community-based weekly iron-folic acid supplementation on serum ferritin, serum folate and blood hemoglobin concentration were identified among adolescent girls which is important to solve malnutrition. A community-based, individually randomized trial (RCT) was conducted at four villages of Wolaita and Hadiya Zones. For assessment of micronutrient status, 5ml venous blood sample was collected at baseline and at the end of the intervention. Primary outcomes were analyzed based on per-protocol analysis principl. The prevalence of anemia was calculated based on the hemoglobin levels measured in venous blood samples using a Hemocue Photometer which was processed in the field. Specimens were transported on dry ice to the Ethiopian Public Health Institute and analyzed for serum ferritin, serum folate and C-Reactive protein by Immune turbid metric methods with a clinical chemistry analyzer (Cobas 6000 system; Roche Diagnostic GmbH) at the Ethiopian Public Health Institute. In this study, linear regression analysis indicated that weekly supplementation of iron-folic acid for intervention group has improved serum folate by 4.10 ng/ml (P-value<0.0001), blood hemoglobin by 1.20 g/dl (P-value<0.0001) and serum ferritin by 39.076 μg/L (P-value<0.001) compared to control group. Recommendations were made based on the findings of this study.

4.5.2 A community-based randomized controlled trial providing weekly iron-folic acid supplementation increased serum- ferritin, -folate and hemoglobin concentration of adolescent girls in southern Ethiopia

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A community-based randomized controlled trial providing weekly iron-folic acid supplementation increased serum- ferritin, -folate and hemoglobin concentration of adolescent girls in southern Ethiopia

Yoseph Halala Handiso[1,5], Tefera Belachew[2], Cherinet Abuye[3], Abdulhalik Workicho[4] & Kaleab Baye[5]✉

Adequate micronutrient status during adolescence can break the inter-generational cycle of malnutrition. This study evaluated the effect of community-based weekly iron-folic acid supplementation (WIFAS) on serum ferritin (SF), serum folate (SFol) and hemoglobin concentration (Hb) among adolescent girls. A community-based, individually randomized-controlled trial (RCT) was conducted in four villages of Wolaita and Hadiya zones. Adolescent girls (n = 226) aged 10–19 years were recruited and randomly assigned (n = 113/group) into: (i) WIFAS and (ii) control (no intervention) groups. Anthropometry, Hb concentration, and serum ferritin (SF), SFol, and C-reactive protein (CRP) was analyzed at baseline and endline. Baseline Hb, SF, SFol and CRP concentrations were similar in both groups (P > 0.05). About 47–49% of adolescents had marginal iron store (< 50 µg/l). Hb, SF, and SFol concentrations increased in the intervention group, but not in the control group (P < 0.05). Marginal iron store decreased from 49 to 12% after 3-months of WIFAS; whereas, the proportion of adolescents with elevated SF (> 15 µg/l) was slightly higher in the WIFAS than in the control group (P = 0.06). After adjusting for confounding factors in the multiple linear regression model, a three-months WIFAS intervention was associated with an improvement of 4.10 ng/ml in serum folate, 39.1 µg/l in serum ferritin, and 1.2 g/dl in hemoglobin concentration relative to the control group (P < 0.001). WIFAS intervention for three-months was effective in reducing iron and folate deficiency in adolescent girls. Future studies should evaluate the long-term impact of intermittent WIFAS.

Anemia is widely prevalent in low and middle-income countries (LMIC) and disproportionately affects women and children[1]. Anemia has been linked to adverse outcomes including poor cognitive and physical performance, increased susceptibility to disease, and perinatal complications like low-birth weight, still-birth, and preterm birth[2,3]. The etiology of anemia is complex and can be of nutritional origin or related to infection or chronic diseases[4]. Among nutritional causes, iron and folic acid deficiencies are the most common in women and relate to the higher physiological needs to compensate for menstrual losses and support a healthy pregnancy and fetal development[5,6]. Consequently, iron-folic acid (IFA) interventions have been the mainstay of anemia prevention interventions[7].

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	Level	WIFAS (n = 92)	Control (n = 112)	P-value
		n (%) or mean ± SD	n (%) or mean ± SD	
Age	10–13	32 (34.8)	39 (34.8)	
	14–16	56 (60.9)	64 (57.1)	0.18
	17–19	4 (4.3)	9 (8.0)	
Educational status	No formal education	4 (4.3)	5 (4.5)	
	grade 1–8	25 (27.2)	20 (17.9)	0.18
	grade 9–12	51 (55.4)	67 (59.8)	
	College/university	12 (13.0)	20 (17.9)	
Family size	≤5	16 (17.4)	26 (23.2)	0.20
	>5	76 (82.6)	86 (76.8)	
Weight (kg)		43.16 ± 8.7	41.8 ± 8.1	0.26
MUAC		21.97 ± 2.13	20.64 ± 2.06	0.79

Table 1. Socio-demographic characteristics of the adolescent girls. *MUAC*, mid-upper arm circumference, *WIFAS* weekly iron-folic acid supplementation.

	WIFAS (n = 92)	Control (n = 112)	P-value
	Mean ± SD or %		
Hemoglobin (g/dl)	13.3 ± 1.4	13.1 ± 0.7	0.15
Serum ferritin (µg/l)	58.5 ± 35.2	61.1 ± 39.1	0.92
Serum folate (ng/ml)	10.2 ± 4.3	11.2 ± 4.6	0.33
CRP (µg/l)	0.66 ± 1.3	0.56 ± 1.2	0.63
Low ferritin level (< 15 µg/l)	5%	3%	0.08
Marginal iron store (< 50 µg/l)	45%	53%	0.97
Excess iron store (> 150 µg/l)	3%	4%	0.32
Folate deficiency (< 6 ng/ml)	10%	13%	0.72

Table 2. Hemoglobin, iron, and folate status of adolescent girls at baseline. *CRP* C-reactive protein, *SD* standard division, *WIFAS* weekly iron-folic acid supplementation; means were compared using t-test. P-values < 0.05 were considered statistically significant.

IFA supplementation has for a long time been considered primarily for pregnant women. This is considering the increased physiological iron and folic acid requirement of the mother and the added demand to support the development of the fetus, but also to prevent neural tube defects[8,9]. However, in LMICs like Ethiopia, women attend their first antenatal care (ANC) visit quite late in their first trimester or often in their second trimester. Besides, adherence to recommendations is low and is often complicated by inadequate supply, social norms, and side effects[10–14]. Altogether, the late and suboptimal adherence of IFA supplementation suggests that it may be strategic to increase the iron stores of adolescent girls and non-pregnant women of reproductive age through weekly IFA supplementation[15,16]. This will allow women to start pregnancy with adequate iron stores and folate status; hence, lowering the risk of iron-deficiency anemia and folate deficiencies. Weekly IFA supplementation can also have the added advantage of supporting cognitive-[17] and the physical-performance of adolescents[18].

The focus on adolescence as a window of opportunity for preventive nutrition interventions is quite recent[19]. Consequently, very few studies have evaluated preventive nutrition interventions including weekly IFA supplementation, and the quality of the evidence remains low as recently evaluated by a systematic review[20]. Recent studies from India, Nepal, and Kenya have all shown positive effects of weekly IFA supplementation on adolescents' hemoglobin concentration[16,21,22]. These studies were all school-based and hence did not capture out of school girls that may be more at risk. They also did not measure markers of iron, folate, and inflammation status. Consequently, studies on the impact of community-based weekly IFA supplementation on anemia and iron and folate status of adolescents are urgently needed. Therefore, the present study aimed to investigate the effect of community-based weekly supplementation of IFA for three-months on serum ferritin, folate and hemoglobin level among adolescent girls in Wolaita and Hadiya zones, southern Ethiopia. We hypothesized that weekly Iron-folic acid supplementation improves serum ferritin, folate, and hemoglobin concentrations.

Results

From the enrolled participants, 81% from the intervention and 99% from the control group completed the study. Nineteen adolescents discontinued the supplementation due to potential side-effects as they have reported vomit, nausea and constipation. Another two, discontinued because they left the villages where the supplementation was taking place. Study subjects were on average 14 years of age and came from an average household size of seven. Close to 80% were in high-school (grades 9–12), and about 4% had no formal education (Table 1).

	WIFAS (n = 92)	Control (n = 112)	
	Mean ± SD		P-value
Hemoglobin (g/dl)	14.5 ± 1.3	13.2 ± 0.7	< 0.001
Serum ferritin (µg/l)	97.8 ± 68.2	63.1 ± 45.9	< 0.001
Serum folate (ng/ml)	14.3 ± 4.6	11.4 ± 4.3	< 0.001
CRP (µg/l)	1.2 ± 3.0	0.82 ± 1.8	0.353
Low ferritin level (< 15 µg/l)	0%	4%	0.045
Marginal iron store (< 50 µg/l)	11%	54%	< 0.001
Excess iron store (> 150 µg/l)	10%	4%	0.066
Folate deficiency (< 6 ng/ml)	0%	11%	< 0.001

Table 3. Hemoglobin, iron, and folate status of adolescent girls at endline. *SD* standard division, *WIFAS* weekly iron-folic acid supplementation; means were compared using t-test. P-values < 0.05 were considered statistically significant.

	Serum folate		Serum ferritin		Hemoglobin concentration	
	β [95.0%CI]	P-value	β [95.0%CI]	P-value	β [95.0%CI]	P-value
IFA supplementation	4.10 [1.841; 4.590]	< 0.001	39.076 [12.329; 47.822]	< 0.001	1.200[0.853; 1.629]	< 0.001
Age	−0.013 [−0.047; 0.021]	0.459	−0.081 [−0.533; 0.371]	0.725	0.004 [−0.013; 0.006]	0.424
Family size	−0.022 [−0.349; 0.305]	0.894	0.138 [−4.291; 4.567]	0.951	0.009 [−0.083; 0.101]	0.847
Height	−0.018 [−0.119; 0.083]	0.731	−0.357 [−1.717; 1.003]	0.605	−0.008 [−0.036; 0.021]	0.583
Weight	0.117 [−0.028; 0.262]	0.114	0.177 [−1.803; 2.157]	0.860	−0.006 [−0.047; 0.035]	0.761
MUAC	−0.266 [−0.783; 0.251]	0.311	1.427 [−5.555; 8.410]	0.687	0.057 [−0.089; 0.203]	0.445
Baseline hemoglobin	−0.009 [−0.516; 0.497]	0.971	4.594 [−2.229; 11.417]	0.186	−0.800 [−0.943;−0.657]	< 0.001
Baseline CRP	0.229 [−0.251; 0.709]	0.347	−0.413 [−6.896; 6.070]	0.900	−0.009 [−0.144; 0.127]	0.900
Baseline serum ferritin	−0.001 [−0.017; 0.014]	0.859	−0.382 [−0.596; −0.168]	< 0.001	0.002 [−0.002; 0.006]	0.379
Baseline serum folate	−0.499 [−0.628; −0.370]	< 0.001	0.276 [−1.476; 2.027]	0.757	0.011[−0.026; 0.047]	0.561

Table 4. Multiple linear regression for the association between WIFAS and serum ferritin, serum folate and hemoglobin concentration. Results are from multiple linear regression; ß = Unstandardized Coefficients; The maximum variance inflation factor (VIF) for serum ferritin status was 6.045, 5.984 for hemoglobin concentration and serum folate, respectively.

There was no statistically significant difference in the mean hemoglobin, serum ferritin, serum folate, and CRP concentrations (P > 0.05), suggesting effective randomization (Table 2). Similarly, the proportion of subjects with depleted iron stores (serum ferritin < 15 µg/l), marginal and excess iron store were not statistically different between the two groups. The proportion of subjects with depleted and the excess iron store was low (≤ 5%), but close to half of the subjects had marginal iron stores. About 10% in the treatment and 13% in the control group had folate deficiency (P > 0.05).

Significant differences in hemoglobin, serum ferritin, and serum folate concentrations were observed between the intervention and the control group after 3 months of supplementation (Table 3), while no significant changes were observed in the control group. At endline, no adolescent in the intervention group had a depleted iron store or were folate deficient. The proportion of adolescents with marginal iron stores decreased from 45% at baseline to 11% at endline. During the same period, excess iron stores, reflected by a serum ferritin > 150 µg/l, increased from 3 to 10%.

The multivariate linear regression showed significant effects of the WIFAS program on endline serum folate, serum ferritin, and hemoglobin concentrations (Table 4). The lower the baseline ferritin, folate and hemoglobin concentrations, the higher the impact of the WIFAS program (P ≤ 0.001). Three months WIFAS intervention was associated with an improvement of 4.10 ng/ml in serum folate, 39.1 µg/l, and 1.2 g/dl in hemoglobin concentration relative to the control group (P < 0.001).

Discussion

We investigated the effect of community-based WIFAS intervention among adolescent girls in southern Ethiopia. To our knowledge, this is the first study to examine the effect of community-based WIFAS on hemoglobin concentration, serum ferritin and serum folate concentrations of adolescent girls in southern Ethiopia. The prevalence of low serum ferritin was surprisingly low (< 5%), but marginal iron store was highly prevalent in about half of the studied adolescents. WIFAS significantly improved hemoglobin, folate and ferritin concentrations. Baseline hemoglobin, ferritin, and folate concentration was inversely associated with endline values.

The present study showed that iron deficiency was low, despite a predominantly cereal-based diet and the low availability of iron-fortified foods, as reported elsewhere[23]. This finding is in line with a recent study from Hirna,

Ethiopia[24]. Both the present and the earlier study from Hirna identified high levels of marginal iron stores. Such low iron stores can increase the risk of iron deficiency in the event of increased demands due to pregnancy or excessive blood loss. This along with folate deficiency in about 10% of the adolescents and the positive response in serum folate and ferritin in the WIFAS intervention group suggests that the intervention is adapted to the context[22,25–27]. This is further confirmed by the higher response to the intervention in those with lower serum ferritin, folate and hemoglobin at baseline.

The elimination of folate deficiency after 3 months of WIFAS further highlights the importance of WIFAS intervention. Folate deficiency in the first 2 to 3 weeks has been linked to increased risks to congenital malformations[28–30]. Although folic acid supplementation is promoted during pregnancy, the delayed first antenatal care means that most pregnant women do not get folic acid supplements at the time when they need it the most (i.e. first 2 weeks of conception). In contrast, the WIFAS program allows adolescents to have an adequate folate status; hence, reducing the risk of deficiency, if and when they become pregnant[29,31]. The weekly regimen is also likely to decrease any of the possible side-effects observed during daily supplementation[21].

The WIFAS program has been promoted in various LMIC through school-systems[25,32]. Many impact evaluations have shown the benefits of such platforms for constant monitoring and reducing school dropouts. Despite the advantages that the school system provides, in LMICs like Ethiopia, a high number of adolescents are out of school and thus cannot benefit from such programs[33]. Unless systems' are in place to reach out of school adolescent girls, the WIFAS intervention for those going to school only is likely to widen inequalities between adolescent girls. Our study provides evidence that a community-based WIFAS program can be successful in improving serum micronutrient status to improvement levels observed in more controlled school settings. However, the rise in high serum ferritin suggests that there is a potential risk of iron overload for a segment of the adolescent population. Whenever possible, assessing iron status prior to WIFAS interventions can minimize possible adverse effects.

The present study has several strengths and limitations. Key strengths include the use of a randomized controlled trial and the implementation of a community-based WIFAS program. The measurement of inflammation marker using CRP measures is also an additional strength that increases the reliability of serum-ferritin and -folate measures. Measurement of α-glycoprotein (AGP), in addition to CRP, could have allowed us to adjust the serum ferritin values, instead of excluding subjects with inflammation. Nevertheless, samples with CRP > 5 mg/l were excluded from the analyses. The excluded subjects represented 2.5% of the total sample, were balanced by intervention group ($P > 0.05$), and had similar socio-demographic characteristics than subjects retained in the analyses. The study was an effectiveness study; hence, although we know that adherence to the WIFAS was generally high; the compliance to the regimen was not strictly monitored. The long-term impact of the WIFAS benefits remains unknown and warrants to be studied.

Notwithstanding the above limitations, the present study highlighted the beneficial impact of a community-based WIFAS program. The community-based WIFAS program significantly improved serum ferritin, serum folate, and blood hemoglobin concentration among adolescent girls proving this concept in the context of Ethiopia. The present finding suggests the potential benefit of scaling-up community-based WIFAS programs in Ethiopia and beyond. Future studies should evaluate the long-term benefits of such programs.

Methods and subjects

Study area and study design. A community-based, individually randomized trial (RCT) was conducted at four Villages of Wolaita and Hadiya zones using a two-arm parallel design (one intervention group and one control group). Wolaita and Hadiya zones are two zonal administrations in Southern Nations, Nationalities, and Peoples' Region (SNNPR). These zones are predominantly dependent on agriculture, practice mixed crop-livestock production and live in permanent settlements. Within their landholdings, community members cultivate fruits, vegetables, roots, tuber crops, and cereals. Participants were randomly assigned into intervention or control group. The intervention group took weekly IFA supplementation, and the control group received nothing. The IFA supplement contained 60 mg of elemental iron and 0.4 mg of folic acid. The IFA supplementation was monitored by four clinical nurses and two supervisors recruited for the study. IFA tablets were provided every weekend through household visits. These household visits also provided a platform to answer any questions by the study subjects. The study period was from April to September 2019. The baseline survey was conducted in April–May, followed by a three-month supplementation period (June–August), and an endline survey in September.

Ethical considerations. The study was approved by the institutional review board (IRB) of Wolaita Sodo University. All methods were performed in accordance to the Helsinki Declaration ethical principles for medical research involving human subjects. Official letter of cooperation was written to Wolaita and Hadiya zones, and the district health office. The nature of the study was fully explained to the study participants and their parents. Informed verbal and written consent/assent were obtained from parents/respondents before the interview and the intervention. The collected data were kept confidential. The trial is registered at the PanAfrican clinical trial registry (PACTR202003545370309).

Sample size and sampling. The sample sizes were calculated by using Gpower 3.0. Sample size calculations were conducted for serum ferritin, serum folate, and blood hemoglobin concentration and the estimate that gave the largest sample size estimate (i.e. hemoglobin concentration) was retained. The power calculations assumed a power of 80%, an effect size of 0.3 and 20% non-response rate, which yielded a total sample size of 226 (n = 113/group).

In the four selected villages, a list of adolescent girls who were eligible for inclusion in the study was established with the help of the health extension worker. From this list, 226 adolescent girls were selected randomly through randomly generated numbers. Then, these adolescent girls (226 in total) were randomly assigned to the intervention group (G1 = 113) and the control group (G2 = 113).

Apparently healthy adolescent girls aged 10–19 years and willing to participate in the study were recruited from four villages from Wolaita and Hadiya zones. Adolescents that smoke or drink and with a known infectious disease like HIV/AIDS, Tuberculosis, and malaria (based on blood smear) were excluded. The initial screening was supported by physicians and laboratory tests were conducted at the Wolaita Sodo University referral hospital. Adolescents with hemoglobin < 12 g/dl (anemic) and > 17 g/dl (with increased risk of excessive intake) were excluded from the study.

Anthropometric measurements. Anthropometric measures such as height, weight, and mid-upper arm circumference were measured at baseline and end line. Weight was measured to the nearest 100 g using a pre-calibrated digital scale (SECA), wearing light closing and without shoes. Height was measured in a standing position to the nearest 0.1 cm using a vertical board with a detachable sliding headpiece. Mid-upper arm circumference (MUAC) was measured using a standard MUAC tape on the upper left arm, after locating the midpoint for measurement between the end of the shoulder (acromion) and the tip of the elbow (olecranon).

Biological/laboratory sample collection and analysis. An experienced phlebotomist drew fasting venous blood (~ 5 ml), from which drops were used to determine hemoglobin concentration in-field using a portable Hemocue photometer (Hb 301 + system). The remaining blood was allowed to settle at the data collection site (nearby health post) for 45 min before centrifugation to separate the serum. The serum was stored at − 20 °C overnight and was transferred to Wolaita Sodo University referral hospital, where it was stored at − 70 °C until further analyses. Samples were then transported on dry ice to the Ethiopian Public Health Institute (EPHI), where serum ferritin was analyzed using a fully automated clinical analyzer electrochemo-iluminescence immunoassay (ECLIA, Elecsys 2010 analyzer Cobas e 411; Roche Diagnostics GmbH, Mannheim, Germany); C-reactive protein (CRP) and Folate were determined by Immune turbid metric methods with a clinical chemistry analyzer (Cobas 6000 system; Roche Diagnostic GmbH). Hemoglobin concentrations were adjusted for altitude by using the following formula:

$$\text{Hb adjustment} = -0.032 \times (\text{altitude} + 0:003280) + 0.02 \times (\text{altitude} + 0:003280)^2.$$

The Hb adjustment values obtained from the above calculation was subtracted from the measured hemoglobin concentration of each individual adolescent. Subjects with Hb values < 12 g/dl were considered anemic. CRP values > 5 µg/l were considered as elevated. Serum ferritin < 15.0 µg/l was considered as depleted iron stores. Serum folate between 3 and 5.9 ng/ml indicated marginal deficiency, whereas < 3 ng/ml is considered as deficient.

Data quality assurance. The questionnaires were translated into the local languages: *Wolaitegna* and *Hadiya* and were back-translated to English to ensure the accuracy of the translation. Experienced data collectors, lab-technicians, and supervisors were recruited and trained for 4 days. The questionnaires were pre-tested and necessary changes were made prior to the actual surveys. The lead author and supervisors spot-checked the data collection and reviewed the questionnaires for completeness. Standardization of anthropometric measurements was taken. Anthropometric measurement was standardized by intensive training till the between and within measurement errors were reduced to an acceptable range. Acceptable technical error of measurement for weight was less than 0.1 kg, height was less than 0.5 cm and MUAC was less than 2 mm during standardization.

Statistical analysis. Primary outcomes were analyzed based on an intention-to-treat principle. Socio-demographic characteristics were summarized as mean ± SD (or median and range) or frequency (percentage).

A comparison of means between the two arms was analyzed using a t-test. A multiple linear regression model was used to examine the impact of weekly IFA supplementation on hemoglobin concentration, serum ferritin, and serum folate, by running separate models adjusting for confounding factors like age, family size, weight, and baseline hemoglobin, serum ferritin, and serum folate concentrations. Multicollinearity was checked by using *variance inflation* factor (*VIF*), with a VIF values < 10 reflecting that mulitcollinearity is not a serious issue. The goodness of fit of the model was also checked.

All hypothesis tests were two-sided with a P-value < 0.05 considered as statistically significant. EP-data version 4.4.2 was used for data entry and SPSS version 21.0 was for analysis.

Data availability

All relevant data are within the paper and its supporting information file.

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Author contributions

Y.H., T.B., C.A., A.W. and K.B. conceptualized the study, looked for funding, contributed to data analyses, and thoroughly edited the manuscript. Y.H. administered the project and wrote the first draft of the manuscript. All authors reviewed and approved the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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Chapter 5- General discussion

5. General Discussion

The present study conducted in southern Ethiopia has identified nutritional status, dietary diversity, hemoglobin concentration, facilitators and barriers of nutrition service utilization and the effect of iron folic-acid supplementation on serum folate, ferritin and hemoglobin concentration among adolescent girls. Stunting and tininess, and factors that affect nutritional status were identified. Similarly, venous blood hemoglobin concentration of adolescent girls was identified by using Hemocue photometer. Adjustment for hemoglobin (Hb) level for altitude was done before defining anemia. Using a focus-group discussion and key informant interviews, barriers and facilitators of nutrition service utilization were identified. The analysis was conducted with open code by identifying concepts, categories and subcategories. The mean dietary diversity score of the study participants was estimated. Structured 24-hour dietary recall (24HR) interview was conducted to capture detailed information about all foods and beverages consumed by the respondent in the past 24 hours, most commonly from early morning to early morning of the previous day. Dietary diversity scores were calculated by summing the number of food groups consumed by the adolescent girl over the 24-hour recall period.

Finally some of the adolescent girls were enrolled to iron folic acid supplementation. The effects of iron-folic acid on hemoglobin concentration, serum ferritin, folate and CRP were identified. Serum ferritin was analyzed using a fully automated clinical analyzer electrochemo-iluminescence immunoassay (ECLIA, Elecsys 2010 analyzer Cobas e 411; Roche Diagnostics GmbH, Mannheim, Germany). C-reactive protein (CRP) and Folate were determined by Immune turbid metric methods with a clinical chemistry analyzer (Cobas 6000 system; Roche Diagnostic GmbH) at the Ethiopian Public Health Institute.

5.1. Undernutrition and its predictors among adolescent girls

Undernutrition is one of the most common causes of mortality and morbidity among adolescent girls worldwide, especially in South-East Asia and Africa(Organization, 2006). Malnutrition, particularly undernutrition, is highly prevalent among adolescents in low and middle-income countries (Ethiopia(CSA), 2016, Ng *et al*., 2014). Undernutrition is an indicator of poor nutrition and has major consequences on human health as well as the social and economic development of the population (Black *et al*., 2003).

Even though the sustainable development goals included an adolescent nutrition service to break the intergenerational cycle of undernutrition, still now 19.5% of the study participants were moderately thin and 8% were severely thin in our study area. In addition to this, 7.8% and 1% of our study participants are moderately stunted and severely stunted, respectively. High magnitude of undernutrition was also reported from Amhara Region (31.5%), Adwa, Ethiopia (21.4%) and Northern Ethiopia (21.6%) (Wassie *et al*., 2015, Gebregyorgis *et al*., 2016, Melaku *et al*., 2015). Similarly, high prevalence of undernutrition was reported from study conducted in Bangladesh which indicated that the magnitude of thinness and stunting was 49.74% and 15.1% (Tamanna *et al*., 2013) respectively. The reasons for the observed undernutrition of this study might be due to their low monthly household income and this might led to low nutritional status(Candler *et al*., 2017, Maehara *et al*., 2019). Similarly, 69.3% of the study participants were from families with ≥ 5 people. In addition to this, the study participants' fathers have low education status and this might led to undernutrition(Kokiwar *et al*., 2018, Berhe and Gebremariam, 2020). Also, 42.0% of our study participants usually use soap when washing their hands while the remaining proportion do not use soap for washing their hands. A similar study, conducted in the Somali Region of Ethiopia, indicated that hand washing with soap after using the toilet and before eating affects the nutritional status of

adolescent girls (Awel *et al*., 2016). This might lead to the low nutritional status of adolescent girls. Moreover, 40.4% of the study participants were purchasing their food from the market. In order to buy food from the market, cash income is needed. This might be affected by market fluctuation, household income, and takes more time which can lead to undernutrition (Sibhatu and Qaim, 2017, Weigel *et al*., 2016).

5.2 Low blood hemoglobin concentration among adolescent girls

According to the definition of WHO, the magnitude of anemia among adolescent girls in the study area was moderately high, i.e. anemia prevalence within 20–39.9 % cut-off point is moderately public health problem (WHO, 2005a). Our study was supported by the study conducted at Nepal (42.5%)(Hamal *et al*., 2018), at three districts of Ethiopia (24 to 38%) (Gebreyesus *et al*., 2019), at eastern Ethiopia (32%) (Teji *et al*., 2016). But low prevalence of anemia was reported from the study conducted at Bahir dar city(11.1%) (Mengistu *et al*., 2019) and at southwest Ethiopia(15.2%) (Tesfaye *et al*., 2015) and at Dembia, Northwest Ethiopia(25.5%) (Gonete *et al*., 2018). Low prevalence of anemia in those studies might be due to adolescent girls were from schools and some were from city administration which have relatively high economic status.

In this study, blood hemoglobin concentration of the adolescent girls is significantly associated with family monthly income. The monthly income may affect purchasing power of the family and this might leads to less access to nutrient-dense food for adolescent girls to consume. This finding is supported by different studies conducted at south India (Koushik *et al*., 2014), Korea (Kim *et al*., 2014), refugee camp of Somale regional state(Engidaw *et al*., 2018), Bahr dar city administration (Mengistu *et al*., 2019) and Berahle district of Afar region (Adem *et al*., 2015) (Balarajan *et al*., 2011, Kim *et al*., 2014) which indicated that income was positively associated with blood hemoglobin

concentration. This might be due to low family income to obtain variety of foods rich in iron can be affected (Worku *et al*., 2017a, Ajani, 2010, Gür *et al*., 2005).

Not taking deworming tablet every six months of the study participants is significantly associated with blood hemoglobin concentration of adolescent girls. This might be due to parasites/worm in the small intestine of the adolescents girls may share the nutrient that adolescent girls are using(WHO, 2017). This finding was supported by the study conducted in 2018 at Nepal (Hamal *et al*., 2018). This might be due to deworming tablet supplementation decrease prevalence of soil-transmitted helminthic infections (Ghogomu *et al*., 2018, Iannotti *et al*., 2015). In many studies, deworming tablet supplementation decreases anemia prevalence and improves blood iron status (Vir *et al*., 2008, Casey *et al*., 2009, Watthanakulpanich *et al*., 2011). Similarly, educational status of participant's father is significantly associated with hemoglobin status of adolescent girls. This study was supported by studies conducted at Nepal in 2018 (Hamal *et al*., 2018), at Kenya (Nelima, 2015), at southwest Ethiopia (Tesfaye *et al*., 2015). Possible reason for this association might be educated fathers have good knowledge about nutrition and have awareness to implement nutrition practice. Better educated people may get better information for healthy and nutritious diets(McKay *et al*., 2006, Choi *et al*., 2011). In addition to this, most of educated fathers have good monthly income to have purchasing power for healthy food(Sullivan, 2017). In addition to this malaria infection was significantly associated with anemia (Nelima, 2015, Haidar, 2010, Asobayire *et al*., 2001, Sowunmi *et al*., 2017). Malaria illness can affect hemoglobin concentration of the study participants.

In this study, thin adolescent girls were more anemic. This study is in line with the study conducted among adolescent girls at Serbia (Djokic *et al*., 2010) and Bahr dar city administration (Mengistu *et al*., 2019) which indicated that low body mass index for age (thinness) was significantly associated

with anemia status of adolescent girls. This might be anemia impairs the physical development(Xiaoliang *et al*., 2009).

5.3 Dietary diversity score among adolescent girls

A diverse diet that contains at least five food groups is necessary for achieving nutrient adequacy and optimal growth and development(Vakili *et al*., 2013). The adequate nutrient is key and is associated with better lives and with potential intergenerational benefits(Bay *et al*., 2016b). Dietary diversity score is low among adolescent girls in low and middle income countries (Jones, 2017, Worku *et al*., 2017a, Nguyen *et al*., 2018).

The dietary diversity score of the adolescent girls in current revealed that 72.4 % of the study participants were not getting diversified diets. But, better dietary diversity score was reported from studies conducted in Bangladesh (Organization, 2006), in Nigeria (Sedodo *et al*., 2014), in Ahvaz-Iran(Vakili *et al*., 2013), in northwest Ethiopia (Birru *et al*., 2018b), in Jimma town (Melaku *et al*., 2018), in Arsi Zone, Eastern Ethiopia (Yemaneh *et al*., 2012). This difference might be due to our study was community-based and socioeconomic status of the study participants were different.

In this study, dietary diversity score of the study participants is significantly associated with family monthly income. Income may affect the purchasing power of the family and this can lead to less access to food choice(Fisher, 2006, Kaufman *et al*., 1997). Poor people often do not have adequate access to diversified food, because food diversity needs high cost. Similar findings were reported from the study conducted at Somale regional state-Ethiopia (Engidaw *et al*., 2018), Ahvaz-Iran (Vakili *et al*., 2013) and Gurage Zone-Southwest Ethiopia (Worku *et al*., 2017b) which indicated that poor economic status of the family was statistically associated with a dietary diversity score of adolescent girls. Adolescent girls from low economic status have a low dietary diversity score.

In addition to this educational status of the participant's father is significantly associated with a low dietary diversity score of adolescent girls. Similar finding also reported from study conducted in the Gurage zone (Worku *et al*., 2017b).Taking nutrition education and decision making power for nutrition service are significantly associated with a low dietary diversity score of adolescent girls. This might leads to low dietary diversity score of adolescent girls.

5.4 Barriers and facilitators of nutrition service utilization among adolescent girls

Barriers for nutrition service utilization of adolescent girls in the study area were lack of awareness of study participants and their families about nutrition service. This finding is similar with the studies conducted in India and Bangladesh among adolescent girls which indicated that awareness creation increases nutrition service utilization (Singh, 2013, Alam *et al*., 2010, Bhatt *et al*., 2011a). This might be due to awareness creation about the importance of nutrition service improves the utilization status of nutrition service among adolescent girls. The adolescent girls and the family who have awareness about the importance of nutrition service have used nutrition service more effectively(Canavan and Fawzi, 2019). Similarly, a study conducted among Latino adolescent girls indicated that misunderstanding of nutrition service for adolescent girls affects nutrition service utilization (Beck *et al*., 2019).

Sometimes a shortage of iron-folate and deworming tablets were barriers for full utilization of nutrition services. Iron-folate and deworming tablets supplementation were implemented only school community. So, adolescent girls who were out of school were no using this supplementation. In addition to this sometimes Iron-folate and deworming tablets were not enough for all adolescent girls in the school. This was due to the supplementation of tablets from stockholders was not proportional to the number of adolescent girls in the area. Similarly, the lack of diagnosis service for specific nutrient and deficiency diseases among adolescent girls was the barrier for the utilization of nutrition.

Adolescent girls were supplemented with the iron-folic acid tablet without a diagnosis for blood iron level and hemoglobin status. Similarly, adolescent girls supplemented deworming tablets without a diagnosis for a gut parasitic load. Lack of knowledge for specific nutrient deficiency and gut parasite/microbial load was a barrier for the utilization of supplements. Studies conducted in the deferent area indicated that diagnosis for a microbial load is very important for effective prevention and utilization of deworming tablets (Albonico *et al*., 2006).

5.5 Effect of community-based weekly iron-folic acid supplementation

The present study showed that iron deficiency was low, despite a predominantly cereal-based diet and the low availability of iron-fortified foods. This finding is in line with a recent study from Hirna, Ethiopia(Seyoum *et al*., 2019). Both the present and the earlier study from Hirna identified high levels of marginal iron stores. Such low iron stores can increase the risk of iron deficiency in the event of increased demands due to pregnancy or excessive blood loss. This along with folate deficiency in about 10% of the adolescents and the positive response in serum folate and ferritin in the WIFAS intervention group suggests that the intervention is adapted to the context (Parwati and Januraga, 2020, Bansal *et al*., 2016b, Angadi and Balu, 2019, Bairwa *et al*., 2017). This was further confirmed by the higher response to the intervention in those with the lower serum ferritin, folate and hemoglobin at baseline.

The elimination of folate deficiency after three months of WIFAS further highlights the importance of WIFAS intervention. Folate deficiency in the first two to three weeks has been linked to increased risks to congenital malformations (Oyama *et al*., 2008, Czeizel *et al*., 2013, Huhta and Hernandez-Robles, 2005). Although folic acid supplementation is promoted during pregnancy, the delayed first antenatal care means that most pregnant women do not get folic acid supplements at the time when they need it the most (i.e. first two weeks of conception). In contrast, the WIFAS program allows

adolescents to have an adequate folate status; hence, reducing the risk of deficiency, if and when they become pregnant(Lassi *et al*., 2013, Czeizel *et al*., 2013). The weekly regimen is also likely to decrease any of the possible side-effects observed during daily supplementation(Joshi and Gumashta, 2013).

The WIFAS program has been promoted in various LMIC through school-systems(Kavle and Landry, 2018, Parwati and Januraga, 2020). Many impact evaluations have shown the benefits of such platforms for constant monitoring and reducing school dropouts. Despite the advantages that the school system provides, in LMICs like Ethiopia, a high number of adolescents are out of school and thus cannot benefit from such programs(Erulkar *et al*., 2017).

Chapter 6-Conclusion &Recommendation

Chapter 6: Concluson and recommendations

6.1 Concluson

Thinness and stunting are found to be high in the study area. Age, family size, monthly household income, fathers' educational status, visits by health extension workers, and nutrition services decision-making power are the main predictors of thinness. Hand washing practice, visits by health extension workers, and nutrition services decision-making power are the main predictors of stunting among adolescent girls in Southern Ethiopia.

Anemia is found to be moderately a public health problem in the study area. Family monthly income, illness with cough and malaria in the past two weeks, DDS and BMI for age are the main predictors of anemia among adolescent girls in Wolaita and Hadiya Zone, southern Ethiopia.

A low dietary diversity score is found to be a public health problem in the study area. Family monthly income, fathers' educational status, Mothers' educational status, not taking nutrition education and decision-making power are the main predictors of low dietary diversity scores among adolescent girls in southern Ethiopia.

Barriers for nutrition service utilization among were lack of awareness for study participants, family and male adolescents, shortage of iron-folate and deworming tablets, lack of trained experts who were responsible for the nutrition service implementation, low economic status of the family, lack of coordination among different sectors for nutrition service, low educational status of the adolescent girls' family. Facilitators for nutrition service utilization among adolescent girls in the study area were supplemented were free from payment. Supplementation of iron folate and the deworming tablet was implemented without payments from adolescent girls to encourage the utilization of nutrition service.

Community-based weekly iron-folic acid supplementation has significantly improved serum ferritin, serum folate, and blood hemoglobin level among adolescent girls. Baseline serum ferritin, serum folate and blood hemoglobin have positive effect on the improvement of weekly supplementation of iron-folic acid. But, Community based weekly iron-folic acid supplementation has no significant change on weight and C- reactive protein among adolescent girls.

6.2 Recommendations

6.2.1 Recommendation for policy makers

Given the prevalence of adolescent girls' undernutrition in Ethiopia, addressing the nutritional needs of adolescents in addition to the already targeted vulnerable age group is urgent as it is important for development. The following issues are recommended for policy makers to prevent the malnutrition on adolescent girls and improve their wellbeing:

- Mainstream issues of adolescent girls' nutrition through all existing nutrition and agricultural interventions in emergency and non-emergency scenarios. This should be reflected in the existing micronutrient guideline, the safety net program and there should also be school and community nutrition program.
- Devise strategies for improving adolescent girl's nutritional status to prevent the intra-household monthly incaome affecting them through strong advocacy using community conversation methods using community's own resource people
- Include indicators on adolescent girls' nutrition in the national nutrition information system to make a continuous surveillance of adolescent nutrition situations for further action.
- Develop inter-sectorial collaboration strategies for supporting adolescent girls from poor households to enable them attend their schools in the face of low economy.
- Design social protection strategies focusing on the rural poor and those households who depend on the market to access food to buffer them from the effects of food price escalation.

6.2.2 Recommendation for Zonal and disctrict level

- Income-generating activities should be implemented to improve the monthly income status of the family as it affects the nutritional status of adolescent girls. Support for small scale trading and backyard agriculture should be provided
- Health extension workers should visit and give nutrition education and hand washing practice regularly for adolescent girls at their homes and at community meetings.

- Everything in the household should be decided jointly (both mother and father) to improve the ability to utilize resources among the household member.
- The inter-sectoral collaboration should be there to implement community-based health and nutrition programs i.e. schools and agricultural experts should work together with health experts to improve meal pattern of adolescent girls.
- Nutrition-sensitive agriculture programs should be promoted through rural agricultural extension programs to improve dietary diversity status
- Trained nutrition experts who are responsible for the nutrition service implementation should be recruited at each kebeles
- Iron-folate and deworming tablet supplementation should be proportional to the number of adolescent girls in each kebele to cover supplementation for adolescent girls at school and community level.
- Supplementation program of iron-folate and deworming tablet should be both school and community level to address all adolescent girls

6.2.3 Recomendation for Future Research

- Further study with longitudinal study design should be conducted to identify predictors of undernutrition, low dietary diversity score and low hemoglobin concentration among adolescent girls
- Future studies should evaluate the long-term more than three months period benefits of iron-folic acid supplementation programs.
- Quantitative dietary intake should be measured to know the adequacy of diet and nutritients by using quantitative 24hr recall and weight food record dietary mthods.

6.3 Strength and Limitation of the study

6.3.1 Strength of the study

This study tried to include large sample size and relatively wider geographic area of the region which can be an input for the design and implementation of adolescent girls' nutrition interventions. In addition to this using community based randomized control trail in fifth paper is important to identify case and effect relationship of community based weekly iron-folic acid supplementation and serum ferritin, folate and hemoglobin concentration.

6.3.2 Limitation of the study

Using cross-sectional study design in paper one, two and four might not allow causal inferences. Even though potential effort applied to minimize dietary recall bias, may be exposed potentially for dietary recall and social desirability bias.

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Annexes

Annex I. Written information sheet and consent form

Introduction and Ascent/Consent

Introduction/Purpose:

My name is_____ and I am working as data collector for Yoseph Halala. He is Ph.D student at Center for Food Science and Nutrition, Addis Ababa University. He is conducting an assessment on nutritional and health behaviors of adolescent girls (10-19 years) with the financial support of Tufts University. I would very much appreciate your participation in this survey since you are an adolescent girl, living in the selected kebele. In total, about 843 adolescent girls will be asked to take part in this study.

Procedures:

If you agree to take part in this study, I would like to ask you about your health and nutritional behaviors and those decisions you might make in seek nutrition services. This information will help us to plan interventions that improve nutrition service seeking behavior among adolescent girls. The questionnaire usually takes about 45 minutes to complete. Additionally, I would like to take some weight, height and MUAC measurements. This information will allow us to assess the health and nutritional status of adolescents in the study area. If you accept, I will take two measurements of height and two measurements of weight and mid-upper arm circumference (MUAC) to ensure the information is consistent and correct. Further, field supervisor may visit your household and ask you few questions in order to countercheck the information I collected from you. If you agree, a medical laboratory technician will also take a drop of blood (venous blood) to assess your hemoglobin levels. If your hemoglobin level is below 7µg/dl, I will refer you to the nearest health center for medical attention.

Risks:

I believe there are no risks to you or your adolescent girl from participating in this study. You/your adolescent girl should not experience any discomfort whatsoever. You/your adolescent girl may experience a minor discomfort when the finger prick is applied, but this is only temporary and will fade away within few minutes.

Benefits:

Taking part in this research study may not benefit you personally, but we may help us improve future nutrition interventions to improve the nutritional and health status of adolescents in the study areas.

Compensation-You will not be paid for participating in this study. I appreciate your participation in this study.

Confidentiality:

We will keep your answers confidential to the best of our ability. We will not share your answers with any of your neighbors or family. We will use a number instead of your name on study forms. Your name and other facts that might help people recognize you will not appear when we present this study to others or publish its results. Any information that might identify you will be kept separate from your answers and your answers will be kept in a secure place for analyses by the researchers only. The original paper questionnaires will be kept in locked cabinets for 3 years and the data must be stored on password-protected computers.

Voluntary Participation and Withdrawal:

Taking part in this study is voluntary. You can choose not to talk to us or ask us to leave, and if you do agree to participate you can stop the interview at any time or skip any questions that you don't want to answer. There is no right or wrong answer. We just want to hear more about your own ideas and experiences. Whether or not you choose to participate will not affect the services that you may receive from the health system in any way.

Contact Persons:

If you have any questions, I will be happy to answer them. And in case you ever want to contact someone from the office we work for, I can write down the telephone number for the Principal Investigator from Addis Ababa University. You should call this number and ask for Yoseph Halala: 0913233179.

Do you have any questions about the survey? Do you have any questions about the measurements we will take of you/your adolescent girl? Please let me know if anything I have stated is not clear and I will be happy to explain it further to ensure you understand.

_____ _____ _____

Signature of witness Date Time

Do you accept participating in the survey and measurements of height, weight and MUAC?

Ascent (if applicable):

Yes_____ No_____

Conscent of primary caregiver (parents) or adolescent ≥18 years:

Yes_____ No_____

Do you accept participating in the anemia assessment of you/your child by taking a drop of blood (venous blood)?

Ascent (if applicable):

Yes_____ No_____

Conscent of primary caregiver (parents) or adolescent ≥18 years:

Yes_____ No_____

VERBAL CONSENT GIVEN TO INTERVIEW, CHECK BOX ☐ _____

_____ _____

Signature of Person obtaining consent Date Time

Printed name of person obtaining consent:_____

Annex II. An interview Questionnaire

Code	Question	Response	Skip
	Part 1. Survey information		
101	Name of Interviewer	_____	
102	Participant's ID number	_____	
103	Date of data collection	_____/_____/_____	
104	Address	Zone_____Woreda_____ Kebele _____	
	Part 2. Socio-demographic information		
201	What is your date of birth? dd/mm/ yy	_____	
202	How old are you? (In completed years)	_____	
203	What is the highest level of	1. No formal education 2. 1-4 grade	

	education you have completed?	3. 5-8 grade 4. 9-10 grade 5. 11-12 grade 6. College and University	
204	Family size residing in the your home	[__][__] (write number)	
205	Occupation of father/Household head	1. Farmer/ Agriculturalworker 2. Skilled laborer 3. Unskilled laborer 4. Business/ Traders 5. Professional jobs 6. Work at home 7. Jobless 8. Other (Specify) ……	
206	Occupation of mother	1. Farmer/ Agriculturalworker 2. Skilled laborer 3. Unskilled laborer 4. Business/ Traders 5. Professional jobs 6. Work at home 7. Jobless 8. Other (Specify) ……	
207	The educational status of your father	1. No formal education 2. 1-4 grade 3. 5-8 grade 4. 9-10 grade 5. 11-12 grade 6. College and University	
208	The educational status of your mother	1. No formal education 2. 1-4 grade 3. 5-8 grade 4. 9-10 grade 5. 11-12 grade 6. College and University	
209	What is the average monthly income		

	of your family (ETB)? (Ask their parents, if adolescent girls are in 10-14 yeas age range)	_____	
	Part 3: Health institution and nutrition service related questions		
301	Is there Health post access?	1. Yes 2. No	
302	Is there Health center access?	1. Yes 2. No	
303	Is there Hospital access?	1. Yes 2. No	
304	Is there Private clinic access?	1. Yes 2. No	
305	What is the distance between your home and the nearest health facilities?	---------- Km 99. I don't know	
306	How long does it take to go the nearest health institution? (single trip)	|___|____|____| , Minutes 1. Walking 2. Vehicle/public transport 3. Mules/horse 99. Don't know	
307	Do you have any information about the benefit of having health institution nearby?	1. Yes 2. No	
308	If yes for Q307, what is the primary source of information?	1.Health workers 2.Friends/ neighbors 3. Radio, TV 4. Parents 5.Guardians 6.Other specify----------	
309	Who is decision-maker in your family to get nutrition service?	1. Father 2. Mother 3. Jointly (both mother & father)	

		4. Other (specify) _____	
310	Have you ever taken nutrition counseling/education services in the last six months?	1. Yes 2. No	
311	If yes for Q310, Who have given nutrition counseling /education services for you?	1. Health extension workers 2. Nurses/ health officer 3. Doctors 4. Others----------	_____
312	If yes for Q310, Where have you taken nutrition counseling/education services? (multiple answers possible)	1. Health facility(HC, HP & Hospital) 2. School 3. Home/community through health extension 4. Other (specify)_____	
313	Have you received any deworming tablet in the past 6 months?	1. Yes 2. No	
314	If yes for Q313, how many deworming tablet per six months?	----------specify the number	
315	If yes for Q314, how (from where) did you receive the deworming?	1. Health facility(HC, HP & Hospital) 2. School 3. Home/community through health extension 4. Other (specify)_____	
316	Have you received any iron-folic acid tablets in the past 6 months?	1. Yes 2. No	
317	If yes for Q316, how (from where) did you receive the iron-folic acid supplements?	1. Health facility(HC, HP & Hospital) 2. School 3. Home/community through health extension	_____

		4. Other (specify)	
318	Do you think that is there gender equality in your family?	1. Yes 2. No	
319	If yes for Q319, girls have equal chance with boys to get food in your family?	1. Yes 2. No	
320	If not, why?	_____specify	
321	Do you think that healthcare providers are providing quality nutrition service for you?	1. Yes 2. No	
322	Have you been ill with a cough or breathing problems in the past 2 weeks?	1. Yes 2. No	
323	Have you been diagnosed with anemia in the past six months?	1. Yes 2. No	
324	Have you been ill with diarrhea in the past 2 weeks (3 or more loose or watery stools in a 24-hour period)?	1. Yes 2. No	
325	Have you been ill with malaria in the past 2 weeks?	1. Yes 2. No	

Part IV: Behavior and lifestyle of adolescents

401	Do you smoke cigarette?	1. Yes 2. No	If no skip to Q403
402	If yes for Q401, how old were you when you first tried cigarette smoking?	----------years	
403	Have you ever drink alcohol?	1. Yes 2. No	If no skip to Q405

404	During the past 30 days on how many days did you have at least one drinking containing alcohol?	1.One 2.Two 3.Three and above	
405	Do you chew khat?	1. Yes 2. No	If no skip to Q501
406	If yes, how old were you when you first tried chewing khat?	----------years	
Part V: Personal hygiene and environmental-sanitation information			
501	Do your family have latrine?	1. Yes 2. No	If no skip to Q503
502	If yes for Q.501, which type of latrine?	1. Pit Latrine/traditional pit toilet 2. Ventilated improved pit latrine (VIP) 3. Flush toilet 4. No facility/Bush/Field 5. Other (Specify)…….	
503	What is your main source of water?	**<u>Piped (Tap)</u>** 1.Piped into dwelling 1. Piped into compound 2. Piped outside compound **<u>Dug well</u>** 3. Protected well 4. Unprotected well **<u>Spring water</u>** 5. Protected spring 6. Unprotected spring **<u>Surface Water</u>** 7. River 8. Pond/Lake/Dam	

		9. Rainwater 10. Other (Specify)_____	
504	How long does it take to collect water?	1. Less than five minute 2. 5-15 minutes 3. 15-30 minutes 4. 30 minutes – 1 hour 5. Greater than 1 hour	
505	How many people slept in your house last night?	----------(enter number)	
506	Do your animals live in the same house wher you are living?	1.Yes 2.No	
507	Housing condition: number of rooms	1 2 3 4 5+	
508	Number of windows you are living	0 1 2 3 4+	
509	Type of floor you are living	1. Cement 2. Muddy 3. Other specify_____	
510	How many times per day did you usually clean or brush your teeth?	----------(enter number)	
511	How often did you wash your hands before eating?	1.Not at all 2.Sometimes 3.Ussually	
512	Do you wash your hands after using the toilet or latrine?	1. Yes 2. No	
513	How often did you wash your hands after using the toilet or latrine?	1.Not at all 2.Sometimes 3.Ussually	
514	Do you use soap when washing your hands?	1. Yes 2. No	If no skip to Q 601

515	If yes for Q514, how often do you use soap when washing your hands?	1.Sometimes 2.Sometimes 3.Ussually	

Part VI. Nutrition and diet information of adolescents girls

601	What is your staple food? (more than one answer is possible)	1. Teff 2. Maize 3. Sorgume 4. barley 5. wheate 6. Enset 7. Other specify---------	
602	What is the origin of the food currently being eaten?	1. Own product 2. Market purchase 3. Own product and market purchase 4. Food aid 5. Gift 6. Food loan 7. Other specify--------	
603	Usually, how many meals per day are you getting?	1.One time 2.Two times 3.Three times 4.Four times and above	
604	Are you skipping your regular meal?	Yes 2. No	
605	If yes for Q604, which meal do you skip usually?	1.Breakfast 2.Lunch 3.Dinner 4.Snack	

Part 7: Food Security and food consumption

For each of the following questions, ask the adolescent girl/her parents to consider what has happened in the past 30 days.

701	In the past 30 days did you worry that your household would not have enough food?	Yes- 1 No -2	If answer is "No" skip to >702
701_1a	If "Yes", how often did this happen?	Rarely (1-2 times)- 01 Sometimes (3-10 times)- 02	

		Often (more than 10 times) -03	
702	In the past 30 days were you or any household members not able to eat the kinds of foods you preferred because of a lack of resources?	Yes -1 No- 2	If answer is "No" skip to >703
702_a	If "Yes", how often did this happen?	Rarely (1-2 times) -01 Sometimes (3-10 times) -02 Often (more than 10 times) -03	
703	In the past 30 days did you or any household member eat just a few kinds of food day after day because of a lack of resources?	Yes -1 No -2	If answer is "No" skip to >704
703_a	If "Yes", how often did this happen?	Rarely (1-2 times) -01 Sometimes (3-10 times) -02 Often (more than 10 times)- 03	
704	In the past 30 days did you or any household member eat food that you did not want to eat because of a lack of resources to obtain other types of food?	Yes -1 No -2	If answer is "No" skip to >705
704_a	If "Yes", how often did this happen?	Rarely (1-2 times) -1 Sometimes (3-10 times) -2 Often (more than 10 times) -3	
705	In the past 30 days did you or any household member eat a smaller meal than you felt you needed because there was not enough food?	Yes -1 No -2	If answer is "No" skip to >706
705_a	If "Yes", how often did this happen?	Rarely (1-2 times) -1 Sometimes (3-10 times) -2 Often (more than 10 times) -3	
706	In the past 30 days did you or any household member eat fewer meals in a day because there was not enough food?	Yes -1 No -2	If answer is "No" skip to >707
706_a	If "Yes", how often did this happen?	Rarely (1-2 times) -1	

		Sometimes (3-10 times) -2 Often (more than 10 times) -3	
707	In the past 30 days was there ever no food at all in your household because there were no resources to get more?	Yes -1 No -2	If answer is "No" skip to >708
707_a	If "Yes", how often did this happen?	Rarely (1-2 times) -1 Sometimes (3-10 times) -2 Often (more than 10 times) -3	
708	In the past 30 days did you or any household member go to sleep at night hungry because there was no enough food?	Yes -1 No -2	If answer is "No" skip to >709
708_a	If "Yes", how often did this happen?	Rarely (1-2 times) -1 Sometimes (3-10 times) -2 Often (more than 10 times) -3	
709	In the past 30 days did you or any household member go a whole day without eating anything because there was no enough food?	Yes -1 No -2	If answer is "No" skip to >710
709_a	If "Yes", how often did this happen?	Rarely (1-2 times) -1 Sometimes (3-10 times) -2 Often (more than 10 times) -3	

Part 8. Nutrition Education

S.N.	Questions	Choices/Answers	Skip
801	Have you been visited by a HEW at your home any time in the last three months?	Yes -1 No -2 I Can't remember-88	 >806 >806
802	How many times did a HEW visit you at your home in the last three months?	One time 01 Two times 02	

		Three times 03 Four or more times 04 Do not remember 88	
803	When was the last time that a HEW visited you at home?	Within last 1 month -01 1-3 months ago -02 Do not remember/know -88	
804	The last time when a HEW visit you at home, did she speak with you about adolescent nutrition?	Yes -1 No -2	>806
805	Could you tell me what the HEW told you about adolescent nutrition? (Probe deep to find out more about this information . Multiple responses allowed)	Eating a diversified diet -01 Taking iron-folic acid supplement -02 Taking deworming tablet -03 Other (specify) -04 _____	
806	Did you have a contact with an HEW in the community (any time in the last three months?)	Yes -1 No -2 I Can't remember-88	>811 >811
807	How many times did you have a contact with an HEW in the community outside your home or health post in last three months?	One time 01 Two times 02 Three times 03 Four or more times 04 Do not remember 88	
808	The last time you had a contact with an HEW in the community, where did this contact occur?	At a village gathering-01 During PSNP Pay day-02 At religion place-03	

		During outreach services-04 other specify -05 _____	
809	The last time when you had a contact with an HEW in the community, did she speak with you about adolescent nutrition?	Yes -1 No -2	>1211
810	During your last contact with an HEW in the community, what did the HEW tell you about adolescent nutrition? (*Do not read out the options provided. Probe deep to find out more about the information, multiple responses possible)*	Eating a diversified diet -01 Taking iron-folic acid supplement -02 Taking deworming tablet -03 Other (specify) -04 _____	
811	Have you been visited by an HDA or WDA at your home any time in the last three months?	Yes -1 No -2 I Can't remember-88	>1216 >1216
812	How many times did an HDA or WDA visit you at your home in the last three months?	One time -01 Two times - 02 Three times - 03 Four or more times - 04 Do not remember -88	
813	When was the last time that an HDA or WDA visited you at home?	Within last 1 month -01 1-3 months ago-02 3-6 months ago -03 Do not remember/know -88	

814	The last time when an HDA/WDA visit you at home, did she speak with you about adolescent nutrition?	Yes -1 No -2	>1216
815	Could you tell me what the HDA/WDA told you about breastfeeding or feeding your children when she visited you last time at your home?(multiple responses allowed)	Eating a diversified diet -01 Taking iron-folic acid supplement -02 Taking deworming tablet -03 Other (specify) -04 _____	
816	In the past 6 months, have you attended an event at in the community that was related to adolescent nutrition?	Yes -1 No -2	
817	Have you had nutrition education sessions in your school in the last three months?	Yes -1 No -2 I Can't remember-88	>900 >900
817	How many times did you have nutrition education in the last three months?	One time -01 Two times -02 Three times -03 Four or more times - 04 Do not remember -88	
818	What was the nutrition education about?	Eating a diversified diet -01 Taking iron-folic acid supplement -02 Taking deworming tablet -03 Other (specify) -04_____-	

Part 9: Mass/multi-media coverage			
S.N.	**Questions**	**Choices/Answers**	**Skip**

900	Have you ever heard/seen any message about adolescent nutrition on any of the following:		
901	Newspaper/magazine	1. Yes 2. No	
902	Radio	1. Yes 2. No	
903	If yes, What do you remember from these radio messages?(do not read out list. select all mentioned.)	1. Eating a diversified diet 2. Taking iron-folic acid supplement 3.Taking deworming tablet 03 4. Other (specify) _____	
903	TV	1. Yes 2. No	
904	Poster/ banner/ board	1. Yes 2. No	
905	Local theatre	1. Yes 2. No	
906	Local loudspeaker	1. Yes 2. No	
907	During a coffee ceremony	1. Yes 2. No	
908	Community/ village gathering (EDIR, EQUB)	1. Yes 2. No	
909	Mobile phone (SMS)	1. Yes 2. No	

Part 10. Adolescents' dietary questions

"I would like you to tell me what you had to eat or drink after you woke up yesterday morning. Did you eat that food at home? What did you have next and at what time?" [Proceed through the day, repeating these questions as necessary, and record each food or drink consumed in column 3 of the 24-hour recall form. Remember to probe for any snacks and drinks consumed between meals]

1001. Day of week (circle the day): 01-Mon 02-Tue 03-Wed 04-Thu 05-Fri 06-Sat 07-Sun

Time	Place eaten	Food/drink	Description of ingredients	Amount consommed in local measurement	Amount consumed in gram

102_02 Probe for sickness: ☐ Yes ☐ No

102_03 If yes, did sickness affect appetite? ☐Yes ☐ No

102_04 If yes, how? ☐Increase ☐decrease

102_05 Was food intake unusual? ☐Yes ☐No

102_06 If yes, how was it unusual?

102_07 Was it a feast day? ☐Yes ☐No

102_08 Was it a market day? ☐Yes ☐No

102_09 Was it a fasting day? ☐Yes ☐No

102_10 Probe for tablets: ☐ Yes ☐ No

802_11 ☐ Iron ☐vitamins ☐other supplements ☐anti-malarial

Part 11. Body Measurements (Height, weight and MUAC)

	Interviewer ID	_____
1101	Height in Centimeters (cm)	Reading 1 _____ Reading 2 _____ Average reading _____
1102	Weight in Kilograms (kg)	Reading 1 _____

		Reading 2 _____ Average reading _____
1103	MUAC in Centimeters (cm)	Reading 1 _____ Reading 2 _____ Average reading _____
	Part 12. Biological sample	
121	Finger prick blood sample was taken	Yes -1 No- 0
122	If yes for Q501, the readings of Hemcue	Reading---------- Sever anemic <7mg/l---------- Moderate anemic 7- 11mg/l ----------

Table 7. Annex III: English version topic guide for the qualitative data collection

Introduction and Ascent/Consent for qualitative data collection

Introduction/Purpose:

My name is_____ and I am working as data collector for PhD student Yoseph Halala. He is student at Center for Food Science and Nutrition, Addis Ababa University. He is conducting an assessment on nutritional and health behaviors of adolescent girls (10-19 years) with the financial support of Tufts university. I would very much appreciate your participation in this survey. In-depth interviews with different stakeholders potentially suitable for the provision of nutrition services will be conducted. FGD will be conducted with (n= 6-8) adolescents from each kebele.

Procedures:

If you agree to take part in this study, I would like to ask you about health and nutritional service of adolescent girls. This information will help us to plan interventions that improve health seeking behavior among adolescent girls. The questionnaire usually takes about 45 minutes to complete. I would like to ask you to indentify enablers and barriers towards nutrition and health nutrition service seeking behaviors of adolescent girls.

Risks:

We believe there are no risks to you from participating in this study. You should not experience any discomfort whatsoever.

Benefits:

Taking part in this research study may not benefit you personally, but may help us improve future nutrition interventions to improve the nutritional and health status of adolescents in the study area.

Compensation

You will not be paid for participating in this study.

Confidentiality:

We will keep your answers confidential to the best of our ability. We will not share your answers with any of your neighbors or family. We will use a number instead of your name on study forms. Your name and other facts that might help people recognize you will not appear when we present this study to others or publish its results.

Voluntary Participation and Withdrawal:

Taking part in this study is voluntary. You can choose not to talk to us or ask us to leave, and if you do agree to participate you can stop the interview at any time or skip any questions that you don't want to answer. There is no right or wrong answer. We just want to hear more about your own ideas and experiences. Also, after finishing the interview, you can refuse to have your answers included in the study. It is difficult to record all important informations obtained from your discussion with in short period of time. Hence, to listen and record again from what was discussed; I want to use tape recorder. So, would you give me a permission to use tape recorder?

Contact Persons:

If you have any questions, I will be happy to answer them. And in case you ever want to contact someone from the office we work for, I can write down the telephone number for the Principal Investigator from Addis Ababa University. You should call this number and ask for Yoseph Halala: 0913233179.

Do you have any questions about the survey? Do you have any questions about the measurements we will take of you/your child? Please let me know if anything I have stated is not clear and I will be happy to explain it further to ensure you understand.

_____ _____ _____

Signature Date Time

Do you accept participating in the qualitative survey?

Ascent (if applicable):

Yes_____ No_____

Conscent of primary caregiver (parents) or adolescent ≥18 years:

Yes_____ No_____

VERBAL CONSENT GIVEN TO INTERVIEW, CHECK BOX

_____ _____ _____

Signature of Person obtaining consent Date Time

Printed name of person obtaining consent:_____

Focus group discussion

Profile:

Zone----------Woredas_____Kebele_____

Guiding questions for Focus group discussion

1. What are the nutrition services that are given for adolescent girls in this community?
2. What are nutrition services that are provided for adolescent girls in this community?
3. Have you ever got nutrition education?

   Who gave it? When? In which platform?

   What do you often learn in the nutrition education sessions?

   How do you find the nutrition messages? (do they make sense? Are they feasible?)
4. Are you taking deworming tablet every six months?

   If yes, what are facilitators, or what would facilitate the regular deworming?
5. What are some of the barriers that prevent you from deworming?
6. Have you received any iron-folic acid tablets in the past 6 months?

   If yes, what are facilitators, or what would facilitate the regular iron-folic acid tablets supplementation?

   What are some of the barriers that prevent you from iron-folic acid tablets supplementation?
7. Do you have any suggestion on what to do to improve your access and utilization of nutrition services?

In-depth interview

Profile:

Zone----------Woredas_____Kebele_____

Guiding questions for in-depth interview

1. What are very common health problems for adolescent girls in this community?
2. Do you have information on feeding habit of adolescent girls in this community?
3. What are nutrition services that are provided for adolescent girls in this community?
4. What are barriers for nutrition education?
5. What are facilitators for nutrition education?
6. What are barriers for supplementation of iron folic acid for adolescent girls?
7. What are facilitators for supplementation of iron folic acid for adolescent girls?
8. What are barriers of supplementation of deworming tablet for adolescent girls in this community?
9. What are facilitators of supplementation of deworming tablet for adolescent girls in this community?
10. Do you have any suggestion on what to do to improve your access and utilization of nutrition services?

አባሪዎች

ሀ. በጽሑፍ የቀረበ የስምምነት ቅጽ

መግቢያ
መግቢያ /ዓላማ   ሄሎ፤ ውድ ተሳታፊ ስሜ _____ይባላል፡ ፡ እኔ የ3ኛ ዲግሪ ትምህርት የመጢቅያ ጥናት/ምርምር ሚጃሰብሳቢ ነኝ፡ ፡ በደቡብ ኢትዮጵያ ውስጥ ያሉ ልጃገረዶች የአመጋገብ ስርዓት፤ የደምማስ፣ የአመጋገብ አገልግሎት አጠቃቀም ችግርና ምቹ ሁኔታ ይጣላከታል፡ ፡   አቶ ዮሴፍ ሃላላ ከቱፍትስ ዩኒቨርስቲ የገንዘብ ድጋፍ በማኘት በደቡብ ኢትዮጵያ ክልል ውስጥ ባሉ ልጃገረዶች(10-19 ዕድሜ ላይ የአመጋገብ ስርዓት፤ ደምማስ፣ የአመጋገብ አገልግሎት አጠቃቀምችግርና ምቹ ሁኔታ ላይ ምርምር እያደረገ ነው ፡   በዚህ ጥናት ውስጥ ስለተሳተፍሽ እናደንቃለን፡ ፡ በጡቅላላ ዕድሜያቸው ከ10-19 ዓመት ውስጥ ያሉ **843** ልጃገረዶች በዚህ ጥናት ውስጥ ይሳተፋሉ፡ ፡ ለዚህ ጥናት የተመረጥሽውበአጋጣሚነው ፡

ሂደቶች፡

በዚህ ጥናት ለማካተፍ ፍቃደኛ ከሆንሽ፤ ስለ ጡንሽ ፣ ስለ አማጋገብሽ እና ስነ - ምግብ አገልግሎቶች እጠይቅሻለሁ:: ይህ ጥናት በአሥራዎቹ ዕድሜክልል ላይ የሚ ኙ ልጃገረዶች እና ወላጆቻቸውስነ -ህዝባዊ እና ኢኮኖሚያዊ ሁኔታ፤ የአማጋገብ ስርዓት፤ ባህሪ እና የህይወት ዘይቤዎች፤ የግል ንጽህና እና የአካባቢ ጡን አጠባበቅ ለማሻሻል ለምሰሩ አካላት ይጠቅማል፡ ፡

በጠቅላላ የሚጃ አሰባሰብ ሂደት 45 ደቂቃ ያህል ይፈጃል፡ ፡ በተጨማሪ ምየሰውነ ት ክብደት፤ ቁመት እና የላይኛውየእጅ ክንድ (MUAC) ልኬት እወስዳለሁ፡ ፡ ፍቃደኛ ከሆንሽ፤ ትክክለኛነ ቱን ለሚጋገጥ የሰውነ ትሽ ልኬት ሁለት ጊዜ አደርጋለሁ፡ ፡ በተጨማሪ የማክ ተቆጣጣሪ ውቤታችውን ጉብኝት በሚድረግ ካንቺ ያገ ኘውትን ሚጃ ለማጣራት ጥቂት ጥያቄዎችን ሜልሰ ልጠይቅሽ ይችላል፡ ፡

ፍቃደኛ ከሆንሽ የላቦራቶር ቴክኒሽያን የደምማ ስ በሽታ ምርሚራ ለሚድረግ ከጣት ጭጭ የደምናሞኛ ይወስዳል:: አነ ስተኛ የሄሞግሎቢን ደረጃ ያላቸውልጃገረዶች (Hb <12 µg / dL) በአካባቢውባለውጡጭ ተቋማት ጋር ተገ ኝተውእንድታከሚያደረጋል፡ ፡

አደጋ/ሥጋት:

በዚህ ጥናት ውስጥ ከማካተፍሽ የተነ ሳ ለጤንነ ትሽ/ለቤተሰብሽ ምንምስጋት እንደሌለ አምናለሁ፡ ፡ ምንምስጭታዊ ጥያቄዎች የሉም፡ ፡ በአንቺ ላይ የጂጸምጎጅ ሂደት የለም ፡ ከጣትሽ ጭጭ ደምለመውሰድ በሹል ነገር ስወጋ ትንሽ ልያምሽ ይችላል፤ ነገር ግን ወድሁኑ/በደቅቃዎች ውስጥ ይተውሻል፡ ፡

ጥቅሞች፡

በዚህ ጥናት ውስጥ ከማካተፍሽ የተነ ሳ የሚኝ ቀጥተኛ ጥቅምባይኖርምበአከባብ ለማ ኙ የአማጋገብ ስርዓት እና የአካባቢ ጡን አጠባበቅ ለማሻሻል ለምሰሩ አካላት ይጠቅማል፡ ፡

ካሳ: በዚህ ምርምር ውስጥ ለተሳተፉ ተሳታፊዎች ምንም ክፍያ የለም ፡ በዚህ ጥናት ውስጥ ስለተሳተፍሽ እናደንቅሻለን፡ ፡

ምስጠራዊነ ት:

ሜልስሽን በተቻለን ማጠን ምሥጠራዊ እናደርጋለን፡ ፡ ሜልስሽን ለጎረቤትሽ ወይም ለቤተሰብሽ አናጋራም ፡ የአንቺ ማነ ት በሚስጡር ይጠበቃል፡ ፡ የጥናቱ ቡድን ኣባላት ሚጃውን ብቻ ለማ ት ይችላል፡ ፡ ስለ አንቺ የተማዘገቡ ሚጃዎችን የማገኘት እና አስፈላጊ ከሆነ እርማቶችን የሚድረግ ጣብት አለሽ፡ ፡ ስምሽና ያንቺ ማነ ት የማ ልፁ ነገሮች በቅጾች ላይ አይጻፉም ፡ ተሞርሚው ሚጃዎችን ለምርምር ሥራ ብቻ ይጠቀማል፡ ፡

የፈቃደኝነ ት ተሳትፎ እና ማቋረጥ

ተሳትፎ በፈቃደኝነ ት ይሆናል፡ ፡ ጥያቄዎቹን በከፊል ወይምሙሉ በሙሉ ላለመመለስ ትችልያለሽ፡ ፡ በማንኛውምጊዜ ከጥናቱ የሚውጣት ጣብት አለሽ፡ ፡ ትክክለኛ ወይምየተሳሳተ ሜልስ የለም ፡ ስለራስሽ እና ያካበተሽውልምዶች

የበለጠ ለማማክ እፈልጋለሁ፡ ፡ ማሳተፍና ያለማሳተፍ አንቺ ከጡፍ ተቁዋም ከምታገኝው ጥቅማጥቅም ጋር አይገነኝም ፡

<u>የ ሚማለከተውአካል:</u>

ማ ኛውጥያቄ ካለሽ ለመማለስ ዝግጁ ነኝ፡ ፡ በተጨማሪ ዋና ተሙራሚ ከፈለግሽ አቶ ዮሴፍ ሃላላ የጥናት ዋነ ኛ ተሙራሚ ስለሆኑ ማነ ኛውምጥያቄ ቢኖርሽ፤ በ +251913233179 ሚደወል ትችያለሽ፡ ፡

ስለ ጥናቱ ጥያቄ አለሽ?

እኔ በምመስዳቸው ልከተቶች/ሚጃዎች ላይ ጥያቄ አለዎት/አለሽ? የበለጠ ማብራሪያ ለማጠት ደስታ ስለሆንኩእባክሽ የገለጽኩትነገር ግልጽ ካልሆነ አሳውቅኝ፡ ፡

<u>ከ18 ዓመት ዕድሜበታች ልጃገረዶች (አስፈላግ ከሆነ) ስምማ ት ቅጽ:</u>

የሰውነ ት ክብደት፤ ቁመት እና የላይኛውየእጅ ክንድ (MUAC) ልኬት ለማሳተፍ ፍቃደኛ ነሽ?

አዎን _____ አይ_____

<u>የ መጀመሪያ ተንከባካቢ (ወላጆች) እና ከ18 ዓመት ዕድሜ ከዛ በላይ ልጃገረዶች ስምማ ት ቅጽ:</u>

ለማሳተፍ ፍቃደኛ ነዎት/ነሽ?

አዎን_____ አይ_____

<u>ከ18 ዓመት ዕድሜበታች ልጃገረዶች (አስፈላግ ከሆነ) ስምማ ት ቅጽ:</u>

የደምማ ስ ምርመራ ለመድረግ ከጣት ጩፍ የደምናሙኛ ለማስጠት ፍቃደኛ ነሽ?

አዎን _____ አይ_____

<u>የ መጀመሪያ ተንከባካቢ (ወላጆች) እና ከ18 ዓመት ዕድሜ ከዛ በላይ ልጃገረዶች ስምማ ት ቅጽ:</u>

የደምማ ስ ምርመራ ለመድረግ ከጣት ጩፍ የደምናሙኛ ለማስጠት ፍቃደኛ ነዎት/ነሽ?

አዎን_____ አይ_____

ፍቃደኛ ከሆነ ች/ከሆኑ በሣጥን ውስጥ √ ምልክት ☐ አድርግ

_____ _____ _____

የሚጃ ሰብሳቢ ፊርማ ቀን ሠዓት

የሚጃ ሰብሳቢ ስም:_____

<u>አባሪ II. ማከይቅ</u>

ኮድ	ጥያቄ	ምላሽ	ዝለል
	ክፍል 1. የ ዳሰሳ ጥና ት ሚ ጃ		
101	የ ቃለ ማኪይቅ አ ድራጊ ስ ም	_____	
102	የ ተሳ ታፊ ማለ ያ ቁ ጥር	_____	
103	ቃለ ማኪይቅ የ ተደረ ገ በ ት ቀ ን	------/------/---------	
104	አ ድረ ሻ	ዞ ን _____ ወረ ዳ _____ ቀ በ ለ _____ ጎ ጥ ------	
	ክፍል 2: ስ ነ -ሕ ዝ ብ ሚ ጃ		
201	የ ል ደ ት ቀ ን ሽ ማ ቹ ነ ው (ቀ ን/ወ ር/ ዓ.ም)	_____	
202	እ ድ ሜ ሽ ስ ን ት ነ ው? በ ዓ ማ ት	_____	
203	ያ ጠ ና ቀ ቀ ሽ ው ከ ፍ ተ ኛ የ ት ም ህ ር ት ደ ረ ጃ ም ን ድ ን ነ ው?	1. ሚ ደ በ ኛ ት/ር ት የ ለ ም 2. 1-4 ክ ፍ ል 3. 5-8 ክ ፍ ል 4. 9-10 ክ ፍ ል 5. 11-12 ክ ፍ ል 6. ኮ ሌ ጅ እ ና ዩ ኒ ቨ ር ሲ ቲ	
204	በ አ ን ድ ቤ ት ው ስ ጥ ያ ለ ው የ ቤ ተ ሰ ብ ማ ከ ን ስ ን ት ነ ው?	[__][__] (ቁ ጥ ር ጻ ፍ)	
205	የ አ ባ ት ሽ / የ ቤ ተ ሰ ብ ራ ስ ሥ ራ ም ን ድ ን ነ ው?	1. አ ር ሶ አ ደ ር / የ ግ ብ ር ና ሰ ራ ተ ኛ 2. የ ሰ ለ ጠ ነ ሰ ራ ተ ኛ 3. ያ ል ሰ ለ ጠ ነ ሰ ራ ተ ኛ 4. ን ግ ድ / ነ ጋ ዴ 5. ተ ቀ ጣ ር ሰ ራ ተ ኛ 6. ቤ ት ው ስ ጥ ሰ ራ ተ ኛ 7. ስ ራ አ ጥ	

		8. ሌላ (ዝርዝር ይግለጹ)	
206	የእናትሽ ስራ ምንድን ነው?	1. አርሶ አደር / የግብርና ሰራተኛ 2. የሰለጠነ ሰራተኛ 3. ያልሰለጠነ ሰራተኛ 4. ንግድ / ነጋዴ 5. ተቀጣሪ ሰራተኛ 6. ቤት ውስጥ ሰራተኛ 7. ስራ አጥ 8. ሌላ (ዝርዝር ይግለጹ)	
207	የአባትሽ የትምህርት ደረጃ ምንድን ነው?	1. ሚደበኛ ት/ርት የለም 2. 1-4 ክፍል 3. 5-8 ክፍል 4. 9-10 ክፍል 5. 11-12 ክፍል 6. ኮሌጅ እና ዩኒቨርሲቲ	
208	የእናትሽ የትምህርት ደረጃ ምንድን ነው?	1. ሚደበኛ ት/ርት የለም 2. 1-4 ክፍል 3. 5-8 ክፍል 4. 9-10 ክፍል 5. 11-12 ክፍል 6. ኮሌጅ እና ዩኒቨርሲቲ	
209	የቤተሰብሽ አማካይ ወራዊ ገቢ ስንት ነው? (ከ10-14 ዓመት ዕድሜ ክልል ውስጥ ከሆኑ ወላጆቻቸውን ጠይቅ)	_____	
	ክፍል 3. የጡት ተቋምእና የአማገብስረዓት አገልግሎት ተዛማጅ ጥያቄዎች		
301	ጤና ኬላ ማእከል በቅርበት አላቸው?	አዎ 2. የለም	
302	ጡት ጣብያ ማእከል በቅርበት አላቸው?	1. አዎ 2. የለም	

303	ሆስፒታል በቅርበት አላችው?	1. አዎ 2. የለም	
304	የግል ክሊኒክ በቅርበት አላችው?	1. አዎ 2. የለም	
305	በቤታችውና በቅርበት ካለው ጤፍ ተቋማት ማካከል ያለው ርቀት ስንት ኪ.ሜነው?	---------- ኪ.ሜ 88. አላውቅም	
306	በአቅራቢያውየሚኝውን የጤፍ ተቋም ለሜድ ምን ያህል ጊዜ ይፈጅብሻል? (አንድጉዞ)	|___|____|____| በደቅቃ 1. በእግር ጉዞ 2. በተሸከርካሪ / በህዝብ ማጓጓዣ 3. በቁሎ/ ፈረስ 88. አላውቅም	
307	በአቅራቢያው ያለውን የጤፍ ተቋማት ስላለውጥቅምሚጃ አለሽ?	አዎ 2. የለም	
308	አዎ ከሆነ ለጥያቄ 303፤ ዋናው የሚጃ ምንጭምንድነው?	የጤፍ ባለሞያ ----------1 ጓደኛ፤ ጎረበት ----------2 ረድኦ , TV----------3, ሌላ ካለ ግለጪ----------4	
309	በቤታችው ውስጥ በአማገብ አገልግሎት ዙርያ ውሳኔ ሰጪ ማነው?	አባት እናት ሌላ ካለ ግለጪ----------	
310	የአማገብ ምክር / ትምህርት አገልግሎት በ6ወራት ውስጥ አግኝተሻል?	1. አዎ 2. አይደለም	
311	ለ ጥያቄ 310 ሜልስ አዎን ከሆነ፤ የአማገብ ምክር / ትምህርት አገልግሎት የሰጡት ማነ ናቸው?	1. ጤፍ ኤክስቴንሽን ባለሞያ 2. ነርስ/ሄልዝ አፍሰር 3. ዶክተር 4. ሌላ ካለ ግለጪ----------	_____

312	ለ ጥያቄ 310 ሜልስ አዎን ከሆነ ፤ የአሞጋገብ ምክር / ትምህርት አገልግሎት ያገኘሽውከየት ነው?	1. በጤፍ ተቁዋም(ጤፍ ጣቢያ/ ጤፍ ኬላ/ሆስፒታል 3. ት/ቤት 3. ቤት/ በሚሀበረሰብ ውስጥ 4. ሌላ ካለ ግለጪ----------	
313	በየ ስድስት ወሩ የፀረ-ተዋስያን ሞድታንት ትወስጅያለሽ? (ክንኒ አሳይ)	አዎ 2. የለም	
314	ለ ጥያቄ 313 ሜልስ አዎን ከሆነ ፤ ስንት ክኒን በየ ስድስት ወሩ ትወስጅያለሽ?	----------ቁጥሩን ግለጪ	
315	ለ ጥያቄ 313 ሜልስ አዎን ከሆነ ፤ የፀረ-ተዋስያን ሞድታንት ከየት ነው ያገኘሽው?	1. በጤፍ ተቁዋም(ጤፍ ጣቢያ/ ጤፍ ኬላ/ሆስፒታል 3. ት/ቤት 3. ቤት/ በሚሀበረሰብ ውስጥ 4. ሌላ ካለ ግለጪ----------	
316	አይሬን-ፎልክ አስድ ክንኒ እየወሰድሽ ነሽ ? (ክንኒ አሳይ)	1. አዎ 2. አይደለም	
317	ለ ጥያቄ 312 ሜልስ አዎን ከሆነ ፤ አይሬን-ፎልክ አስድ ክንኒ ከየት ነው ያገኘሽው?	1. በጤፍ ተቁዋም(ጤፍ ጣቢያ/ ጤፍ ኬላ/ሆስፒታል) 3. ት/ቤት 3. ቤት/ በሚሀበረሰብ ውስጥ 4. ሌላ ካለ ግለጪ----------	_____
318	በቤተሰብዎ ውስጥ የጾታ እኩልነት አለ ብለሽ ታስብያለሽ?	1. አዎን 2. አይደለም	
319	ለ ጥያቄ 319 ሜልስ አዎን ከሆነ ፤ ሴት ልጆች ከወንዶች ልጆች ጋር በቤተሰብዎ ውስጥ ምግብ እንዲያገኙ እኩል እድል አላቸው?	1. አዎን 2. አይደለም	

320	ካልሆነ ለምን?	----------ግለጪ	
321	የጡፍ እንክብካቤ አቅራቢዎች(ጡፍ ባለሞያዎች) ጥሩ የአሞጋገብ ስርዓት አገልግሎት ይሰጡሉ ብለሽ ታስብያለሽ?	1. አዎን 2. አይደለም	
322	ሳል /የሞትንፈስ ችግር ባለፈውሁለት ሳምንታት ዉስጥአሞሽ ያዉቃል?	1. አዎን 2. አይደለም	
323	ባለፈው ስድሰት ወራት ዉስጥ የደም ማስ ምርሙራ አስደርገሽ ታውቅያለሽ?	1. አዎን 2. አይደለም	
324	ባለፈው ሁለት ሳምንታት ዉስጥ የተቅማጥበሽታአሞሽ ያዉቃል?	1. አዎን 2. አይደለም	
325	በወባ በሽታ ታምመሽ ታውቂያለሽ?	1. አዎን 2. አይደለም	

ክፍል 4: የልጃገረዶች ባህሪ እና የአኗኗር ዘይቤ

401	ሲጋራ ታጨሽያለሽ?	1. አዎን 2. አይደለም	ጫልስሽ ለጥያቄ 401 አይደለም ከሆነ ወደ ጥያቄ 403 እለፊ
402	አዎን ከሆነ ፣ ለመጀመሪያ ጊዜ ሲጋራ ሲትሞክሪ ምን ያህል ዕድሜሽ ነበር?	----------	
403	አልኮል ማጡጥ ጡጥተሽ ታውቅያለሽ?	1. አዎን 2. አይደለም	ጫልስሽ ጥያቄ ለ403 አይደለም ከሆነ ወደ ጥያቄ 405 እለፊ
404	አዎን ከሆነ ለ403፤ አልኮል ማጡጥ ቢያንስ ስንት ግዜ በ 7 ቀናት ውስጥ ጡጥተሻል?	1. አንድ 2. ሁለት 3. ሶስት እና ከዚያ በላይ	
405	ጭት ትቅምያለሽ ?	1. አዎን 2. አይደለም	ጫልስሽ ለጥያቄ 405 አይደለም ከሆነ ወደ

			ጥያቄ 501 እለፊ
406	አዎን ከሆነ፣ ለሞጅሚያ ጊዜ ጩት ሲትሞክሪ ምን ያህል ዕድሜሽ ነበር?	----------በአሞት	
407	ጩት ቢያንስ ስንት ግዜ በ 7 ቀናት ውስጥ ትቅምያለሽ?	1. አንድ ጊዜ 2. ሁለት ጊዜ 3. ሶስት ጊዜ እና ከዚያ በላይ	
ክፍል 5: የግል እና የአካባቢን ንፅህና ሚጃ			
501	ሞዳጃ ቤት አላችዉ?	1. አዎን 2. የለም	ሜልስሽ ለጥያቄ 501 የለም ከሆነ ወደ ጥያቄ 503 እለፊ
502	ለጥያቄ 501 አዎን ከሆነ፤ የትኛው የሽንት ቤት አይነት ነው?	ጎድጓድ ሞዳጃ / ባህላዊ የተሻሻለ የህንፃ ሞዳጃ ቤት (VIP) ግድግዳውጩቃ ሽንት ቤት ቡሽ / ሜዳ ላይ ሌላ (ዝርዝር ግለጪ)	
503	ለቤተሰብሽ አባላት ዋና የሞኩጥ ውታ ምን ጩምን ድነ ው?	**<u>የቧንቧ ውሃ</u>** 1. ወደ ቤት የገባ የቧንቧ ውሃ 2. ወደ ግቢ የገባ የቧንቧ ውሃ 3. ከግቢ ውጩያለውየ ቧንቧ ውሃ **<u>የጉድጓድ ውሃ</u>** 4. የተጠበቀ የጉድጓድ ውሃ 5. ያልተጠበቀ የጉድጓድ ውሃ **<u>የምንጩውሃ</u>** የተጠበቀ የምንጩውሃ	

		ያልተጠበቀ የምንጭውሃ **<u>የገፀ-ምድረ ውሃ</u>** ወንዝ ኩሬ የዝናብ ውሃ ሌላ ካለ ግለጪ_____	
504	ውሃ ለማሰብሰብ/ለመቅዳት ምን ያህል ጊዜ ይወስዳል?	1. ከ 5 የሚይበልጥ/ያነሰ 2. 5-15 ደቂቃ 3. ከ15-30 ደቂቃዎች 4. 30 ደቂቃ - 1 ሰዓት 5. ከ 1 ሰዓት በላይ	
505	ትላንት ሌሊት በቤታችሁ ስንት ሰዎች አድረዋል?	----------	
506	እንስሳት በቤት ውስጥ ይኖሩ ይሆን?	1. አዎን 2. አይደለም	
507	የቤቶች ሁኔታ: የክፍሎች ቁጥር	1 2 3 4 5+	
508	የሚኝቶች ቁጥር	0 1 2 3 4+	
509	የወለል አይነት	ጭቃ 2. ስሚንቶ 3. ሌላ ካለ ግለጪ _____	
510	በየቀኑስንት ጊዜ ጥርስሽን ታጸጅያለሽ?	----------(ቁጥሩን አስገቢ)	
511	ከጫብላትሽ በፊት እጅሽን ምን ያህል ግዜ ትታጠቢነበር?	1. በፍጹም 2. አልፎ አልፎ 3. ዘወትር	
512	ከጫዳጃ ቤት በኋላ እጅሽን ትታጠብያለሽ?	1. አዎን 2. አይደለም	

513	ሜልስሽ ለጥያቄ 512 አዎን ከሆነ ፤ ከሜዳጃ ቤት በኋላ ምን ያህል ግዜ እጅሽን ትታጠቢ ነበር?	1. በፍጹም 2. አልፎ አልፎ 3. ዘወትር	
514	እጅሽን ስትታጠብ ሳሙና ትጠቀምያለሽ?	1. አዎን 2. አይደለም	ሜልስሽ ጥያቄ 512 አይደለም ከሆነ ወደ ጥያቄ 601
515	ሜልስሽ ለጥያቄ 514 አዎ ከሆነ ,፤ እጅሽን ስትታጠቢ ምን ያህል ጊዜ ሳሙና ትጠቀምያለሽ?	1. በፍጹም 2. አልፎ አልፎ 3. ዘወትር	

ክፍል 6. ወጣት ሴት ልጆች የ አመጋገብ ስርዓት ሚጃ

601	ዋንኛው ምግብ ምንድነው? (ከአንድ በላይ ሜልስ ሊገኝ ይችላል)	1. ጡጩ 2. በቆሎ 3. ሜሽላ 4. ገብስ 5. ስንዴ 6. ሌላ የተለየ ----------	
602	በአሁኑ ጊዜ እየተማበ ያለው የ ምግብ ምንጭምንድነው?	1. ከቤት 2. ከገበያ ግዢ 3. ከቤት እና ከገበያ ግዢ 4. ከዕርዳታ 5. ከስጦታ 6. ከብድር 7. የተለየ ካለ----------	
603	በቀን ስንት ግዜ ምግብ ትማብያለሽ?	1. አንድ ጊዜ 2. ሁለት ጊዜ 3. ሶስት ጊዜ 4. 4 ጊዜና ከዚያ በላይ	
604	ሚወደኛ ምግብሽን ዘልለሽ/ትተሽ ታውቅያለሽ?	1. አዎን 2. አይደለም	ሜልስሽ ለጥያቄ 604 አይደለም ከሆነ ወደ ጥያቄ 701
605	አዎ ከሆነ ፤ የትኛው ምግብ ነው የሚዘለለው?	1.ቁርስ 2. ምሳ 3. ዕራት 4. ማክሰስ	

ክፍል 7-የ ምግብ ዋስትና እና አማገ ብ ጥያቄዎች

ለሚከተሉት ጥያቄዎች፤ ባለፉት 30 ቀናት ውስጥ ተሳታፊዋን ምን እንዳጋጠማት ጠይቂ

701	ባለፉት 30 ቀናት ውስጥ ቤተሰብሽ በቂ ምግብ ያለመኖሩ ተሰምቶሻል?	አዎን - 01 አይ -0	መልስሽ "አይ" ከሆነ, ወደ >702 እለፊ
701_1a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	
702	የሀብት/ገንዘብ እጥረት ምክንያት ባለፉት 30 ቀናት ውስጥ አንቺ ወይም ማንኛውም የቤተሰብ አባል የፈለጉትን ምግብ ሳይመገቡ ቀርተዋል?	አዎን - 01 አይ -0	መልስሽ "አይ" ከሆነ, ወደ >703 እለፊ
702_a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	
703	የሀብት/ገንዘብ እጥረት ምክንያት ባለፉት 30 ቀናት ውስጥ አንቺ ወይም ማንኛውም የቤተሰብ አባል ጥቂት የምግብ አይነት ተመገበዋል?	አዎን - 01 አይ -0	መልስሽ "አይ" ከሆነ, ወደ >704 እለፊ
703_a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	
704	አማራጭ ባለመኖሩ ምክንያት ባለፉት 30 ቀናት ውስጥ አንቺ ወይም ማንኛውም የቤተሰብ አባል መብላት የማትፈልጉትን ምግብ በልተዋል?	አዎን - 01 አይ -0	መልስሽ "አይ" ከሆነ, ወደ >705 እለፊ
704_a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	

705	ባለፉት 30 ቀናት ውስጥ አንቺ ወይም ማንኛውም የቤተሰብ አባል በቂ ምግብ ባለሞሩ ምክንያት ትንሽ ምግብ ጫበላቱ ቅር ብሎሻል/ተሰማሽ?	አዎን - 01 አይ -0	ሜልስሽ "አይ" ከሆነ, ወደ >706 እለፊ
705_a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	
706	በቂ ምግብ ባለሞሩ ምክንያት ባለፉት 30 ቀናት ውስጥ አንቺ ወይም ማንኛውም የቤተሰብ አባል ጥቅት ምግብ (meals) በልቱዋል?	አዎን - 01 አይ -0	ሜልስሽ "አይ" ከሆነ, ወደ >707 እለፊ
706_a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	
707	የሀብት/ገንዘብ እጥረት ምክንያት ባለፉት 30 ቀናት ውስጥ በቤተሰብ ውስጥ ሙሉ በሙሉ ምግብ ጠፍቶ ያውቃል?	አዎን - 01 አይ -0	ሜልስሽ "አይ" ከሆነ, ወደ >708 እለፊ
707_a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	
708	በቂ ምግብ ባለሞሩ ምክንያት ባለፉት 30 ቀናት ውስጥ አንቺ ወይም ማንኛውም የቤተሰብ አባል እየተራበ ባዶ አድሮ/ተኝቶ ያውቃል?	አዎን - 01 አይ -0	ሜልስሽ "አይ" ከሆነ, ወደ >709 እለፊ
708_a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	
709	በቂ ምግብ ባለሞሩ ምክንያት ባለፉት 30 ቀናት ውስጥ አንቺ ወይም ማንኛውም የቤተሰብ አባል ሙሉ ቀን ምንም ምግብ ሳይበላ ቆይቶ ያውቃል?	አዎን - 01 አይ -0	

709_a	"አዎን" ከሆነ ለምን ያህል ጊዜ ነበር የተከሰተው?	አልፎ አልፎ (1-2 ጊዜ) - 01 አንዳንድ ጊዜ (ከ3-10 ጊዜ) - 02 ብዙ ጊዜ (ከ 10 ጊዜ በላይ) - 03	

ክፍል 8. የ አ ሞ ጋ ገ ብ ት ም ህ ር ት ሁ ኔ ታ

ተ.ቁ.	ጥያቄዎች	ምርጫ/ ሜልስ	ይዝለሉ
801	ባለፉት ሦስት ወራት ውስጥ በቤታችው በጡ ት ኤክስቴንሽን ሰራተኛ ተጎ ብኝተሻል?	አዎን - 01 አይ -02 አላስታውስም-88	 >806 >806
802	ባለፉት ሦስት ወራት ውስጥ በቤታችው በጡ ት ኤክስቴንሽን ሰራተኛ ስንት ጊዜ ተጎ ብኝተሻል?	አንድ ጊዜ -01 ሁለት ጊዜ- 02 ሦስት ጊዜ -03 አራት ወይምከዚያ በላይ ጊዜ- 04 አላስታውስም-88	
803	የ ጡ ት ኤክስቴንሽን ሰራተኛ በቤታችው የ ሚጨረሻ ጉብኝት ያደረገችበት ጊዜ ሜቼ ነበር?	ባለፈው1 ወር ውስጥ -01 ከ 1-3 ወራት በፊት -02 ከ3-6 ወራት በፊት -03 አላስታውስም/ አላውቅም-88	
804	የ ጡ ት ኤክስቴንሽን ሰራተኛ በቤታችው የ ሚጨረሻ ጉብኝት ስታደርግ የ ልጃገረዶች አ ሞ ጋ ገ ብ ሁ ኔ ታ ተናግራ ነበር?	አዎን - 01 አይ -02	 >806

805	የጡት ኤክስቴንሽን ሰራተኛ በቤታችው የሜጨፈሻ ጉብኝት ስታደርግ የልጃገረዶች አማገብ በተሟላከተ የተናገረችውምን ነበር?(ከአንድ በላይ ምላሾች ተፈቅደዋል)	የተለያዩ የምግብ አይነቶችን መመገብ -01 የደምማክስ መድኃኒት መውሰድ -02 የሆድ ውስጥ ትላትል መድኃኒት መውሰድ -03 ሌላ ካለ ግለጪ_____ -04 _____	
806	በማህበረሰቡ ውስጥ የጡት ኤክስቴንሽን ሰራተኛ (ባለፉት ሶስት ወራት ውስጥ) ተገነኝተሽ ታውቂያለሽ?	_____ አዎን - 01 አይ -02 አላስታውስም-88	 >811 >811
807	ባለፉት ሦስት ወራት ውስጥ በማህበረሰቡ ውስጥ በጡት ኤክስቴንሽን ሰራተኛ ስንት ጊዜ ተነብኝተሻል?	አንድጊዜ -01 ሁለት ጊዜ- 02 ሦስት ጊዜ -03 አራት ወይምከዚያ በላይ ጊዜ- 04 አላስታውስም-88	
808	በማህበረሰቡ ውስጥ የጡት ኤክስቴንሽን ሰራተኛ (ባለፉት ሶስት ወራት ውስጥ) የተገነኝሽውየትነበር?	በማንደር ስብሰባላይ -01 በ ሴፍትነት ክፍያ ቀን-02 በሃይሞት ቦታ/ተቁዋም-03 በአገልግሎት አቅራቢዎች(outreach) ወቅት -04 ሌላ ካለ ግለጪ_____ 05 _____	
809	የጡት ኤክስቴንሽን ሰራተኛ በማህበረሰብ ውስጥ የሜጨፈሻ ጉብኝት ስታደርግ የልጃገረዶች አማገብሁኔታተናግራ ነበር?	_____ አዎን - 01 አይ -02	 >121

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810	የጡፍ ኤክስቴንሽን ሰራተኛ በሚሀበረሰብ ውስጥ የሜጨፈሻ ጉብኝት ስታደርግ የልጃገረዶች አማገብ በተጣለከተ የተናገረችው ምን ነበር?(ከአንድ በላይ ምላሽ ተፈቅደዋል)	የተለያዩ የምግብ አይነቶችን መመገብ -01 የደምሳ ስ ሞድኃኒት ማውሰድ -02 የሆድ ውስጥ ትላትል ሞድኃኒት ማውሰድ -03 ሌላ ካለ ግለጪ-04 _____	
811	ባለፉት ሦስት ወራት ውስጥ በቤታችው በጡፍ ልማት ሠራዊት ተጎብኝተሻል?	_____ አዎን - 01 አይ -02 አላስታውስም-88	>1216 >1216
812	ባለፉት ሦስት ወራት ውስጥ በቤታችው የጡፍ ልማት ሠራዊት ስንት ጊዜ ተጎብኝተሻል?	አንድ ጊዜ -01 ሁለት ጊዜ- 02 ሦስት ጊዜ -03 አራት ወይምከዚያ በላይ ጊዜ- 04 አላስታውስም-88	
813	የጡፍ ልማት ሠራዊት በቤታችው የሜጨፈሻ ጉብኝት ያደረገችበት ጊዜ ሜቼ ነበር?	ባለፈው1 ወር ውስጥ -01 ከ 1-3 ወራት በፊት -02 ከ3-6 ወራት በፊት -03 አላስታውስም/ አላውቅም-88	
814	የጡፍ ልማት ሠራዊት በቤታችው የሜጨፈሻ ጉብኝት ስታደርግ የልጃገረዶች አማገብ	_____ አዎን - 01 አይ -02	>816

	ሁኔታ ተናግራ ነበር?		
815	የጡት ልማት ሠራዊት በቤታችው የሜጨፈሻ ጉብኝት ስታደርግ የልጃገረዶች አማገብ በተማላከተ የተናገረችው ምን ነበር? (ከአንድ በላይ ምላሽ ተፈቅደዋል)	የተለያዩ የምግብ አይነቶችን መመገብ -01 የደምማስ ሞድኃኒት ማውሰድ -02 የሆድ ውስጥ ትላትል ሞድኃኒት ማውሰድ -03 ሌላ ካለ ግለጪ-04 _____	
816	ባለፉት ስድስት ወራት በማህበረሰቡ ውስጥ የተደረገውን የልጃገረዶች አማገብ ሁኔታ ተከታትለሽ ነበር?	_____ አዎን - 01 አይ -02	
817	ባለፉት ሦስት ወራት ውስጥ በት/ቤታችው የአማገብትምህርት ነበር?	_____ አዎን - 01 አይ -02 አላስታውስም-88	>900 >900
817	ባለፉት ሦስት ወራት ውስጥ የአማገብ ትምህርት ለምንያህል/ስንት ጊዜ ነበር?	አንድ ጊዜ -01 ሁለት ጊዜ- 02 ሦስት ጊዜ -03 አራት ወይምከዚያ በላይ ጊዜ- 04 አላስታውስም-88	
818	የአማገብትምህርት ስለ ምን ነበር?	የተለያዩ የምግብ አይነቶችን መመገብ -01 የደምማስ ሞድኃኒት ማውሰድ -02 የሆድ ውስጥ ትላትል ሞድኃኒት ማውሰድ 03	

		ሌላ ካለ ግለጪ04_____	

ክፍል 9. የመገናኛ ብዙሃን ሽፋን

ተ.ቁ.	ጥያቄዎች	ምርጫ/ መልስ	ይዝለሉ
900	የልጃገረዶች አመጋገብ ሥርዓት በተመለከተ በሚከተሉት ማናኛ ብዙሃን ላይ አይተሽ/ሰምተሽ ከሆነ ፡		
901	በጋዘጣ	አዎን - 01 አይ -02	
902	በራድኦ	አዎን - 01 አይ -02	
903	መልሱ አዎን ከሆነ ፣ ከራድኦ ምን ታስታውሽያለሽ	የተለያዩ የምግብ አይነቶችን መመገብ -01 የደምማስ መድኃኒት መውሰድ -02 የሆድ ውስጥ ትላትል መድኃኒት መውሰድ -03 ሌላ ካለ ግለጪ04	
903	ቲቪ	አዎን - 01 አይ -02	
904	ፖስተር/ባነር/ሰለዳ	አዎን - 01 አይ -02	
905	በአከባብ ቤተ ተውኔት	አዎን - 01 አይ -02	
906	በአከባብ ድምጽ ማጉያ	አዎን - 01 አይ -02	
907	በአከባብ ቡና እየ ጡጣን	አዎን - 01 አይ -02	
908	በአከባብ እድር/እቁብ	አዎን - 01 አይ -02	
909	በሞባይል መልዕክት	አዎን - 01 አይ -02	

ክፍል 10. የልጃገረዶች አመጋገብ ጥያቄዎች

ትናንት ጠዋት ከእንቅልፍ በኋላ ምን እንደበላሽ ወይምምን እንደጡጣሽ እንድነ ግርኝ እፈልጋለሁ፡ ፡ ያንን ምግብ በቤት ውስጥ ነው የበላሽው፡ በቀጣይ እና በየ ትኛውሰዓት ነበር

የበላሽው? እነዚህን ጥያቄዎች እንደአስፈላጊነቱ እየደጋገሚ በ 24 ሰዓታት ውስጥ የተበሉ ምግቦችንና ማከሎችን አይነቱንና ማከኑን ጨምር ሚዝግብ፡

1001. የሳምንት ቀን (ቀኑን ክበቢ): 01-ሰኞ 02-ማክሰኞ 03-ዕሮብ 04-ሐሙስ 05-አርብ 06-ቅዳሜ 07-እሁድ

ሠዓት	ምግብ የተበላበት ቦታ	ምግብ/ማከሎ	የምግብ ዝርዝሮች እና የምግብ አቀራረብ (ምግብ የተሰራበት ዝረዝር ነገሮች)	የተበላ የምግብ ማከን (በአከባብ ሚላክያ)	የምግብ ክብደት

102_02 ታማእንደሆነች አውጥኪ: አዎን - 01 አይ -02

102_03 አዎን ከሆነ ፤ በሽታውበምግብ ፍላጎት ተፅእኖ አድረጉዋል? አዎን - 01 አይ -02

102_04 አዎን ከሆነ ፤ እንዴት? 1. ቀንሱዋል 2. ጨምሩዋል

102_05 የምግብአቅርቦት ያልተለሚደነበር? አዎን - 01 አይ -02

102_06 አዎን ከሆነ ፤ እንዴት ያልተለሚደነበር?

102_07 የበዓል ቀንነበር? አዎን - 01 አይ -02

102_08 የገበያ ቀንነበር? አዎን - 01 አይ -02

102_09 የጾምቀንነበር? አዎን - 01 አይ -02

102_10 ሚድታኒት ወስዳ እንደሆነች አውጥኪ: አዎን - 01 አይ -02

802_11 1. አይረን 2. ቫይታሚኖች 3. ሌሎች ተጨማሪ ሚድሃኒቶች 4. ፀረ-ወባ ሚድሃኒት

ክፍል 11. ሰውነት ልኬቶች (ቁሜት፤ ክብደት እና MUAC)

	የቃለ ማኪይቅ ሚላያ ቁጥር	⌊__⌋⌊__⌋⌊__⌋
1101	ቁሜት በሴንቲሜትር (ሴ.ሜ)	ንባብ 1 _____ንባብ 2 _____ አማካይ ንባብ _____
1102	ክብደት በኪሎግራም(ኪ.ግ.)	ንባብ 1 _____ንባብ 2 _____አማካይ ንባብ _____
1103	**MUAC** በሴንቲሜትር (ሴ.ሜ)	ንባብ 1 _____

		ንባብ 2 _____አማካይ ንባብ _____
	ክፍል 12. ባዮሎጂካል ናሙና	
121	ከጣት ጫፍ የደምናሙና ተወሰደ?	አዎን - 01 አይ -02
122	ለጥያቄ 121 አዎን ከሆነ ፤ የልከት ሜሪያ ንባብ	ንባብ _____ በጣምአደገኛ <7 ሚሊ ግራም / ሊ---------- መካከለኛ 7-11 ሚሊ ግራም/ ሊ ----------

አባሪ III: በአማረኛ የተዘጋጀ ጥራት(qualitative) የመረጃ ማሰባሰብያ መመሪያ

Qualitative (ጥራት) ጥናት በጽሑፍ የቀረበ የስምምነት ቅጽ

መግቢያ/ዓላማ

ሄሎ፤ ውድ ተሳታፊ ስሜ _____ይባላል፡፡ እኔ የ3ኛ ዲግሪ ትምህርት የመጢቅያ ጥናት/ምርምር ሚጃ ሰብሳቢ ነኝ፡፡ በደቡብ ኢትዮጵያ ውስጥ ያሉ ልጃገረዶች የአመጋገብ ስርዓት፤ የደምማነስ፣ የአመጋገብ አገልግሎት አጠቃቀም ችግርና ምቹ ሁኔታ ይማላከታል፡፡

አቶ ዮሴፍ ሃላላ ከቱፍትስ ዩኒቨርስቲ የገንዘብ ድጋፍ በማኘት ምርምር እያደረገ ነው፡ የቡድን ውይይት የሚካሄደውከእያንዳንዱ ቀበሌ (n = 6-8) ልጃገረድ ወጣቶች ላይ ነው፡

በተጨማሪ የአመጋገብ አገልግሎት አጠቃቀም ችግርና ምቹ ሁኔታ በተማላከተ ከሚሞቻቸው ባለድርሻ አካለት ጋር ጥልቀት ያለውቃለ-ማጢይቅ ይካሄዳል፡፡

ሂደቶች፡

በዚህ ጥናት ለማሳተፍ ፍቃደኛ ከሆናችው፤ ስለ ጤፍ እና ስለ አመጋገብ እና ስነ - ምግብአገልግሎቶች እጢይቃቸዋለሁ:: ይህ ጥናት በአሥራዎቹ ዕድሜክልል ላይ የሚ ኙልጃገረዶች የአመጋገብስርዓት፤ ባህሪ እና የህይወት ዘይቤዎች፤ የግል ንጽህና እና የአካባቢ ጤፍ አጠባበቅ ለማሻሻል ለምሳሩ አካላት ይጠቅሜል፡፡ በጠቅላላ የሚጃ አሰባሰብሂደት 15 ደቂቃ ያህል ይፈጃል፡፡

አደጋ/ሥጋት:

በዚህ ጥናት ውስጥ ከማሳተፍ የተነሳ ምንምስጋት እንደሌለ አምናለሁ፡ ምንምስሜታዊ ጥያቄዎች የሉም፡፡ በእናነተላይ የሚጸምጎጅሂደት የለም ፡

ጥቅሞች፤

በዚህ ጥናት ውስጥ ከማሳተፍ የተነሳ የሚኝ ቀጥተኛ ጥቅምባይኖርምበአከባብለማኘ የአመጋገብስርዓት እና

የአካባቢ ጤና አጠባበቅ ለማሻሻል ለምናሩ አካላት ይጠቅማል፡ ፡

<u>ካሳ</u>: በዚህ ምርምር ውስጥ ለተሳተፉ ተሳታፊዎች ምንም ክፍያ የለም ፡ በዚህ ጥናት ውስጥ ስለተሳተፋችው እናደንቃለን፡ ፡

<u>ሚስጥራዊነት</u>:

ሜልሳችውን በተቻለን ማከን ምሥጢራዊ እናደርጋለን፡ ፡ ሜልሳችውን ለማንኛውምሳ ረቤት ወይምቤተሰብ አናጋራም ፡ የእናነተ ማንነት በሚስጢር ይጠበቃል፡ ፡ የጥናቱ ቡድን ሚጃውን ብቻ ለማዋት ይችላል፡ ፡ ተሞርሚውሚጃዎችን ለምርምር ሥራ ብቻ ይጠቀማል፡ ፡

<u>የ ፈቃደኝነት ተሳትፎ እና ማቋረጥ</u>

ተሳትፎ በፈቃደኝነት ይሆናል፡ ፡ ጥያቄዎቹን በከፊል ወይምሙሉ በሙሉ ላለመመለስ ትችላላችው ፡ በማንኛውም ጊዜ ከጥናቱ የመውጣት መብት አለችው ፡ ትክክለኛ ወይም የተሳሳተ ሜልስ የለም ፡ ማሳተፍና ያለማሳተፍ እናነተ ከጤና ተቁዋምከምታገኝውጥቅማጥቅምጋር አይገናኝም ፡

በአጭር ጊዜ ውስጥ በውይይቶች የተገኙ ሁሉንም ጪቃሚ ሚጃዎችን መመዝገብ በጣም ከባድ ነው ፡ በሚሆኑ ምከተወያየንበት እንደገና ለማዳመጥና ለመመዝገብ የቴፕ ሪኮርድን ማከቀም እፈልጋለሁ፡ ፡ ስለዚህ የቴፕ ማዳመጫን ለማከቀምፈቃደኛ ናችው?

<u>የ ሚመላከተውአካላት:</u>

ማ ኛውጥያቄ ካላችው ለመመለስ ዝግጁ ነኝ፡ ፡ በተጨማሪ ዋና ተሚራሚ ከፈለጋችውአቶ ዮሴፍ ሃላላ የጥናት ዋነ ኛ ተሚራሚ ስለሆኑ ማንኛውምጥያቄ ቢኖራችው፤ በ +251913233179 መደወል ትችላላችው ፡

ስለ ጥናቱ ጥያቄ አለችው? _____

በጥናቱ ለማሳተፍ ፍቃደኛ ናችው? አዎን - 01 አይ -02

_____ _____ _____

ፊርማ ቀን ሠዓት

_____ _____ _____

የ ሚጃ ሰብሳቢ ፊርማ ቀን ሠዓት

የ ሚጃ ሰብሳቢ ስም:_____

<u>የ ትኩረት ቡድን ውይይት</u>

<u>የ ተሳታፍዎች ሚጃ</u>:

ዞን _____ወረዳ _____ቀበሌ_____

<u>ለትኩረት ቡድን ውይይት- የ ተዘጋጀ ማከይቅ</u>

1. በዚህ ማህበረሰብ ውስጥ ለወጣት ልጃገረዶች በጣም የተለመዱ የጤና ችግሮች ምንድናቸው?

2. በዚህ ማህበረሰብ ውስጥ ለወጣት ልጃገረዶች እየተሰጠ ያለው የአመጋገብ አገልግሎቶች ምንድን ናቸው?

3. የአመጋገብ ትምህርት አግኝታቸዋል?

   ማን የሰጠው? መቼ? በትኛው መድረክ ነው?

   በአመጋገብ ትምህርት ክፍለ ጊዜ ላይ ምን ያስተማራሉ?

   የአመጋገብ ትምህርት መልዕክቶች እንዴት ናቸው? (ትርጉም ይሰጣቸዋል? ሊሆኑ የሚችሉ ናቸው?)

4. በየ ስድስት ወሩ የሆድ ውስጥ ትላትል መድኃኒት ትወስዳላችው?

   አዎ ከሆነ ፤ አመቻቾች ምንድን ናቸው

5. በየ ስድስት ወሩ የሆድ ውስጥ ትላትል መድኃኒት ልጃገረዶች እንዳይስጥ የሚያደርጉ እንቅፋቶች ምንድን ናቸው?

6. ባለፉት 6 ወራት ውስጥ የደምማ ስ በሽታ የምላከል መድኃኒት(iron-folic acid) ክኒን ወስዳቸዋል?

   አዎ ከሆነ ፤ አመቻቾች ምንድን ናቸው

   ባለፈው 6 ወራት ውስጥ ደምየ ሜጨምሩ ክኒን(iron-folic acid) ለወጣት ልጃገረዶች እንዳይስጥ የሚያደርጉ እንቅፋቶች ምንድን ናቸው?

7. ለልጃገረዶች የአመጋገብ አገልግሎትን እንዴት ማሻሻል እንደሚቻል የሜጨፈሻ ምን አስተያየት አላችው?

<u>ጥልቀት ያለውቃለ ማኪይቅ</u>

<u>የተሳታፍዎች ሚጃ</u>:

ዞን_____ወረዳ_____ቀበሌ_____

<u>ጥልቀት ያለውቃለ ማኪይቅ ለሚድረግ የሚዱ ጥያቄዎች</u>

1. በዚህ ማህበረሰብ ውስጥ ለወጣት ልጃገረዶች በጣም የተለመዱ የጤና ችግሮች ምንድናቸው?
2. በዚህ ማህበረሰብ ውስጥ ስላሉ የልጃገረዶች የአመጋገብ ልሚድ ሚጃ አለችው?
3. በዚህ ማህበረሰብ ውስጥ ለታዳጊ ልጃገረዶች የሜቋርቡ የአመጋገብ አገልግሎቶች ምንድን ናቸው?
4. ለአመጋገብ ትምህርት እንቅፋት የሚሆኑ ትነገሮች ምንድን ናቸው?
5. ለአመጋገብ ትምህርት ምቹ ሁኔታዎች ምንድናቸው?
6. ለልጃገረዶች የደምማ ስ በሽታ የምላከል መድኃኒት(iron-folic acid) ክኒን ለማቅረብ እንቅፋቶች ምንድን ናቸው?

7. የልጃገረዶች የደም ማነስ በሽታ የምከላከል ሞድኃኒት(iron-folic acid) ክኒን ለማቅረብ ምቹ ሁኔታዎች ምንድን ናቸው?
8. በየ ስድስት ወሩ የሆድ ውስጥ ትላትል ሞድኃኒት ለልጃገረዶች እንዳይስጥ የሚያደርጉ እንቅፋቶች ምንድን ናቸው?
9. በየ ስድስት ወሩ የሆድ ውስጥ ትላትል ሞድኃኒት ለልጃገረዶች እንድስጥ የሚያደርጉ ምቹ ሁኔታዎች ምንድን ናቸው?
10. ለልጃገረዶች የአማገገብ አገልግሎትን እንዴት ማሻሻል እንደሚቻል የሜጩፈሻ ምን አስተያየት አላችው?

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20 March 2020

To Whom It May Concern:

RE: Effect of community-based weekly iron-folic acid supplementation on serum ferritin, folate and hemoglobin level among adolescent girls in southern Ethiopia

As project manager for the Pan African Clinical Trial Registry (www.pactr.org) database, it is my pleasure to inform you that your application to our registry has been accepted. Your unique identification number for the registry is **PACTR202003545370309**.

Please be advised that your trial is registered under an initiative within our system that allow us to capture data of trials that are already in progress or completed. As such, your trial registration may not adhere to the mandates set forth by the International Committee of Medical Journal Editors for registration requirements, and it is your duty to be transparent to any journal that may ask about the retrospective status of your registration.

Please note that it is now a WHO requirement to include, at a minimum, summary results or a link to summary results within the trial registration record. This should be done within 12 months of the study completion date.

Please note you are responsible for updating your trial, or for informing us of changes to your trial. Additionally, please provide us with copies of your ethical clearance letters as we must have these on file (via email or post or by uploading online) at your earliest convenience if you have not already done so.

Please do not hesitate to contact us at +27 21 938 0835 or email epienaar@mrc.ac.za should you have any questions.

Yours faithfully,

Elizabeth D Pienaar
www.pactr.org Project Manager
+27 021 938 0835