ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

CENTRE FOR FOOD SCIENCE AND NUTRITION

Determining Dietary Patterns, Exploring Barriers for Diversified Dietary Consumption, and Causal Analysis of Determinant of Undernutrition among Adolescents, Northwest Ethiopia

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A Dissertation Submitted to the Center for Food Science and Nutrition for the Fulfillment of the Requirements for the Degree of Doctor of Philosophy (Ph.D.) in Community Nutrition

June 2024

Addis Ababa University

School of Graduate Studies

Approval and signature sheet

This is to testify that the PhD dissertation submitted at the Center for Food Science and Nutrition of Addis Ababa University prepared by Eskezyiaw Agedew, entitled: "To determine dietary patterns, exploring barriers for diversified dietary consumption, and causal analysis of undernutrition among Adolescents, Northwest Ethiopia " as fulfilling requirements for doctor of philosophy in community nutrition.

Signed by the Supervisors:

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Statement of author

I have a Bachelor of Science in Public Health from Wollega University and a Master of Public Health from Arba Minch University. These classes have been extremely helpful to acquire practical and applicable skills for my PhD work. Furthermore, I had more than 11 years of experience teaching, conducting research and provision of community services in higher education.

During my study, I was able to learn theoretical and practical skill on scientific writing, research publications, and statistical analysis. Thanks to Addis Ababa University, Center for Food Science and Nutrition allowing me to join PhD study in Community Nutrition, which is perfectly aligned with my professional background.

All these experiences and my Supervisors helps me on designing, planning, executing, and working on my PhD study. In addition, my training on Epi info, SPSS, and STATA software helps me conduct my PhD work.

We can confirm that all authors of the published works and the manuscripts made substantial contributions to conceptualization, design, interpretation, drafting, and editing the final versions of the work.

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Abbreviations and Acronyms

AOR: Adjusted odds ratio

BMI: Body Mass Index

DALYs: Disability adjusted life years

DP: Dietary patterns

EFA: Exploratory factor analysis

FFQ: Food Frequency Questionnaire

GSEM: General structural equation modeling

Hg: Hemoglobin

IDI: In-depth interview

IDA: Iron deficiency Anemia

IDI: In-depth interviews

IQ: Intelligence quotient

KII: Key informant interview

NCD: Non-communicable diseases

NGOs: None–Governmental Organizations

PCA: Principal Component Analysis

SCE: Socio-cultural and economic

SDGs: Sustainable development goals

RDA: Recommended Daily Allowance

WASH: Water, sanitation, and hygiene

WHO: World Health Organization

Acknowledgement

First and most I would like to express my heartfelt gratitude to my supervisors Dr. Abebe Ayelign and Dr. Zeweter Abebe for their support during this dissertation development. Without their close follow up and dedicated support, this dissertation work may not be finalized.

I would like to thank the Center for Food Science and Nutrition for hosting me for this PhD study and Addis Ababa University for covering the expenses and providing financial support to accomplish my dissertation work.

I would like to acknowledge Deber Markos University for providing me anthropometric data collection materials of weight and height scale, financial support and arranging internet accessed and study room. Besides, I extend my thanks to study participants, data collectors, and Kebele administrators, and the staffs of Dembecha District health, education, and agricultural office for their holistic support during this study.

Abstract

Background: Adolescence is a critical developmental stage susceptible to all forms of malnutrition. During adolescence, various dietary habits are established, and health-related behaviors, either positive or negative, are adopted, persisting into the next phase of the life cycle. However, a comprehensive evidence on dietary habits, dietary patterns, and causes of under nutrition has not been generated sufficiently using qualitative and quantitative approaches in the country. Therefore, this study was conducted to fill this gap among adolescents of the agrarian community of Northwest Ethiopia.

Objective: to determine dietary patterns, exploring barriers for diversified dietary consumption, and causal analysis of Undernutrition among Adolescents, Northwest Ethiopia.

Methods: An exploratory sequential mixed-method study design was employed for this study. First a community based cross-sectional survey was conducted to determine dietary pattern and its relation with nutritional status. Following the survey qualitative study was conducted to identify barriers to dietary diversification. Finally a case-control study was conducted to identify determinant factors for stunting and thinness. Data was collected using in-depth and key informant interviews, observational cheek lists, pre-tested structured and semi-structured contextually adapted questionnaires, food frequency questioner; and anthropometric measurement tools. Qualitative data analysis was conducted using ATLAS-ti version 7.1 software for thematic analysis based on inductive and thematic analysis approach. Exploratory factor analysis (EFA) was employed to derive major dietary patterns based on food consumption data, after checking for assumptions. A multivariable binary logistic regression analysis was conducted to identify factors associated with the identified dietary patterns. Nutritional status was determined using WHO Anthro-plus 2010 software. In addition, STATA version 17 was used for the causal analysis of under nutrition by conducting general structural equation modeling. To establish statistical significance, a p-value of 0.05 was used as the cutoff point. Result: Three dietary patterns, namely traditional, mixed, and animal-source foods with traditional alcoholic beverage drinking, were identified, accounting for 58.64% of the variance in the adolescent diet. In the study setting oil-seeds are accessible but there were limited consumption habit among adolescents and entire family member.

Significant variation in was observed on the burden of stunting among adolescents for each dietary patterns and consumption level. Stunting was 15.12% vs. 11.21% lower and higher traditional dietary pattern, 19.40% vs. 6.94% in lower and higher mixed dietary pattern, and the rest 8.36% vs. 17.97% in lower and higher animal source food with traditional alcoholic drinking habits of adolescent's respectively (P-value 0.05). But there were no significant differences in thinness in the identified dietary patterns (P-value > 0.05). The diversified dietary feeding habits of adolescents are affected by multiple interconnected layers of barriers, ranging from an individual level to multi-sectorial collaboration. Adolescents dietary patterns, lack of deworming, being

female, and breakfast eating frequency were key directed and mediated determinant factors for stunting and thinness.

Conclusion: From the identified dietary pattern traditional, mixed, and animal-sourced foods were considered healthy type whereas high carbohydrate and traditional alcoholic beverages were unhealthy type. Modifiable factors were identified that could be targeted for public health interventions that influence dietary patterns of adolescents. Integrated and multifaceted intervention approaches are needed to promote a healthy diet and discourage unhealthy diets. Promoting of locally available oil seeds consumption and enhancing sea-food consumption habits of adolescents and the entire community by introducing small-scale fish farms as nutrition-sensitive intervention pilot projects in study settings and beyond. Further public health interventions should be implemented to reduce under nutrition by improving dietary behaviors, breakfast consumption habits, and providing de-worming services for adolescents. Overall promotion of local sustainable diet, which is nutritionally adequate, economically affordable and having low environmental impact, should be taken as a holistic public health nutrition strategy to overcome all form of malnutrition for adolescents.

Keywords: Dietary patterns, Causal analysis, Adolescents, Northwest Ethiopia

1. GENERAL INTRODUCTION

1.1. Background

Adolescence is a transitional period characterized by physical, cognitive, emotional, and social changes that lay the foundation for later life, health, and well-being. It is a stage of human development that requires essential nutrients such as protein, calcium, and iron for optimal growth and development (Abdulai, Abdul-Nasir, Bashiratu, & Faith, 2023; Abizari & Ali, 2019a).

During period of adolescence, body growth with a rapid increase in height, weight, psychological and sexual maturity with cognitive development are observed which affect nutritional needs and habits (Nicholaus, Martin, Kassim, Matemu, & Kimiywe, 2020).

Adolescence age provides a second window of opportunity to address stunted growth resulting from under nutrition and micronutrient deficiencies to break the intergenerational malnutrition cycle (Akseer, Al-Gashm, Mehta, Mokdad, & Bhutta, 2017). Hence, healthy eating behaviors during adolescence are is a fundamental pre-requisite for physical growth, psychosocial and cognitive development, and ultimately for the prevention of diet-related chronic disease (Abizari & Ali, 2019a).

Consumption of diversified diet and following healthy dietary patterns during this period are crucial for the establishment of healthy dietary habits that will persist in later life (Akseer et al., 2017). Dietary habits have a strong relationship with the nutritional status of a person. The modification of these habits during adolescence can prevent malnutrition (Tamiru et al., 2016). Healthy eating behaviors during adolescence are a fundamental prerequisite for physical growth, psychosocial and cognitive development, and, ultimately, for the prevention of diet-related chronic diseases (Abizari & Ali, 2019a).

Adolescence is the most appropriate time to develop positive health behaviors that can continue throughout life. At the same time, it is the most vulnerable period in terms of the development of diseases that can be seen in adulthood (Omage & Omuemu, 2018). Dietary patterns in adolescents have been useful in understanding the overall diet and its relationship with nutritional status in all forms, such as nutrition (Zhang, Tapera, & Gou, 2018).

1.2. Statement of Problems

Dietary practice of adolescent contributes to delayed growth and development. Many risk factors that affect maternal and newborn health exist right from adolescence, including nutritional deficiencies (Salam et al., 2016).

Globally, adolescent diets are characterized by insufficiently diverse food, less nutrient-dense food, and more processed foods and beverages, resulting in the emergence of various micronutrient deficiencies such as, vitamin A, iron, and iodine (Ghasemifard N, 2017; Bhavani RV. Nithya DJ, 2018). A high proportion of starchy staples in all diets in low-income and middle-income countries, inadequate dietary diversity is more prevalent across all age groups (Akter F, 2021; Isabirye N, 2020).

Adolescents consume diets that are not in line with healthy dietary patterns, and 60.76% of adolescents had poor diversified diet in Ethiopia, 72.4% of adolescents in Southern Ethiopia, 75.4% had a low dietary diversity score and adolescent girls in the context of urban Northwest Ethiopia (Ayele et al., 2023; Birru, Tariku, & Belew, 2018a; Halala Handiso, Belachew, Abuye, & Workicho, 2020).

Poor dietary patterns affect not only the health and physical growth of adolescents, but also their intellectual capacity, social skills, and academic performance. This nutrition problem impairs learning capacity in achieving the full advantage of educational opportunities, with a potential far-reaching consequence on future economic and human development (Peters, Kok, Ten Dam, Buijs, & Paulussen, 2009; Siekmann et al., 2003). Many lifestyle factors, including poor dietary patterns acquired during adolescence, can lead to diet-related chronic non-communicable diseases in later life (Akseer et al., 2017; Cutler, Flood, Hannan, Slavin, & Neumark-Sztainer, 2012).

Undernutrition in adolescents contributes to the increased risk of low birth weight, morbidity and mortality associated with pregnancy and delivery. Especially anemia, also causes impaired growth and intelligence quotient (IQ), developmental delay, 30% decreased physical activity and performance, behavioral abnormalities, impaired cognitive function, and poor school performance (Jadgal, Sayedrajabizadeh, Sadeghi, & Nakhaei-Moghaddam, 2020; Rao, Vijayapushpam, Rao, Antony, & Sarma, 2007).

A meta-analysis study conducted among adolescents in Ethiopia indicated that the pooled prevalence of stunting and underweight was 20.7% and 27.5% respectively (Berhe, Kidanemariam, Gebremariam, & Gebremariam, 2019b). But a secondary analysis of the 2016 Ethiopian Demographic and Health Survey (EDHS), the prevalence of stunting and thinness was 14.2 and 28.8% (Badu, Awel, & Asres, 2022). This evidence indicates that nutrition is still a public health problem in Ethiopia among adolescents (Gonete, Tariku, Wami, & Derso, 2018; Tura, Egata, Fage, & Roba, 2020).

There was no scientific evidence on dietary pattern and its influence on nutritional status, and how socio-cultural and other influences affect adolescents' dietary diversification feeding habit. Therefore, this study was conducted to fill this evidence gap among adolescents.

1.3. LITERATURE REVIEW

1.3.1. Adolescents Dietary Patterns and Diversified Dietary Feeding

Adolescent's dietary patterns and diet diversity is a modifiable risk factor to alleviate all form of malnutrition. Hence understanding dietary patterns can provide useful information about the associations between diet quality and its influence on nutritional, and health status (Abdulai et al., 2023; Hormenu, 2022). The analysis of dietary patterns has been identified as a more realistic representation of dietary habits, since it takes into account the complex interactions between nutrients and other components of a diet, thus making interventions to change eating habits possible (Liberali, Kupek, & Assis, 2020; Perera, Fernando, & Wickramarachchi, 2017).

Improving adolescent dietary habits is one of the key nutritional interventions to improve their nutritional status in low- and middle-income countries (Verstraeten et al., 2016). Dietary behaviors of adolescents are influenced by a complex barriers that involves individual, family, community level, and environmental factors (de Sales et al., 2024).

A studies conducted in developing countries demonstrate that adolescents consumed low intake of fruits, vegetables, dairy products, and whole grains but higher consumption of soft drinks and fast food items this type of dietary quality is poor and intake of ultra-processed foods is high among children and adolescents (Tucker, Martinez-Steele, Leung, & Wolfson, 2024). Current evidence showed that 50% of European adolescents fail to consume fruit and vegetables daily; and 25% and 15% consume sweets and soft drink regularly (Beal, Morris, & Tumilowicz, 2019; Desbouys, Méjean, De Henauw, & Castetbon, 2020).

Unhealthy dietary habit of adolescents was shifted to developing countries and become one of the public health problems. This poor-quality diets providing insufficient fruits, vegetables and animal source foods and increasing consumption of unhealthy foods may be exposing African adolescents to the triple burden of malnutrition (Kanerva et al., 2023; Madzorera et al., 2023).

As study indicated on the adolescent, dietary patterns had common dietary habit like eating energy dense foods; meal skipping, particularly breakfast, or irregular meals; wide use of fast food; and low consumption of fruits and vegetables (Kotecha et al., 2013). As research evidence indicated that adolescents are increasingly exposed to unhealthy food environments due to aggressive

marketing of unhealthy foods (on television, in film, social media, and point-of-sale advertising) (Lassi, Moin, Das, Salam, & Bhutta, 2017; Liang, Kuhle, & Veugelers, 2009).

Research evidence indicated that disordered eating habits, such as skipping breakfast, one of the problems of adolescents due to various reasons (Dalky, Al Momani, Al-Drabaah, & Jarrah, 2017). In a study conducted on influences on adolescent eating patterns, a large percentage of adolescents reported eating less than the recommended amount of vegetables (71%), fruits (55%), and dairy foods (47%) (Ronca et al., 2020; Videon & Manning, 2003).

A study done in Brazilian adolescents found the usual median intake was five to seven fold below the recommendations for vegetables and fruit. This dietary pattern was observed in 49 LMICs, which reported that <50% of adolescents consumed below WHO recommended five servings of fruits and vegetables daily (Ronca et al., 2020).

A study conducted on dietary intake and quality for young adolescents in four sub-Saharan Africa courtiers in Burkina Faso, Ethiopia, Sudan and Tanzania; diet quality in Adolescent diet quality was poor across all study countries and consumption of micronutrient-rich food such as vegetables, fruit, nuts and seeds, and animal sources was low (Madzorera et al., 2023).

1.4. Factors Affecting Dietary Patterns and diversified feeding of Adolescents

1.4.1. Socio-demographic, and economic factors

Numerous factors influence the dietary habits and behaviors of adolescents, socio-cultural and economic environment in which an adolescent lives, eats, studies, and works. Dietary choice is an extremely complex behavior, multiple factors such as psychosocial influence, family, and peer influence have an impact on increasing fruit and vegetable intake and decreasing dietary fat intake among adolescents. Families play a key role in establishing eating habits of children, yet whether families continue to influence eating behaviors of young adults (Haque et al., 2024; Nebel-Schwalm, 2024). Research evidence showed that living environments in which adolescents live, play, and go to school are linked to behaviors that encourage or discourage a healthy dietary habit (Sallis & Glanz, 2006). Healthy favorable dietary patterns, higher dietary scores, greater consumption of fruits, vegetables and dairy products, and lower consumption of sugary sweetened

beverages and energy-dense foods, were associated with better parental socio-economic status, particularly in terms of higher education (Desbouys et al., 2020).

A study conducted on dietary intake and quality for young adolescents in four sub-Saharan Africa courtiers in Burkina Faso, Ethiopia, Sudan and Tanzania; diet quality influenced by socio-demographic, and economic factors such as sex and age differences. Adolescent boys were less likely to consume unhealthy foods but had lower consumption of some healthy foods (Madzorera et al., 2023).

1.4.2. Culture, beliefs and norms its effect on dietary patterns of adolescents

Diverse sociocultural influences play a critical role in the adoption of unhealthy dietary practices or behaviors of adolescents. Culture is viewed as the major determinant of diet. Different dietaries practice will evolve within similar environmental niches. Traditions and cultural beliefs on nutritional practices can impact the nutritional status (Lennox, Petrucka, & Bassendowski, 2017; Mosha & Philemon, 2010).

A study undertaken in Jordan indicated that culture has massive influences on eating practices and food choices, including influences that negatively affect good eating practices (Dalky et al., 2017).

Myths about ‘food’ was affected adolescent feeding habits because of parental attitude, even though they themselves personally did not believe in it leads to poor adolescent nutrition. Inappropriate food habits, social/cultural pressures, and gender discrimination of adolescents were the identified factors that negatively affected adolescent nutritional intake and anemia (Ambrosini et al., 2009).

As a research result, we indicate that gender difference in dietary beliefs and practices during menstruation, pregnancy, and lactation, and in the intra household allocation of food is one existing practice in the community. Staple food items (i.e., rice, lentil, soup, bread, etc.) are distributed fairly equally, side dishes usually containing more micronutrients (i.e., vegetables, meat, yogurt, etc.) are often preferentially allocated to valued household members, including adult males and small children (of both sexes) (Martínez Pérez & Pascual García, 2013).

1.4.3. Household Accessibility and Availability of variety food and agricultural production

Adolescent dietary habit influenced mostly related to household variety of food items existence. The availability and accessibility of household variety of food items determine the consumption of diversified food by adolescents and family members. So adolescents food choices influenced by what is available, affordable, or advertised in the food environment (Raza et al., 2020; Watts, Barr, Hanning, Lovato, & Mâsse, 2018).

The feeding habit of family and adolescents was influenced agricultural production of a verity of food items. Food environments play a critical role in the diets of low-income populations (Martínez Pérez & Pascual García, 2013). Fruit tree-based agroforestry system has a great role to play in livelihood improvement and it provides multiple contributions of household income and supplementary food for smallholder farmers (Bhaskar, Nithya, Raju, & Bhavani, 2017).

For rural populations, diverse systems of agricultural production are an important factor in enhancing the variety of food consumption and improving nutrition outcomes. Own-food production and nutrition outcomes are varied due to sales of nutritious foods to the market (Zanello, Shankar, & Poole, 2019).

Studies have verified that healthy foods are more expensive than unhealthy foods. Within the last 20 years, the cost of fresh produce has increased by nearly 40%, while the price of soda, sweets, and fats and oils has decreased. The low prices of energy-dense, nutrient-poor foods compared with healthier options create an incentive for people to consume an unhealthy diet (Jetter & Cassady, 2006). A recent study indicated that adolescent dietary intake can be affected by various factors like food cost, availability, and access to various food items (Cutler, Flood, Hannan, & Neumark-Sztainer, 2011; Papakonstantinou, Hargrove, Huang, Crawley, & Canolty, 2002; Shrestha et al., 2020).

1.4.4. Family and peer influence on adolescent dietary pattern

Adolescent eating patterns are established through a complex process involving internal and external factors such as food preferences, availability, parental, and peer influences (Story, Neumark-Sztainer, & French, 2002; Videon & Manning, 2003). Parental control, counseling, and involvement in dietary patterns is crucial to influence adolescent eating behavior (Tiedje et al., 2014).

Adolescents typically prefer to associate with their group and conform to their peers, although this could result in risk-taking behaviors, including unhealthy eating habits (Ganasegeran et al., 2012). As reviews are done in European countries with adolescents identified lack of understanding of the role of eating attitudes, food choices, and food preferences were the identified challenges for dietary intake (Moreno et al., 2008; Sirot, Dumas, Leblanc, & Margaritis, 2011).

Besides, eating behaviors such as irregular consumption of meals and skipping breakfast becomes more prevalent during adolescence (Lubans et al., 2012; Sjöberg, Hallberg, Höglund, & Hulthen, 2003). Peer pressure, parents' dietary habits, and media exposure influence the dietary pattern of adolescents. Family environment strongly determines dietary intake and dietary habits in older children and adolescents (Ambrosini et al., 2009; del Mar Bibiloni, Martínez, Llull, Pons, & Tur, 2012; Moreno et al., 2005).

Dietary feeding behaviors of adolescents are influenced by peer influences, parental modeling, food preferences, cost, personal and cultural beliefs, mass media, and body image perception (Story et al., 2002). Understanding the health beliefs of adolescents is particularly important because they had significant differences from those of adults (Y. Melaku, Dirar, Feyissa, & Tamiru, 2018).

As evidence indicated that lack of family support and their dietary behavior are major barriers to consumption of fruit, vegetables, and animal sources in developing countries in adolescents. Family better home support, knowledge of national recommendations, interest in a healthy diet, and verbal praise were positive contributing factors for fruit and vegetable intake (Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003). Food habits of adolescents are complicated and various factors are involved in their development like the taste, appetite, availability, time, attitude,

belief, and knowledge related to food (Neumark-Sztainer, Story, Perry, & Casey, 1999; Zebsyn, Akheruzzaman, Huq, & Bhuyan, acessed on dec 2020.).

Evidence indicated that many actors influence food habits in a complex interactive way. Socio-economic and lifestyle factors (parental occupational status, maternal level of education, cultural and/or religious habits, and the role of family and patterns of beauty) have a strong influence on eating habits in adolescents (del Mar Bibiloni et al., 2012; Neumark-Sztainer et al., 2003).

1.4.5. Adolescent nutritional knowledge

Dietary knowledge is critical to improving health and nutrition for adolescents. As adolescence age is the time to learn and adopt healthy habits to avoid many health and nutritional problems later in life (Özdenk & Özcebe, 2018; Pearson & Biddle, 2011).

Adolescents have more easy access to health and nutrition information through schools, recreational activities, and mass media (Moreno et al., 2008). As different evidence indicated that in many developing countries school students had no basic understanding of both nutrition and diversity of feeding knowledge (Hart, Bishop, & Truby, 2002; Shaka & Wondimagegne, 2018; Shi-Chang et al., 2004; Teji, Dessie, Assebe, & Abdo, 2016).

An study conducted among adolescent's girls in Iran and southern Benin; indicated that focused nutritional education using available resources, brings improvement in nutrition knowledge, which brings improvement in dietary iron intake that can ultimately improve iron intake (Alaofè, Zee, Dossa, & O'Brien, 2009; Amani & Soflaei, 2006). From a life-course perspective, interventions that target food literacy early in life offer the greatest potential for lifelong impact. Addressing food literacy among adolescents and young adults may be particularly impactful, given this group's developmental period when they are navigating new eating independence, establishing their own identity, and building a lifelong health-related (Brooks & Begley, 2014; Vaitkeviciute, Ball, & Harris, 2015).

1.4.6. Adolescent Nutritional Status

Adolescence is the most appropriate time to develop positive health behaviors that can continue throughout life. At the same time, it is the most vulnerable period in terms of development of diseases that can be seen in adulthood (Akman, Tuzun, & Unalan, 2012). Adolescents encounter many factors that threaten their health during their growth and development stages. One of these factors, malnutrition, adversely affects both the physical and mental development of adolescents (Organization, 2018). The main nutritional problems of adolescents living in developing countries are malnutrition, obesity and other chronic diseases, and inadequate/unhealthy eating habits and lifestyle (Lee, Liao, Lai, & Chang, 2019; Sarkar, Manna, Sinha, Sarkar, & Pradhan, 2015).

Adolescent are particularly vulnerable to malnutrition (including undernutrition, micronutrient deficiency, overweight and obesity) due to poor dietary intakes due to the influence of inequitable distribution of food within households, dietary taboos (Monge-Rojas, Garita, Sánchez, & Muñoz, 2005), and gender inequality, Growth spurts (Koca & Arkan, 2021), pregnancy and lactation during adolescence substantially increase nutrient requirements, making adolescents even more at risk is a persisting public health problem in low and lower middle income countries (Sarkar et al., 2015).

The prevalence of stunting (low height-for-age) is a key indicator of long-term chronic undernutrition which reflects an anthropometric failure to reach linear growth potentials due to prolonged food deprivation and/or disease or illness during the early stage of life (Rengma, Bose, & Mondal, 2016). It is a key indicator of long-term chronic undernutrition which reflects an anthropometric failure to reach linear growth potentials due to prolonged food deprivation and/or disease or illness during the early stage of life (Rengma et al., 2016).

Most of the adolescent population grows up in countries with multiple health problems, including diseases of poverty, under nutrition, poor sexual and reproductive health, injury and violence, and non-communicable diseases (Lassi et al., 2017). Chronic under nutrition is a global public health problem affecting both developing and developed countries with its varied adverse consequences

on health as well as on the socio- economic development of the country (Alelign, Degarege, & Erko, 2015).

Adolescent nutrition is given less attention to nutrition policies, strategies, and programs in low-income countries. Improved nutrition is the second of the Sustainable Development Goals. Moreover, targeting adolescent girls only when they are pregnant is often too late to break the intergenerational cycle of malnutrition. Despite the fact that the health sector (including the Ethiopian Ministry of Health) has increased its efforts to enhance good nutritional practices through health education, treatment of extremely malnourished children, and provision of micronutrients for mothers and children, malnutrition is still a challenge in the area (Arage, Assefa, & Worku, 2019; Kennedy et al., 2015).

Unequal progress in adolescent's stunting reduction was observed among along different developing countries. A cross-sectional study among rural adolescents in West Bengal, India 54% of adolescents were stunted and 49% were thin (Pal, Pari, Sinha, & Dhara, 2017). A body of evidences showed that adolescent undernutrition is a serious public health problem in developing countries including Ethiopia. As study conducted in Afar, Northeastern Ethiopia revealed that the prevalence of thinness and stunting were 15.8%, and 26.6% (Hadush, Seid, & Wuneh, 2021), in Debark, Northwest Ethiopia overall prevalence of stunting and thinness were 20.1% and 10.3%, respectively , and in 27.2% in the underweight in Ambo West Showa (Alemu, Muhye, & Ayele, 2021).

1.5. Determinant of Adolescents undernutrition

1.5.1. Basic cause of Adolescents under Nutrition

To mitigate the burden of adolescent undernutrition, identifying the determinant factors in specific context is very important for public health intervention. Nutritional trajectories are complexly interrelated with socio-cultural and economic (SCE) trajectories. Throughout adolescence, nutrition is complexly interrelated with social, cultural, and economic trajectories including education, family formation (e.g., marriage and fertility), and labor participation (Madjdian, Azupogo, Osendarp, Bras, & Brouwer, 2018; Y. A. Melaku, Zello, Gill, Adams, & Shi, 2015).

At the community level, particularly place of residence and environmental factors were found significantly associated with malnutrition. Mainly, studies showed that adolescents in rural areas were worse off in terms of stunting, thinness, and underweight (Madjdian et al., 2018). A study conducted Prevalence and factors associated with stunting and thinness among adolescent students in Northern Ethiopia place of residence had significantly higher odds of being stunted (Y. A. Melaku et al., 2015) .

At the individual level, significant determinants included age, sex, birth order, educational and literacy level, working status, and marital status. At the household level, parental education and occupation, household size and composition, income, socioeconomic status, and resources were associated with undernutrition (Madjdian et al., 2018). The age of adolescents, place of residence, and mother's occupation was significantly associated with stunting and thinness (Wati et al., 2022).

Recently, socio-demographic factors and economic factors including adolescent's age, mother's age, eating habits, place of residence, income, parents' occupation, education or literacy level, and cultural factors are associated with the nutritional status of adolescents (Naser et al., 2014). Age was often reported to influence undernutrition. Four studies found that stunting increased with age in general, and in particular for boys. The opposite was found for thinness that decreased with age in four studies (Y. A. Melaku et al., 2015).

In addition adolescents belonged to lower social class were significantly more likely to be stunted. Adolescents Mother's working status showed significant and positive association with undernutrition. Adolescents of working mothers were more likely to be stunted and thin than those who do not worked outside of the home. The adolescents of women with higher education were less likely to be undernourished than adolescents of poor and uneducated women. Adolescents of nuclear families (family size <4) were more likely to be stunted and thin (Pal et al., 2017).

Adolescents from rural residence, mother educational status, having family size, and households with an unprotected water source for drinking and were significant associated factors for adolescent stunting in Ethiopia (Berhe, Kidanemariam, Gebremariam, & Gebremariam, 2019a).

1.5.2. Underlying causes of adolescent Under Nutrition

The underlying determinant factors of undernutrition, include household food access, availability and utilization of latrine (Hadush et al., 2021). The underlying causes, which impact nutritional status through the immediate determinant factors, manifest themselves at the household level. Among factors Family size was also found to be another predictor of nutritional status of adolescents in a study conducted in Bangladesh and Southwest Ethiopia (Wolde et al., 2014). Nutritional status is a complex interplay of many factors like socio demographic and economic with food preference and dietary habits (Akhtar, Zareen, & Sarmad, 2018).

1.5.4. Immediate causes of adolescent Under Nutrition

The most important immediate determinant factors contributing to child undernutrition, include the disease burden and dietary intake at the individual level (Victora, Huttly, Fuchs, & Olinto, 1997). These factors themselves are interdependent since adolescents with inadequate dietary intake are more susceptible to disease; and disease in turn depresses appetite, and inhibits the absorption of nutrients in food (Black, Lutter, & Trude, 2020).

The immediate causes under nutrition based on UNICEF conceptual framework include inadequate food intake and risks posed by the disease environment on the individual. Inadequate food intake refers to both quantity of food and quality of the diet. The nutritional quality of food intake holds importance in driving the biological processes that govern the growth and development of the musculoskeletal (Reinhardt & Fanzo, 2014). Dietary intakes are categorized

under the immediate causes of undernutrition (Black et al., 2020). These factors themselves are interdependent since children with inadequate dietary intake are more susceptible to disease; and disease in turn depresses appetite, inhibits the absorption of nutrients in food, and competes for the child's energy (Smith & Haddad, 2015).

1.6. Conceptual Framework

This conceptual framework was developed based on previous research on the determinants of under nutrition, and based UNICEF conceptual framework and from related pear reviewed articles nutritional status (Haque et al., 2024; Madjdian et al., 2018; Tamrat, Yeshaw, & Dadi, 2020; UNICEF, 2020). The UNICEF conceptual framework revised 2020 to 2030 remains to be one of the most commonly used important frameworks to explore barriers for under nutrition of adolescents and other population groups (figure1).

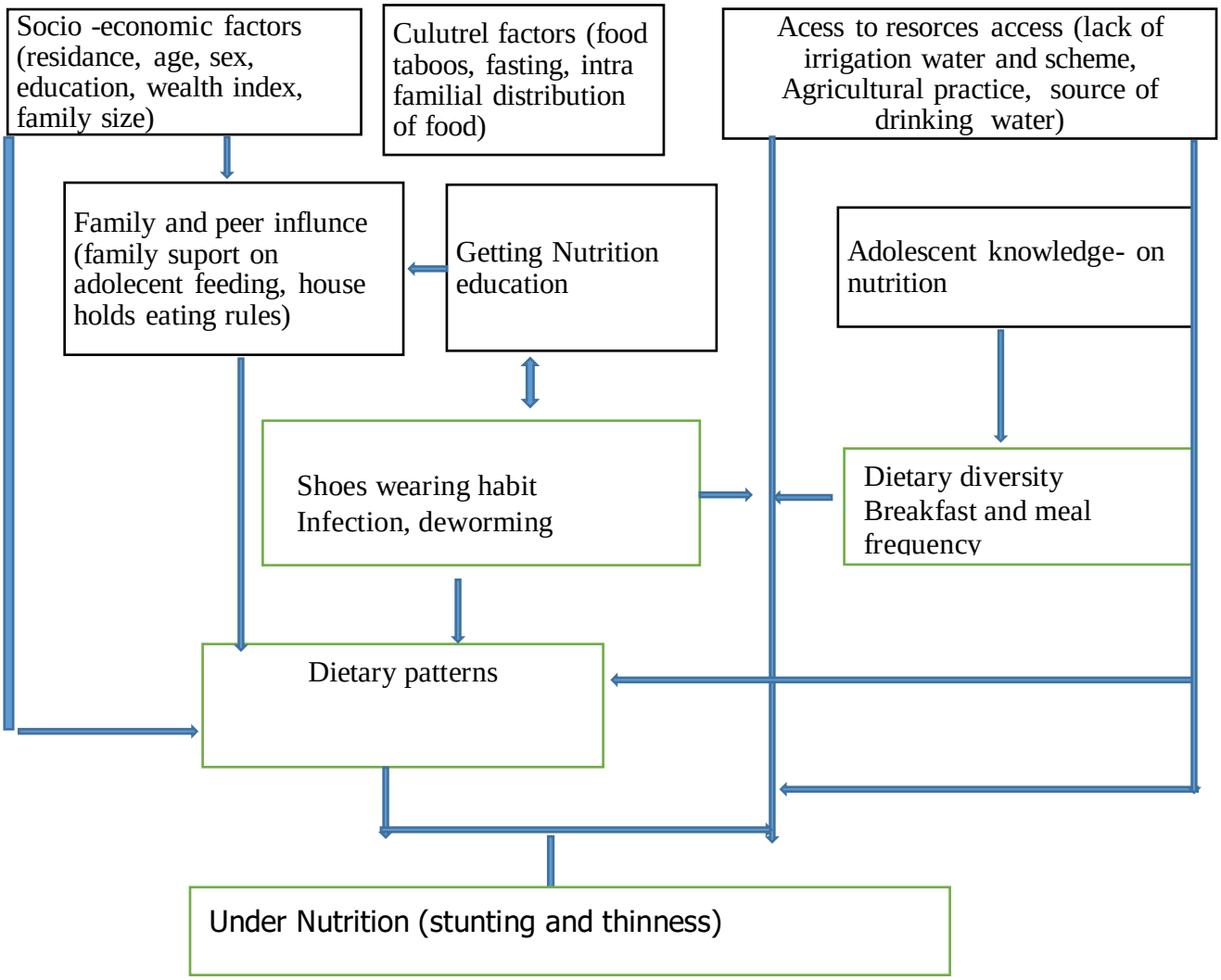

Figure 1: Conceptual framework on Diversified dietary feeding habit, dietary pattern and its effect on nutritional status among adolescents in Agrarian communities, North West Ethiopia, 2021.

1.7. Research questions/Hypothesis

- ✓ Could dietary patterns of adolescents have effect on their nutritional status?
- ✓ What were the barriers for diversified dietary consumption of adolescents?
- ✓ What were the potential causal determinants of under nutrition among adolescents?

1.8. Objectives

1.8.1. General objective

- ✓ To determine dietary patterns, exploring barriers for diversified dietary consumption, and determinants of Undernutrition among Adolescents, Northwest Ethiopia, 2021.

1.8.2. Specific objectives

- ✓ To determine dietary patterns in relation with nutritional outcomes and associated factors among Adolescents, Northwest Ethiopia, 2021.
- ✓ To explore barriers on diversified dietary feeding habit among Adolescents, Northwest Ethiopia, 2021.
- ✓ To identify determinants of undernutrition among Adolescents, Northwest Ethiopia, 2021.

1.8. Justification of the study

Adolescent's nutritional intervention is to improve their dietary quality, nutritional and health status. However, there is no adequate evidence on how to do this in adolescents since the problem has not been studied extensively. To develop better nutrition intervention programs, it is necessary to examine the existing barriers and determinants of dietary diversification, dietary patterns and its influence on adolescents' nutrition outcomes. Assessment of behavioral profiles, dietary patterns, and the main influencers of adolescents in the context of their social and psychosocial development is necessary to inform programs and policy making. In developing countries, including Ethiopia, nutritional studies have focused on under five children and women of reproductive age; in addition, most studies among adolescents were focusing on nutritional status and dietary diversity.

However, context-specific understandings of how socio-cultural influences shape adolescents' diversified feeding, dietary patterns and its effect on nutritional out-come is lacking. Also, there is no adequate evidence on barriers to dietary feeding habit, dietary pattern as well as causal factors for adolescent undernutrition. Therefore, this study was conducted to generate evidence on dietary diversification of adolescents, dietary pattern and factors associated with under nutrition using mixed study designs.

1.9. Significance of the study

The evidence generated from this study helps nutrition programmers to plan and monitor dietary knowledge, patterns, and nutritional status. It helps to design local context effective nutritional interventions to improve the adolescent's nutritional status in resource-constrained settings. Most of the sustainable development goals (SDGs), such as (1) no poverty, (2) no hunger, (3) quality education, and (4) gender equality will not be achieved without addressing nutritional problems of adolescents based on the evidence generated (Griggs, et al., 2013). So it helps to generate evidence to design both nutrition-specific and sensitive interventions.

This study helps to measure how existing dietary patterns and its effect on nutrition within a specific population. It helps to design strategies that can improve their dietary habits for short- and longer-term nutrition intervention measures. Since adolescents become tomorrow's parents, this study helps to design nutrition intervention to improve preconception nutritional status as a way to control and prevent under nutrition.

The evidence generated from this study will be used to design a nutritional intervention for production and consumption of varieties of micronutrient-rich food items and develop a healthy dietary feeding practice for consumption of diverse diets throughout the year.

1.10. Scope of the study

This doctoral thesis focused on exploring barriers to diversified feeding habits; determining dietary patterns and effect on nutritional outcomes, and finally investigating causal analysis of under nutrition among Adolescents in the context of Agrarian Community of North West Ethiopia of adolescents.

In terms of target population it focused on adolescents from 10-19 years for quantitative part of the study. In qualitative part of the study the study participants were adolescents and their mothers, from representatives of farmers, health, agricultural, and educational sector focal. Due to logistic and financial limitation the study was covered one representative Woreda by randomly selecting six study setting from high, mid and low land agroecology climatic zones.

1.11. Limitations of the study

This doctoral dissertation was thoroughly conducted with respect to legitimate and trustworthy scientific methodologies, but its findings have certain limitations. Due to the nature of the study, adolescents in the first and third papers may over report consuming high-quality food items and under-report consuming low-quality food items because of social discrimination bias, even when the interview was conducted in a separate interview area. In second paper the inability to identify all food items that are used to prepare the local diet as adolescents were partially involved in food cooking at home might lead to under-reporting food items like spices. In addition this study lack on determining portion size due to inability to measure properly due to cultural feeding norm of the community. All most all adolescent shared major meals like lunch and dinner with whole family members, so it is difficult to measure portion size to estimate nutrient intake.

1.12. Structure (Organization) of the Dissertation

This doctoral dissertation is organized into four chapters with separate papers. The first paper was dedicated to determine dietary patterns and its determinants factors. This section of the study also answer the effect of the identified dietary patterns with nutrition outcomes. Then after determining the dietary pattern the second paper was organized to explore barriers on diversified dietary feeding habit of adolescent's through qualitative approach. The third paper answer determinants of undernutrition, which was conducted after adolescents nutritional status was determined in paper one (figure 2).

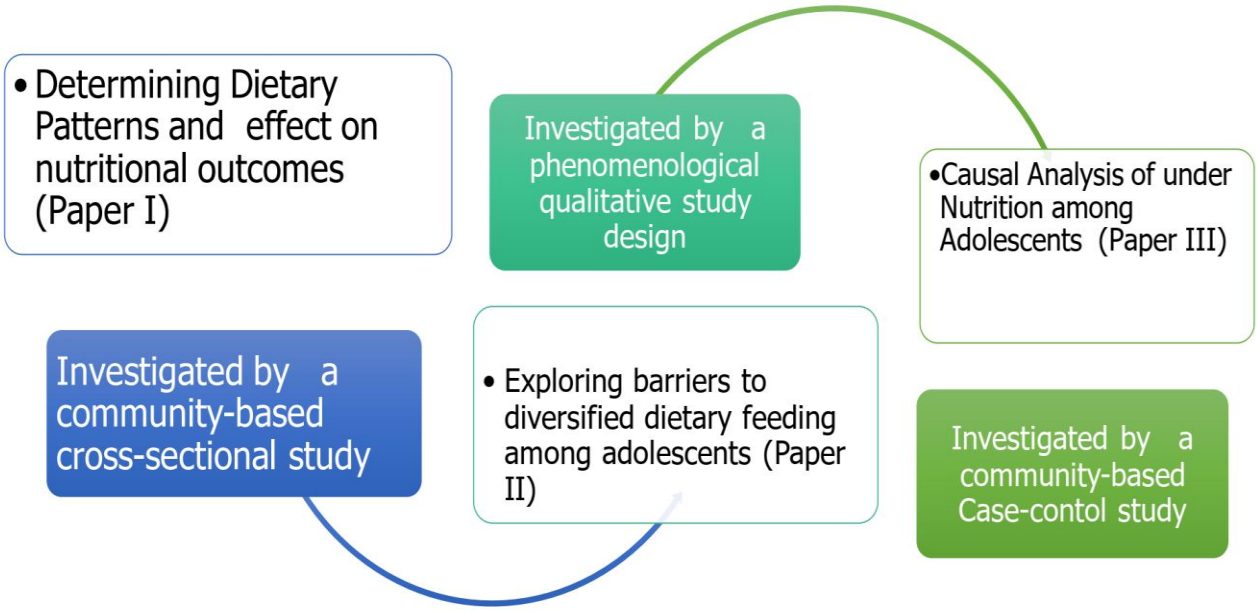

Figure 2: Structure (Organization) of the Dissertation on explore to explore barriers for diversified dietary consumption, determine of dietary patterns, and causal analysis of undernutrition among adolescents in North-West Ethiopia, 2021.

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Chapter 2. Dietary Patterns in Relation with Nutritional Status and Associated Factors among Adolescents in Agrarian Community, North West Ethiopia

Abstract

Introduction: Dietary pattern analysis allows us to characterize the dietary intakes of individuals rather than nutrient intake data and strongly predicts disease risks. The relationship between food intake and adolescents' nutritional health is not well understood, yet. Therefore, this study aimed to generate evidence for context-specific dietary intervention for adolescents.

Objective: This study aimed to determine dietary patterns and their relation to nutritional outcomes and to identify the contributing factors among adolescents in the Agrarian Community of North-West Ethiopia.

Methods: A cross-sectional survey was conducted among 622 randomly selected adolescents. Dietary data was collected over a one-week recall period using the Food Frequency Questionnaire (FFQ). After testing the basic assumptions, an exploratory factor analysis was conducted to determine the dietary patterns. Anthropometric data on weight and height was collected to determine nutritional status using WHO Anthroplus 2010 software. A chi-square test was conducted to evaluate the effect of different dietary patterns on nutritional outcomes. A multivariable binary logistic regression model was used to identify factors affecting the dietary patterns of adolescents.

Result: Result: Three types of dietary patterns, namely traditional, mixed, and animal-source foods with traditional alcoholic beverage consumption were identified. There is no sea-food consumption habit. These dietary patterns explain 58.64% of the variance in adolescent diet in the study setting. Stunting was 15.12% vs. 11.21% lower and higher traditional dietary pattern, 19.40% vs. 6.94% in lower and higher mixed dietary pattern, and the rest 8.36% vs. 17.97% in lower and higher animal source food with traditional alcoholic drinking habits of adolescent's respectively (P-value 0.05).

Adolescents who resided in low-land agroecology (AOR = 2.44; 95% CL: 1.24, 4.81) and had access to animal-source foods (AOR=1.64; 95% CI: 1.04, 2.60) were associated with lower consumption of traditional dietary patterns. Similarly, adolescents who resided in lowlands (AOR = 1.80; 95% CI: 1.18, 2.74), had formal education (AOR =2.38; 95% CI: 1.35, 4.19), and had poor nutrition knowledge (AOR = 2.83; (95% CL: 1.55, 5.19) were associated with lower consumption of mixed dietary patterns. Moreover, adolescents residing in the highlands (AOR = 2.50; 95% CI: 1.37, 4.56) and being female (AOR =1.87; 95% CI: 1.27, 2.74) were significant factors associated with lower consumption of animal-sourced foods with traditional alcoholic beverage consumption patterns.

Conclusion: Adolescents who lived with large family size, nutritional knowledge, ownership of irrigation land, and agro-ecology setting were identified factors to predict dietary patterns. Burden of stunting was relatively higher among adolescents who had lower consumption habits of traditional dietary pattern and mixed dietary pattern and higher consumption habits of animal source foods with traditional alcohol. Integrated and multifaceted dietary intervention approaches are needed to promote healthy diets and discourage the consumption of unhealthy diets to reduce undernutrition in the study area and similar settings.

Keywords: Dietary patterns, Nutrition outcomes, Context-Specific, Adolescents, Ethiopi

1. Introduction

Adolescence is a transitional period characterized by the rapid growth and development that are the foundation for later life, health, and well-being. At this time, adolescents require essential nutrients such as protein, calcium, and iron for optimal growth and development (Abdulai et al., 2023; Abizari & Ali, 2019a). This rapid growth rate combined with a lower nutrient intake leads to a risk of nutritional vulnerability and deficiencies in this age group (Deka, Malhotra, Yadav, & Gupta, 2015).

Dietary pattern of individual is sustainable nutrition behaviors to enhance the overall health of adolescents (Abdulai et al., 2023; Abizari & Ali, 2019b). It helps to measure the number, proportion, variety, or combination of different foods and beverages in a more comprehensive way. This approach considers the interactions between foods and nutrients to promote health or reduce disease risk (Corrêa, Vencato, Rockett, & Bosa, 2017; Keflie, Samuel, Christine, Nohr, & Biesalski, 2018).

Dietary pattern analysis of the target population helps to predict the risk of disease better than the analysis of isolated nutrients, because the joint effect of the various nutrients involved would be better identified (Corrêa et al., 2017). It helps to understand the relationship between dietary habits and disease outcomes, which is important for public health actions to develop and provide diet-based intervention programs (Borges et al., 2018).

Unhealthy dietary patterns developed during adolescence can lead to diet-related chronic non-communicable diseases in later life (Akseer et al., 2017; Hinnig et al., 2018). Adolescents consume diets that are not in line with the recommended healthy diet; only 17% of adolescents have a diversified diet at the global level (Birru, Tariku, & Belew, 2018b). This poor nutritional habit of adolescents leads to stunting, which exposes them to concurrent and future adverse health outcomes (Deka et al., 2015).

Adolescents' from developed countries like the United States, Europe, and Australia had low consumption habits of healthy diets like fruits, vegetables, dairy products, and whole grains, but higher consumption of unhealthy diets like soft drinks and fast foods (Keats et al., 2018; Thana'Y, Takruri, & Tayyem, 2019). This problem also exists in adolescents living in low- and middle-income countries, where their eating habits are characterized by unhealthy habits (Abdulai et al., 2023; Abizari & Ali, 2019a; Alangea, Aryeetey, Gray, Laar, & Adanu, 2018; Borges et al., 2018).

Adolescents had poor dietary habits in Ethiopia (Worku, Hailemicael, & Wondmu, 2017). According to a study conducted in North-West Ethiopia, 32.30% of the adolescents had adequate dietary diversity; 97.70% of adolescent girls consumed starchy staples; 42.6% had no fruit intake; and only 1.70% of them consumed animal-source food (Birru et al., 2018b; Gonete, Tariku, Wami, & Akalu, 2020).

The burden of stunting and thinness among adolescents in Ethiopia ranges from 12.50%–33.10% and 12.60%–58.30%, respectively (Amha & Girum, 2018; Gebregyorgis, Tadesse, & Atenafu, 2016; Tariku et al., 2019; Tegegne, Sileshi, Assefa, & Kalu, 2016). This figure indicates that undernutrition among adolescents is a significant health problem (Berhe et al., 2019a; De, 2017). Adolescents' dietary habits were influenced by various socioeconomic factors, lack of exposure to nutrition education, and influence from family, peers, and the media. Access to and availability of diversified food items were the most commonly reported factors (Abizari & Ali, 2019a; Adamu, Adjei, & Kubuga, 2012).

Adolescence provides a second opportunity for nutritional interventions to mitigate all forms of nutritional deficiency (Nithya & Bhavani, 2018). Hence, there is a need for updated evidence on dietary consumption patterns for designing and implementing appropriate nutrition interventions targeting for adolescents. Previous studies have mainly focused on determining adolescents' nutritional status and dietary diversity score assessments, which did not consider the complexity of diets (Endalifer, Andargie, Mohammed, & Endalifer, 2021; Gonete et al., 2018; Halala Handiso et al., 2020; Y. Melaku et al., 2018).

There is a lack of evidence to investigate dietary patterns and their relationship with nutrition outcomes among adolescents. Therefore, this study was conducted to generate evidence for public health interventions for adolescents' nutritional interventions.

2. Material and methods

2.1. Study approach and setting

North West Ethiopia consists of different districts with low land (below 1500 meter above sea level, mid land (1501-2000 meter above sea level) and high land agro-ecology (above 2000 meter above sea level) Zone. Dembecha district is purposively selected for this study because it consists of all agro ecology which can represent North West Ethiopia.

Agriculture is the dominant livelihood with surplus variety food crop production. Based on the district agricultural report data, the major cultivated crops are *teff*, maize, wheat, legumes (beans), and barley. This study setting has low, mid, and high land ecology zone which is suitable for fruits and vegetable production. The study area is known for cattle, sheep, and goat and poultry raring.

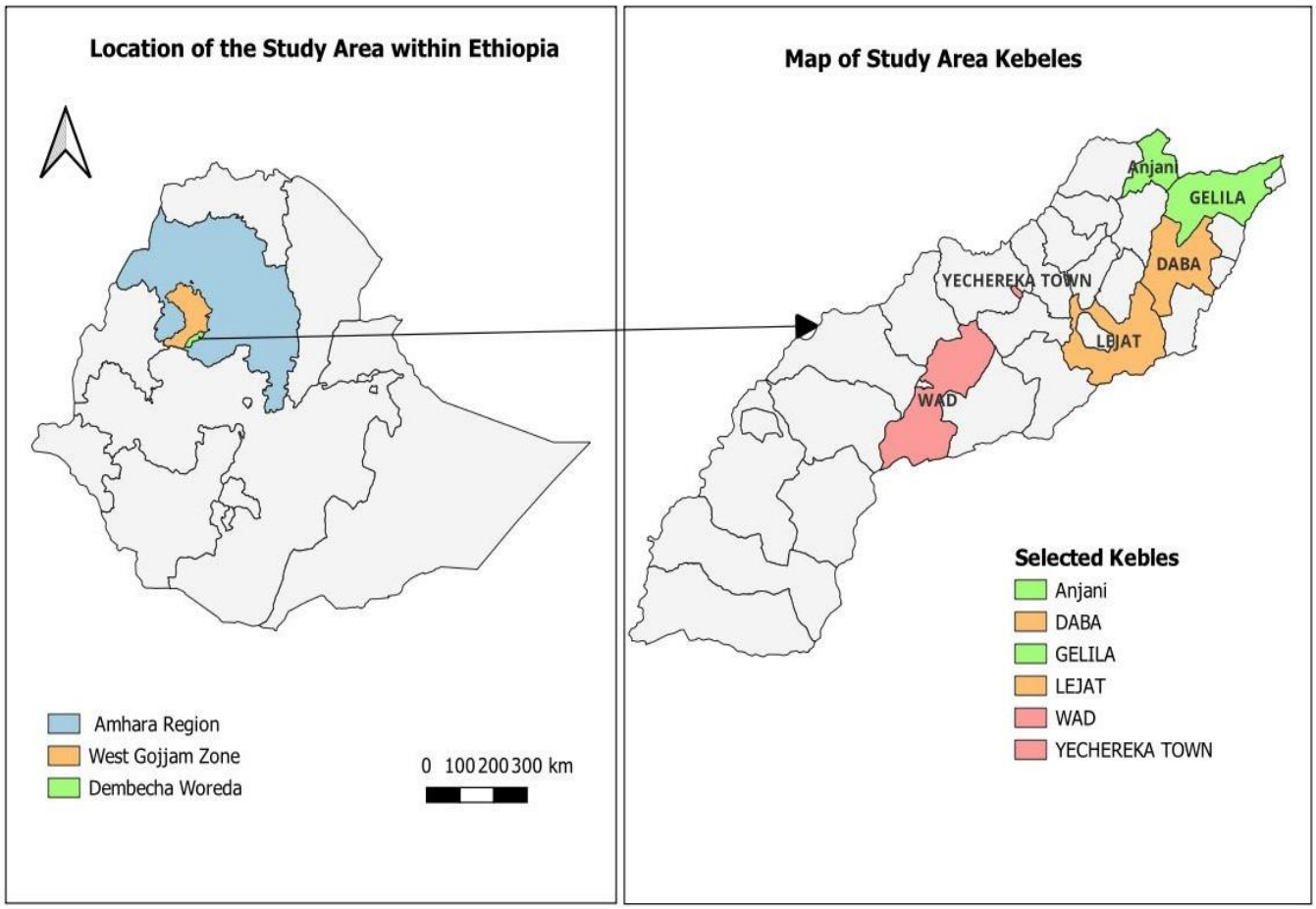


Figure 3. Map of study area, 2021.

A cross-sectional survey was conducted among adolescents who resided in six randomly selected areas of Dembecha Woreda, North-West Ethiopia. Data were collected from December 10 to January 20, 2021. The study area consists of three agroecology-zones (low, mid, and high lands), which are conducive to diversified agricultural production.

Adolescents aged 10–19 years were the target population for the current study. These populations are overlooked for nutritional intervention in developing countries, including Ethiopia, as well as in the current setting. Adolescents with spinal curvature, who could not stand properly or walked with a wheelchair, did not participate in the study.

2.2. Sample determination and approach

A single population proportion formula was used to determine the total number of adolescents in this study, based on the following assumptions: 5% error margin, a 95% confidence interval, and a proportion of 44.6% for the consumption habit (P) of dark green leafy vegetables in south-west Ethiopia(Y. Melaku et al., 2018) with a design effect of 1.5. After adding a 10% non-response rate, the final sample size was 627.

The study area was purposefully selected due to its unique three agro-ecologies (low, mid, and high land), which represent the North-West region of the country. Then, from each agro-ecologic zone, two research settings, or Kebeles (the lowest administrative unit in the case of Ethiopia), were randomly selected as study areas for data collection.

Subsequently, from a randomly selected study setting, eligible households with at least one adolescent were registered, and a sampling frame was prepared. The number of adolescents assigned is proportional to the size (Population) of a particular site. Finally, 357 Adolescents from high land, 77 from Midland, and 188 from Low Land Agro-Ecologic Zones were interviewed.

2.3. Data collection tools and methods

A pretested, structured interviewer-administered questionnaire was used for data collection. The tool was adapted from peer-reviewed articles and customized to the local context. Data on the dietary patterns of adolescents were collected using a validated food frequency questionnaire (FFQ) contextualized to the setting over one week. To develop the FFQ assessment tool, a list of local food items that were consumed at different times during meals and snacks was collected by conducting a pilot study on 30 adolescents for two non-consecutive weekdays and one weekend day (FAO, 2017). The FFQ was organized in a semi-quantitative manner and administered using 24-hour dietary recall methods. Adolescents anthropometric data of weight and height were measured using a standard weight and height scale with precisions of $\pm$0.1 kg and $\pm$0.1 cm, respectively, based on WHO protocol (World Health Organization, 2005). During measurement, adolescents wore lightweight clothing without shoes to minimize error. Trained human nutrition graduates collected data through interviews and anthropometric measurements.

2.3. Data quality control

Data quality was ensured in all phases of the research activities. The tool was translated from English into an Amharic version (the local language). Training was provided to data collectors on the sampling procedures and interview techniques. The questionnaire was pretested using 5% of the total sample size at one site, which was not included in the actual study. In addition, before conducting actual dietary data collection from each sample, the FFQ was tested for internal reliability in 30 adolescents. The test results showed a Cronbach's alpha coefficient (α) of 0.79.

This result indicates that the FFQ is reliable for measuring the dietary patterns of adolescents. During the Measurement of anthropometric weight and height data, calibration of the instrument was performed after each measurement. In addition, local food-colored pictures were used to minimize recall bias. The research lead investigator closely followed the day-to-day data collection process to ensure the completeness and consistency of the administered questionnaire.

2.3. Statistical analysis

Statistical analysis was carried out using SPSS version 25 and WHO Anthro Plus software. A descriptive analysis was conducted to characterize the data using frequencies, percentages, means, and standard deviations. Before conducting further analysis, extreme values and the normality distribution of continuous variables were checked.

Dietary patterns were determined using exploratory factor analysis (EFA). Kaiser–Meyer–Olkin (KMO) (p-value >0.05) and Bartlett's test of sphericity (p-value<0.05) were used to check the adequacy of the sample-to-factors ratio. The existence of a correlation between food items was determined for each step of factor analysis (Mengistu, Azage, & Gutema, 2019). Then EFA was run under orthogonal rotation with the varimax procedure to select interpretable and independent dietary patterns. Factors with a communality above 0.5 and an eigenvalue above 1 explained by principal components were used to decide the final dietary patterns (Omage & Omuemu, 2018). Wealth index of household was measured using principal component analysis. Modal assumption was checked and finally classified in to thirds for categorization (Gautam, Vanga, Ariese, & Umapathy, 2015).

Nutritional outcomes of adolescents were determined based on height for age (HA), and body mass index (BMI) for age z-scores were computed using WHO Anthro Plus (World Health Organization, 2007, 2010). A Chi-square test was conducted to evaluate the effect of the identified dietary patterns on the burden of stunting and thinness of adolescents. Significant differences was determined with a P-value< 0.05.

To identify factors for the identified dietary patterns, first binary logistic regression analysis was carried out to measure existence of association between dietary patterns and factors. Before conducting binary logistic regression multicollinearity was checked using chi-square test assumption. Model of goodness of fit was check by running the Hosmer-Lemen show test and p-value score 0.341 which the model fitted. Multicollinearity was assessed by variance inflation factor and variables showed moderate and strong correlation one of the variable drop for final analysis. Then, factors that showed association in binary logistic regression analysis, and those with a P-value <0.3 were fitted to multivariable logistic regression model to identify significant factors. Significant factors were reported with P-value less than 0.05.

2.4. Operational definition

Dietary Patterns: Determined using EFA and determined based on factor loadings. Based on the score, possible different dietary patterns were developed (Kabir, Shahjalal, Saleh, & Obaid, 2010; McNaughton, Ball, Mishra, & Crawford, 2008). Then each dietary pattern was classified into quartiles (Q) based on their contribution to each pattern, assuming an increasing order from Q1 to Q4 [36]. Finally Q1 and Q2 was combined to represent low consumption habit (0), while Q3 and Q4 represent high consumption of dietary habit (1) (Zhen, Ma, Zhao, Yang, & Wen, 2018).

Adolescents nutritional status is determined based on height for age and body mass index for age using the WHO Anthro Plus (World Health Organization, 2010). Then HA z-scores < -2 SD were categorized as "stunted" and <-3 SD were categorized as "sever stunted" and BMI for age z-scores < -2 SD were categorized as "thin", and > +1 SD were categorized as "overweight/obese" using the WHO cut-off points (World Health Organization, 2007).

3. Ethical clearance

Ethical approval was obtained from College of Natural and Computational Sciences institutional review board (IRB) with IRB number CNCSDO/188/14/2021, Addis Ababa University. Besides, a permission letter was secured from Dembecha Woreda health office. The aim, potential risk, benefits, and confidentiality were made known to respondents in the informed consent form. Additionally, participation was voluntary based and we gave them full right to refuse or accept to participate. Anonymity and confidentiality of the respondents' data were assured. Informed oral assent for participants under 18 years old adolescents were taken from their parents or legal guardians. Direct informed consent was taken from adolescents who were above 18 years and adults study participants.

4. Results

4.1. Background characteristics

From the calculated sample size of 627 participants, 622 were involved in the study, with a response rate of 99.20%. The mean age of adolescents was 15.2±2.02 years. More than half (60.10%) of the participants were female. From all, 82.30% of adolescents' mothers had no formal education; 11.90% attended elementary education, and the remaining 5.80% attended secondary education and above. Regarding the wealth index, 40.50% had lower thirds, 34.40% had medium thirds, and the remaining 25.10% had higher thirds (table 1).

Table 1. Background characteristics of adolescents in Dembecha District, North-West Ethiopia, 2021.

Socio-demographic factors	Category of factors	Frequency (n)	Percentage (%)
Age of adolescents	10-13 years	26	4.2
	14-16 years	370	59.5
	17-19 years	226	36.3
Sex of adolescents	Male	248	39.9
	Female	374	60.1
Adolescents mother educational level	No formal education	512	82.3
	Elementary school	74	11.9
	Secondary school and above	36	5.8
Wealth index of households	Lower thirds	252	40.5
	Medium thirds	214	34.4
	Higher thirds	156	25.1
Marital status of adolescents	Single	599	96.3
	Married	23	3.7
Family size	≤ 4 Members	209	33.6
	5-6 Members	292	46.9
	≥ 7 Members	121	19.5

4.2. Dietary Diversity

The prevalence of adequate dietary diversity practices of adolescents were 15.6%. Adolescent's consumed starchy cereals based food groups and legumes type of food items. The consumption habit of animal sources foods, nuts and oils, and fruit and vegetables were very low (figure 4).

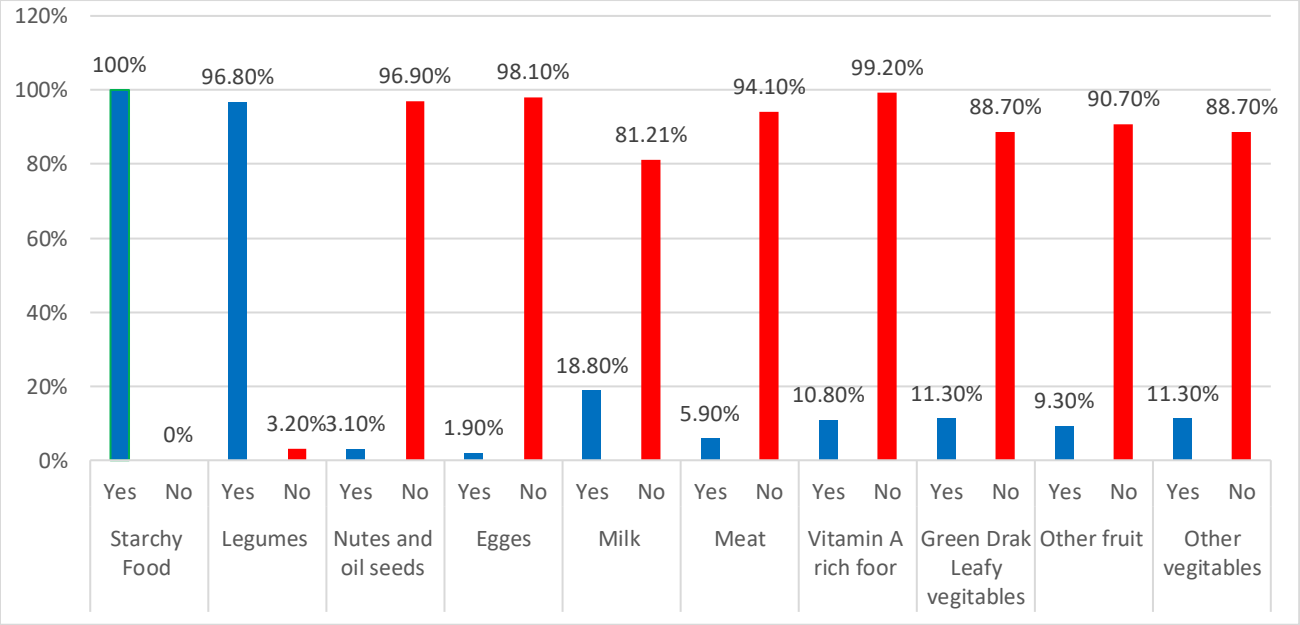


Figure 4. Dietary diversity practices of adolescents in Dembecha district, North West Ethiopia, 2021.

4.3. Dietary patterns of adolescents

The food lists were grouped into common food groups based on their similarity in nutrient contributions. Eight food-groups were identified from the collected dietary consumption data. These food groups consist of traditional, legumes, tubers, whole grains, foods with high carbohydrate content, fruit and vegetables, animal sources, and traditional alcoholic beverages. Based on the EFA factor loading analysis, traditional and legume diets had higher scores of 0.962 and 0.964, respectively, in the first component. In the second component, fruit and vegetable diets, high carbohydrate (tea and white bread), and whole grain diets were identified with scores of 0.710, 0.653, and 0.519, respectively. In the third component, animal source foods (eggs, meat, milk, and milk products) with a traditional alcoholic beverage were identified with factor loadings of 0.746 and 0.625, respectively. In the study setting some oil-seeds like flax seed, Niger seeds, groundnuts, sunflower seeds, and sesame seeds) are accessible but there were limited consumption habit. However, there was no sea-food consumption habit (table 2).

Table 2. Exploratory factor analysis results of food frequency and factor loading consumed by adolescents in Dembecha district, Northwest Ethiopia, 2021.

S.No	Food list (item)	Type of dietary pattern	Components			H^2
			1	2	3	
1	*Injera, Injera with Wot (*Shiro stew added salt, spices, and oils)	Traditional type	0.962*	0.017	0.014	0.938
2	Legumes (Peas, Beans)	Legume's type	0.964*	0.020	0.020	0.383
3	Roasted wheat, barley, maize consumed as *kollo*, high-fiber sliced bread, mixed-grain	Whole grain	0.262	0.519*	0.034	0.558
4	White bread , tea, and pasta	High Carbohydrate	-0.065	0.65*	0.310	0.326
5	Potato and sweet potato	Tuber's type	0.048	0.409	-0.440	0.415
6	*Tella* (traditional home-fermented alcoholic beverage), *areki or katicala* (traditional distilled alcoholic beverage)	Traditional alcoholic beverage	0.153	-0.134	0.625*	0.629
7	Eggs, meat, cooked meat, milk and milk products (butter, cheese, whole milk, and yogurt)	Animal source foods	-0.095	0.201	0.746*	0.512
8	Banana, orange, pumpkin, carrot, fresh and cooked tomato, cabbage, green pepper, lettuce)	Fruits and Vegetables	-0.059	0.710*	-0.228	0.931

H^2-Refers to communality, with items contributing significantly to each principal component analysis
*The food group score is the highest factor loading in each component.

Based on EFA analysis, three major types of dietary patterns were identified, which explained 58.64% of the variance in adolescent diets. The label assigned to each component was based on the items with high factor-loading-scores within each component as well as the interpretability of the factors. These include: (1) the traditional type, explained by 26.71%; (2) mixed type, explained by 16.63% (3) animal-source foods with traditional alcoholic beverages, explained by 15.30% (figure 5). From the identified dietary patterns, traditional, mixed, and animal-source dietary patterns were identified as healthy types; high-carbohydrate and traditional alcoholic beverage drinking patterns were unhealthy types. Meal skipping particularly breakfast was the main unhealthy eating habit observed among adolescents. About 62.10% of adolescents did eat breakfast less than 4 days per week and almost there was no snack eating habit.

In the study area, there were access oilseeds like sunflower seeds, sesame seeds and Niger seeds, but almost this food items were not consumed by adolescents and other family members. There was no consumption of sea-food among the adolescents and the entire family due to lack of access to these foods.

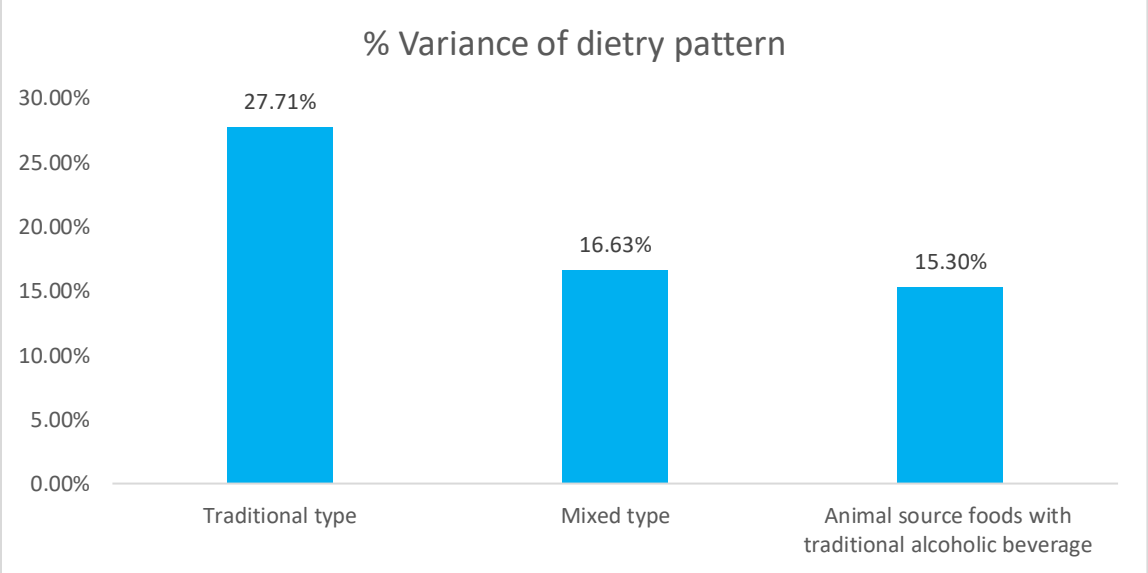
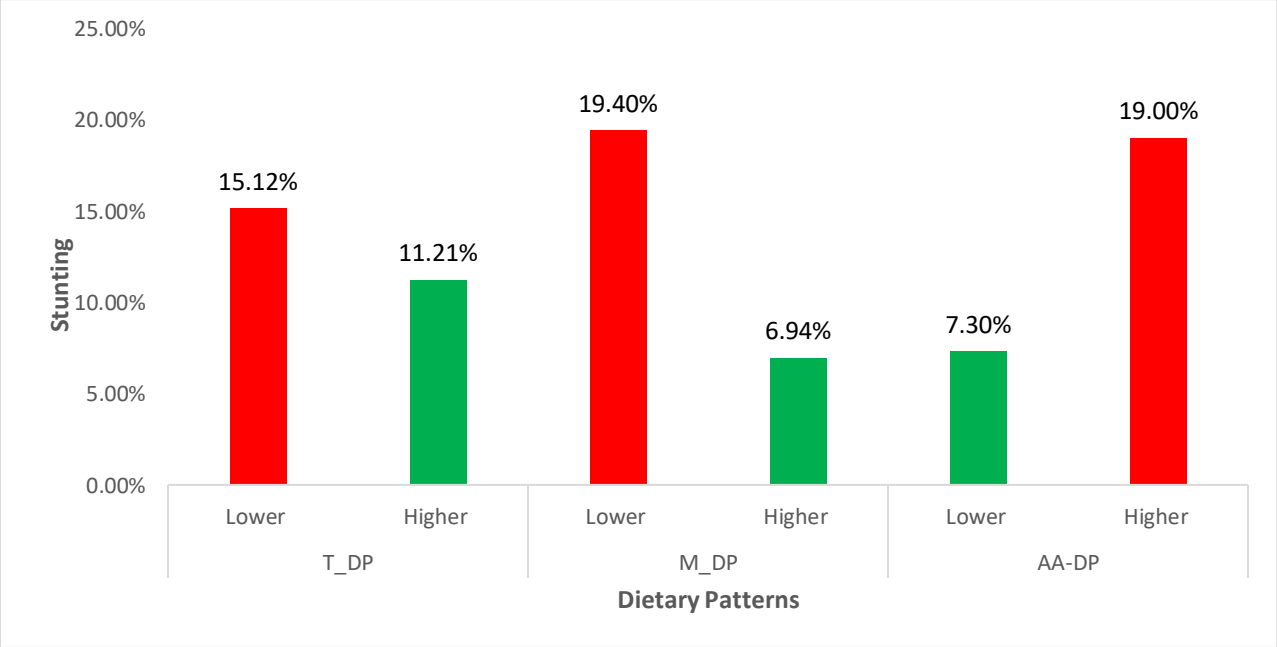


Figure 5. Percentage variance explained the three emerging dietary patterns of adolescents in Dembecha district, North West Ethiopia, 2021.

4.4. Dietary patterns and its effect on nutritional outcomes

The prevalence of stunting and thinness were 26.30% (95% CL: 22.70%, 30.20%) and 9.60% (95% CL: 7.30%, 12.40%) respectively, while overweight was 1.80% among the adolescents. On the other hand moderate and severe stunting were 22.80% and 3.60% respectively. This community-level under nutrition indicated that one in four and one in ten adolescents were stunted too short for their age and too thin for their age) in their nutritional status, which are a significant public health problems (figure 6).



T_DP-Tradition dietary pattern, M_DP-Mixed dietary pattern, and AA_DP- Animal-source foods with traditional alcoholic beverage

Figure 6. Effect of dietary patterns on nutritional status of adolescents in Dembecha District, North West Ethiopia, 2021

The burden of stunting was 15.12% vs. 11.21% and 19.40% vs. 6.94% for the lower and higher traditional and mixed dietary patterns, respectively. In contrast, 7.30% vs. 19.00% of stunting was observed in higher and lower animal sources with alcoholic dietary patterns consuming habits of adolescents, respectively ($p < 0.05$). However, there were no significant differences in thinness between the lower and the higher consumption habits of the identified dietary patterns (P-value > 0.05) (table 5).

Table 3. Dietary patterns and its effect on nutritional outcomes of adolescents in Dembecha District, North-West Ethiopia, 2021

Types of Dietary Patterns	Nutritional Status	Frequency of lower dietary score	Prevalence in lower dietary score	Frequency of High score	Prevalence in high dietary score	Pearson Chi-square	P-value
Traditional	Stunting	85	**15.12%**	63	**11.21%**	14.23	0.0001**
	Normal	163	29.00%	251	44.66%		
Mixed	Stunting	109	**19.40%**	39	**6.94%**	1.79	0.018**
	Normal	157	27.94 %	257	45.73%		
Animal source with traditional alcoholic beverage	Stunting	41	**7.30%**	109	**19.00%**	9.13	0.003**
	Normal	173	30.80%	241	42.90%		
Traditional	Thinness	26	4.63%	28	4.98%	0.378	0.54
	Normal	218	38.79%	280	49.82%		
Mixed	Thinness	19	3.38%	35	6.23%	0.001	0.97
	Normal	174	30.96%	324	57.65%		
Animal source with a traditional alcoholic beverage	Thinness	20	3.40%	35	6.30%	0.17	0.83
	Normal	190	34.40%	308	55.80%		

** Significant (p-value <0.05**)**

4.5. Factors affecting the dietary patterns of adolescents

Adolescents who resided in low-land agro-ecology (AOR=2.4; 95% CL: 1.24, 4.81), mid-land agro-ecology (AOR=0.48; 95%: 0.31, 0.74), those at the early adolescent stage 10–13 years (AOR=0.6; 95% CL: 0.46, 0.99), and had access to animal sources food (AOR=1.64; 95% CL: 1.04, 2.60) were significantly associated with a lower consumption of traditional dietary pattern (table 6).

A mixed type of dietary pattern was the second component of a dietary pattern, which explained by 16.63% of all dietary patterns. Among socio-demographic factors, adolescents who were male (AOR =2.28; 95% CL: 1.56, 3.34), who resided in mid-land (AOR = 1.80; 95% CL: 1.18, 2.74), high land agro ecology (AOR = 2.14; 95% CL: 1.19, 3.87), adolescents' mothers who had no formal education (AOR = 2.38; 95% CL: 1.35, 4.19), adolescents who lived with a large family size (AOR = 1.69; 95% CL: 1.02, 2.80), and those who had poor nutritional knowledge (AOR=2.83; 95% CL: 1.12, 4.05) had a significant association with lower consumption of a mixed type of dietary pattern (table 6).

A third type of dietary habit was explained by a 15.30% variance. This dietary pattern was characterized by the consumption habits of animal-source foods (milk, eggs, and meat) with traditional alcoholic drinking which was unhealthy dietary pattern. Overall, this type of dietary pattern lacks vitamins and minerals that were found in vegetables and fruits. Being female (AOR=1.87; 95% CL: 1.27, 2.74), residing in high-land agro ecology (AOR=2.50; 95% CL: 1.37, 4.56), and access to irrigation land (AOR=0.68; 95% CL: 0.47, 0.99) had a significant association with lower consumption of animal source foods with traditional alcoholic beverage dietary patterns (table 6).

Table 4. Contributing factors for lower consumption of major dietary patterns among adolescents, Dembecha district, Northwest Ethiopia, 2021

Variables	Variable category	Traditional type			P-value	Mixed dietary pattern			P-value	Animal source foods and traditional alcoholic beverage patterns			P-value
		AOR				AOR				AOR			
		AOR	LC	UL		AOR	LC	UL		AOR	LC	UL	
Sex of adolescent	Male	1	1	1		**2.28****	**1.56**	**3.34**	**0.0001****	1	1	1	
	Female	1.32	0.89	1.95	0.12		1			**1.87****	**1.27**	**2.74**	**0.0001****
Agro ecology	low land	**2.44**	**1.24**	**4.81**	**0.01****	**1.80****	**1.18**	**2.74**	**0.01 ****	1	1	1	
	Mid land	**0.48**	**0.31**	**0.74**	**0.001****	**2.14****	**1.19**	**3.87**	**0.01 ****	1.47	0.96	2.25	0.7
	High land	1	1	1		1	1	1		**2.50****	**1.37**	**4.56**	**0.0001****
Age in years	10-13	**0.67**	**0.46**	**0.99**	0.045**	1	1	1		1.77	0.70	4.52	0.23
	14-16	1.01	0.42	2.41	0.99	0.99	0.41	2.38	0.98	0.91	0.35	2.37	0.85
	17-19	1	1	1		1.09	0.75	1.59	0.64	1	1	1	
Adolescent mothers' level of education	No formal education	1	1	1		**2.38****	**1.35**	**4.19**	**0.001****	0.54	0.26	1.12	0.10
	Elementary level	0.95	0.41	2.17	0.89	0.64	0.30	1.39	0.26	0.42	0.17	1.02	0.06
	Secondary and above	1.00	0.39	2.58	0.99	1	1	1		1	1	1	
Wealth index	Lower thirds	1	1	1		1.11	0.69	1.78	0.67	0.81	0.54	1.21	0.31
	Medium thirds	0.63	0.39	1.03	0.23	1.05	0.65	1.68	0.84	0.62	0.38	1.01	0.05
	Higher thirds	0.72	0.44	1.17	0.16	1	1	1		1	1	1	
Family Size	< 4 Member	1	1	1		1	1	1	0.14	1	1	1	
	5-6 Member	0.94	0.56	1.60	0.83	1.44	0.89	2.32		0.68	1.87	0.64	0.64
	> 7 Member	0.74	0.45	1.22	0.24	**1.69****	**1.02**	**2.80**	**0.04 ****	0.79	2.03	0.33	0.33
Nutrition knowledge	Poor	0.69	0.38	1.26	0.23	**2.83****	**1.55**	**5.19**	**0.001****	0.82	2.62	0.19	0.19
	Medium	0.66	0.37	1.17	0.16	**2.90****	**1.60**	**5.28**	**0.01****	0.56	1.74	0.97	0.97
	Good	1	1	1		1	1	1		1	1	1	
Irrigation land access	Yes	1.22	0.83	1.79	0.32					**0.6 8****	**0.47**	**0.99**	**0.04 ****
	No	1	1	1		1.29	0.89	1.87	0.18	1	1	1	
Getting nutrition education	Yes	1.51	0.78	2.92	0.23	1	1	1		1	1	1	
	No	1	1	1		**2.13****	**1.12**	**4.05**	**0.02 ****	0.92	0.50	1.69	0.79
Access to animal-source food	Yes	**1.64**	**1.04**	**2.60**	0.03**	1	1	1		1	1	1	
	No	1	1	1		0.97	0.68	1.37	0.84	0.87	0.56	1.36	0.54
Access to vegetables and fruits	Yes	1.20	0.83	1.74	0.33	1	1	1		1.20	0.85	1.71	0.30
	No	1	1	1		0.97	0.68	1.37	0.67	1	1	1	

** Significant factors (p-value <0.05); **AOR**-Adjusted odd ratio; **LC**-lower confidence level; **UL**-upper confidence level

5. Discussion

Three main types of dietary patterns were identified, of which traditional, mixed, and animal-sourced foods were considered healthy types. However, high-carbohydrate and traditional alcoholic beverages were unhealthy. The identified dietary patterns were the most common and easily accessible in the local area through agricultural production in developing countries (Alangea et al., 2018). These identified healthy and unhealthy dietary habits of adolescents were practiced among adolescents in developing countries like Ghana (Abizari & Ali, 2019a) and India (Kotecha et al., 2013).

In the current study, adolescents had lower consumption habits of healthy dietary patterns of fruit and vegetables. This finding is similar to the study conducted among urban adolescents in Bangladesh, where their habitual dietary pattern indicated poor consumption of leafy vegetables (Kabir et al., 2010). This feeding habit predisposes adolescents to essential micronutrient deficiencies (Kabir et al., 2010; Ochola & Masibo, 2014).

Overall, 26.30% and 9.60% of adolescents were stunted and thin in their nutritional outcomes. These findings indicate that undernutrition among adolescents is a public health concern in the study setting. The burden of stunting was 15.12% vs. 11.21%, 19.40% vs. 6.94%, and 8.36% vs. 17.97% in adolescents with lower traditional, mixed, and higher animal sources with alcoholic dietary consumption habits, respectively. This is due to the effect of lower consumption dietary pattern did not satisfy the daily requirement of nutrients for adolescents' physical growth and development (Adamu et al., 2012). Due to inadequate intake of macro- and micronutrients, poor quantity and quality dietary habits lead to undernutrition (Benazeera, 2014; Borges et al., 2018; Ochola & Masibo, 2014).

Regarding animal sources with the traditional alcoholic dietary pattern, the prevalence of stunting was 7.30% in the lower consumption group and 19.00% in the higher consumption group. This diet is characterized by the feeding habits of food items such as meat, eggs, milk, and milk products, along with traditional alcoholic drinking. But the effects of alcohol and its metabolism prevent the absorption and utilization of nutrients. Hence, it leads to a deficiency of micro- and macronutrients, leading to undernutrition. This finding is supported with study done in Meket district of the Amhara region, North Ethiopia showed that *tella* drinking during pregnancy and lactating had effect on child stunting and underweight than those who never had *tella (Tafese, Berhan, & Stoecker, 2022).*

There were no significant differences in thinness between adolescents with a lower and higher score in the three identified dietary patterns. Adolescent thinness was not affected by long-term dietary habits, but rather by immediate factors like infections (Mersha, Tariku, & Gonete, 2021; Shiferaw & Gebremedhin, 2020), diversification in feeding practice (Mersha et al., 2021), and household food insecurity (Candler, Costa, Heys, Costello, & Viner, 2017; Wassie et al., 2015).

The second type of dietary pattern was identified as the mixed type. Of all adolescents, one-fourth (25.5%) consumed a whole-grain diet per week. This is considered a healthy type due to the nutritional contribution of vitamins and minerals, which are found in fruit and vegetables. In addition, a whole-grain-based diet can contribute energy, starch, and dietary fiber (Borneo & León, 2012; McKevith, 2004; Šramková, Gregová, & Šturdík, 2009). A similar pattern was identified in a study done among school-age children in Scandinavian countries (Frølich, Åman, & Tetens, 2013) and Ghana (Alangea et al., 2018).

Among socio-demographic factors, adolescents who live with large family sizes had two times lower consumption habits of mixed types of dietary patterns. This is due to the effect of large family influence on household's economic insufficiency to meet their diversified dietary needs (Heather & Karen, 2012; Koca & Arkan, 2021). A similar study confirmed that the dietary patterns of adolescents were significantly determined by family socioeconomic status (Nilsen, Krokstad, Holmen, & Westin, 2010). Adolescents who belonged to low socio-economic status did not consume healthier diets as compared to those of middle and high socio-economic status (Koca & Arkan, 2021; McClain, Chappuis, Nguyen-Rodriguez, Yaroch, & Spruijt-Metz, 2009).

Adolescents' mothers who did not attend formal education were two times more likely to have lower consumption of mixed types of dietary patterns. As the educational status of adolescent mothers improved, they had a chance to get information on healthy dietary habits to translate nutritional knowledge into practice (Tefera, Pereznieto, & Emirie, 2013; Videon & Manning, 2003).

Among modifiable factors, adolescents who had poor nutrition knowledge and lack of exposure to nutrition education were three and two times more likely to have a lower consumption habit of mixed types of dietary patterns, respectively. This might be due to the effect of poor nutritional knowledge on adolescents mixed feeding habits (Koca & Arkan, 2021). Furthermore, as adolescents have sufficient basic nutritional knowledge, they can get enough information about the nutrient contents of diversified food items (Koca & Arkan, 2021; Özdenk & Özcebe, 2018; Papakonstantinou et al., 2002).

The third dietary pattern was mainly characterized by the consumption of milk, meat, and eggs, along with the drinking habit of traditional alcoholic beverages. From the animal source foods, sea foods such as fish were not consumed at all in the study area due to a lack of access in the study setting (Kris-Etherton, Harris, & Appel, 2002; Sirot et al., 2011).

In addition, evidence in developing countries indicates that at the household level, staple food items are distributed fairly to all family members, and side dishes usually containing more micronutrients (like meat) are often preferably allocated to male heads of household and male children. This brings lower consumption habits for animal-source foods among adolescent girls. (Contento, Williams, Michela, & Franklin, 2006; Martínez Pérez & Pascual García, 2013).

6. Strengths and limitations of the study

This study assesses the dietary patterns of adolescents and their effect on nutrition in the study setting. The study focused on adolescents, who were understudied and overlooked population group in nutrition interventions in developing countries. As a limitation, the inability to identify all food items that are used to prepare the local traditional diet as adolescents were not involved in food cooking at home might lead to under-reporting food items like spices**.**

7. Conclusion

Dietary pattern of adolescents was dominated by a plant-based diet with limited consumption of micronutrient-rich sources of nutrition. From the identified dietary patterns, traditional, mixed, and animal-source dietary patterns were identified as healthy types; high carbohydrate and traditional alcoholic beverage drinking patterns were identified as unhealthy types. Significantly, the burden of stunting was relatively higher among adolescents who had lower consumption habits of traditional, mixed dietary patterns and higher consumption habits of animal sources with alcoholic diets. But there were no significant differences in thinness among lower and higher consumption habits in the identified dietary pattern.

Multi-dimensional modifiable factors were identified for lower consumption of healthy dietary patterns, which could be targeted for public health interventions.

8. Recommendation

For Health and Education sectors

- Integrated and multifaceted dietary intervention approaches needed to promote the identified healthy diet
- Discouraging the consumption of unhealthy diets (traditional alcoholic beverage drinking & high carbohydrate).
- Promoting of locally available oil seeds consumption

For Agricultural sectors

- ✓ Enhancing sea-food consumption habits of adolescents and the entire community
- ✓ By introducing small-scale fish farms as nutrition-sensitive intervention pilot projects in study settings and beyond.
- ✓ Encourage farmers to cultivate oil-seeds

For researcher

- ✓ Further study will be conducted to determine nutrient level of adolescent's diets and effect on macro and micro nutrients level of adolescents.

Abbreviation

AOR- Adjusted odd ratio

BMI-Body mass index

EEA-Exploratory factor analysis

HA-Height for age

FFQ-Food frequency questionnaire

IDA- iron deficiency anemia

IDD-iodine deficiency disorders

MNDs-Micronutrient deficiencies

VAD-vitamin-A deficiency

WHO-World Health Organization

Acknowledgments

We would like to thank the study participants for their substantial contributions to participating in the study. In addition, we would like to thank our data collectors and field facilitators for their support in collecting the data. We also extend our thanks to the Dembecha Woreda Health Office for their administrative support while implementing this study.

Author Contributions

E.A. conceived and designed the study, did data analysis, and drafted and prepared a manuscript. Z.W. and A.A. contributed to designing the methodology and editing the manuscript.

Conflict of interests

The authors declare that they have no conflicts of interest related to this article.

Funding Source

The authors of this research work were sponsored with financial support from Addis Ababa University with Grant number FDSN/03/2021.

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Chapter 3. Exploring barriers on diversified dietary feeding habit among adolescents in agrarian community, North West Ethiopia

Abstract

Introduction: Adolescence is a critical and neglected age group of population in any form of nutritional intervention. A comprehensive study that assesses barriers that influence their diversified feeding habit is not well investigated in current study setting. Therefore, this study was conducted to fill this gap by providing evidence on exploring barriers for diversified feeding habits of adolescents in Agrarian community, North West Ethiopia.

Objective: The aim of the study was to explore barriers for diversified feeding habits of adolescents in Agrarian community, North West Ethiopia.

Methods: A phenomenological qualitative study was conducted among adolescents in age group 10-19 years, and adults in age range of 25 to 64 years (representatives of farmers, agricultural, health, and education sectors). We conducted total of 24 in-depth and key informant interviews (12- adolescents, 4-health, 2- agricultural extension, 3-education, and 3-farmer representative) among purposively selected community groups. In-depth interviews guides and observation check list were utilized for data collection. The audio-recorded qualitative data was transcribed word by word to English. Finally, the translated data was exported to ATLAS ti version 7.1 software for thematic analysis based on inductive analysis.

Results: Dietary habit of adolescents in study area was predominantly plant-based cereals with limited consumption of fruits, vegetables and animal source foods. This feeding habit, adolescent's had suboptimal intake of micro- nutrients and proteins that are crucial for their fast stage of growth. Dietary habits of adolescents were influenced by multiple and interconnected barriers which were identified as individual-level, family level influence, dietary tradition of community, agricultural practice (poor agroforestry practice of the community, and poor agricultural practice to produce year-round diverse food items) and weak multi-sectorial collaboration for nutritional intervention.

Conclusion: In study setting, diversified dietary habit of adolescents were affected by multiple layers of barriers. These multiple and interconnected influences were ranged from individual level to multi-sectorial collaboration. To improve diversified dietary habit of adolescents' nutritional intervention should be implemented at the individual, family, agricultural, and multi-sectorial levels.

Key-words: Adolescents, dietary habit, qualitative study, barriers, agrarian communality, North West Ethiopia

1. Introduction

Adolescence is a transitional life phase characterized by marked bio psychosocial changes capable of determining the future health status in adulthood. During this phase, dietary habits are established and health-related behaviors, either positive or negative, are adapted, and persisting throughout adulthood (Alangea et al., 2018; Ochola & Masibo, 2014).

During the period of adolescence, body growth with a rapid increase in height, weight, psychological, and sexual maturity with cognitive development are observed which affects nutritional needs and habits (Moreno et al., 2008; Rao et al., 2007). During this period, the nutritional requirements also increase tremendously compared to the preceding years of growth. At this time the diet should provide not only sufficient calories but also essential elements and nutrients such as proteins, vitamins, and minerals (Maliye et al., 2010; McNaughton et al., 2008).

Adolescent diets are characterized by insufficiently diverse food, less nutrient-dense food, and more processed foods and beverages, resulting in the emergence of various micronutrient deficiencies such as, vitamin A, iron, and iodine (Ghasemifard N, 2017; Bhavani RV. Nithya DJ, 2018). A high proportion of starchy staples in all diets in low-income and middle-income countries, inadequate dietary diversity is more prevalent across all age groups (Akter F, 2021; Isabirye N, 2020).

Adolescents consume diets that are not in line with healthy dietary patterns, and 60.76% of adolescents had poor diversified diet in Ethiopia, 72.4% of adolescents in Southern Ethiopia, 75.4% had a low dietary diversity score and adolescent girls in the context of urban Northwest Ethiopia (Ayele et al., 2023; Birru et al., 2018a; Halala Handiso et al., 2020)

Poor diversified dietary habits in adolescents resulting micronutrient deficiencies including, vitamin A deficiency, iron deficiency (anemia), and iodine deficiency. These micronutrient deficiencies have been a major nutritional problems in developing countries, adversely affecting adolescents' health and performance (Deka et al., 2015).

Adolescent diets are characterized by insufficiently diverse food, less nutrient-dense food, and more processed foods and beverages, resulting in the emergence of various micronutrient

deficiencies such as, vitamin A, iron, and iodine (Ghasemifard N, 2017; Bhavani RV Nithya DJ, 2018.). This dietary habit of adolescents was shifted to developing countries and become one of the public health problems (Ochola & Masibo, 2014).

Dietary behaviors in adolescents are influenced by a different barriers that involves individual, family, community level, and environmental factors(Gittelsohn & Vastine, 2003). There was lack of updated evidence on context-specific understandings of how socio-cultural and other influences affects adolescents' dietary diversified feeding habits in the current study setting. Therefore, it is crucial to understand barriers influencing the dietary behavior of adolescents. Hence, this study was conducted to fill this evidence gap among adolescents in agrarian community, North West Ethiopia.

2. Methods

2.1. Study design and subjects

A phenomenological qualitative study design was employed to conduct the study among purposively selected adolescents as well as farmers, health, agriculture, and education sector focal persons, by taking the principle of maximum variation into consideration. The study participants were, adolescents aged between 10-19 years, and adults aged between 25 to 64 years.

2.2. Data Collection

The in-depth (IDI) and the key informant (KII) interview guides were used to collect data by incorporating theoretical and practical guidelines. During the interview, probing questions were forwarded in advance to make to be able to collect optimal data from the respondents. The in-depth and key informant interviews were conducted to identify the multiple layers of barriers that influence dietary diversification of adolescents.

The IDI and KII guides were used to collect family level influences, community traditions that influence diet, cultural and religious influences on dietary diversification. The IDI and KII data were collected from different audiences using IDI and KII guides from 12-adolescents, 4-health and 2-agricultural extension workers in addition to 3-education and 3-farmer sector representatives that were selected from the community. The number of IDI and KII were determined based information saturation principles. Similarly, institutional and multi-sectorial related barriers were collected by conducting KII from institutional focal experts who were working in health, education and agriculture sectors. To characterize the actual type of food items in diet of adolescent's observation check list were utilized for data collection during adolescent's meal times.

2.3. Data analysis

The audio data was transcribed contextually word by word, translated to English, and saved as plain text. To realize this, the contents, meanings, and interpretation of the collected data were carefully translated based on the local context. Much of the analysis was done in field to reduce data loss. Finally, the data was exported to ATLAS ti-version 7.1 software for further coding and thematic analysis. An inductive content analysis was conducted to explore barriers on diversified dietary habits of adolescents. Finally, themes were identified and coded to categorize to explanation and describe each participant's views. Based on the identified themes for barriers, conceptual framework model was constructed/developed. This model is a conceptual framework explaining barriers of diversified dietary habit of participants in the current study area as well as in other similar setting.

2.4. Trustworthiness of the study

Different measures were taken to assure the trustworthiness or validity of the research findings. First, interview guide and observational check-list were developed by reviewing related published papers. Second, data were collected from diversified study participants to ensure social representativeness (adolescents, farmers, health, education and agriculture sector representatives), and also recruited from urban and rural settings. This helps to triangulate further the data to be more dense and reliable from various perspectives using IDI and observation the actual practice. Third, a research assistant was employed who has master of Public Health and experience of conducting research. Fourth, member checking was done at the end of data collection by summarizing major thematic areas raised during the interview. To ensure the transferability of the findings, about the study setting, study participants, and study findings were described in detail with a diversified group of population with different sex, age category, different sectors representatives, and responsibilities. Conformability was achieved through collecting of dense (thick) data from lived experience of study participants. The preconception knowledge, skill and exposure in study setting helps the principal investigator to translate participant's response and views contextually while conducting this research. To minimize interpretation bias, the principal investigator was focused on the idea of participants, recruited different participants from different social segment, documents reviewed by peers and research advisors and focused on the context idea of participants. All the research team checked the consistency of the interpretation with the quotations taken from study participants.

3. Result

A total of 12 IDI and 12 KII were conducted consisted both male and female participants from rural and urban setting of study area. In this section of study different individuals from each age category, sex, rural, urban settings and roles were participated to collect data for social representation of the result (table 1).

Table 5. Demographic profile of in-depth and key informant interview participants' on adolescent nutrition study, 2021.

IDI-KII participants	Number of IDI and KII	Age-range
Adolescents	12	12-17 years
Health workers	4	29-49 years
Agricultural extension	3	28-38 years
Education sector	3	31-46 years
Adolescents mothers and Farmer representative	5	32-52 years

3.1. Diversified dietary feeding habit of adolescents

The existing dietary habit of adolescents was predominantly cereal-based with low protein, vitamins, and mineral content. Based on direct observation of selected adolescents' meals, the predominantly consumed diet was *injera* (a traditional cereal based dish made mainly from mixture of maize, barley, wheat and *teffe* flours through house-hold traditional fermentation and baking method).

"The adolescent diet was almost in observed household consists of traditional diet injera with wote sauce in all meal times" (*Female, diet observer data collectors, 27 years).* The same observation result was confirmed by second data collector *"in my observation during all meal time of adolescents, there was no variation of diet*" *(male, diet observer data collector, 31 year).*

Regarding the sauce (wote or shero), it was prepared from pea/flour after roasting and cooking with red pepper, spices and oils. This traditional diet *injera* with *shero* was the major diet not only for the adolescents but also for all family members that showed the monotonous dietary habit of the study participants.

A 16 years of old male respondent said that "my daily meals during breakfast, lunch, and dinner was injera with wote sauce made from mixed salt and red pepper" (IDI- male, 16 year).

Regarding daily meal schedules adolescent eat only lunch and dinner, but breakfast consumption habit was low due to fasting and lack of availability of ready-to-eat food in the morning. Adolescents did not have the habit of snake consumption. This feeding habit of adolescents lead to in-adequate daily nutrient intake or recommended dietary allowance due to meal skipping.

A 17 years of old female participant said that "I had a breakfast eating habit during non-fasting, but I do not eat at time of fasting" (IDI, 17 female). Similar response was reported from other male adolescents, I prefer food items like potatoes, legumes, fruit, and vegetables but I do not get access to this variety of food items in my family. Because in my area there is no accessibility of a variety of food items (IDI, male, 16 year).

Animal source foods are usually consumed during major religious festivals in the study area. For the religious celebration different segments of the population, including adolescents, were gathered. During this celebration, meat and traditional alcohol drinking mainly *tella* (a fermented alcoholic beverage) are widely consumed. This is a time when adolescent get access to, animal sources food.

I rarely eat eggs, meat, and milk during none fasting times and most of the time I eat during fasting season beginning and at the end during religious festivals such as Chris-mass, Epiphany, Easter, and New Year (IDI, female, 16 years).

Fruit and vegetable consumption habit of adolescents was very low, only few green vegetables mainly cabbage was consumed at time of rainy sessions of the year. This is due lack of access and seasonal influences fruit and vegetable consumption among adolescents.

This supported with response of a 16 year old male adolescent "*I know a healthy diet but due to limited food items in my home, I do not consume diversified food items. I have a preference to eat fruit and vegetables" (IDI*, male 16 year).

3.2. Barriers that influence diversified dietary feeding habit of adolescents

After qualitative data analysis, five main themes were identified after categorizing the codes to a category of similar contents of themes. The major identified barriers for diversified dietary feeding habit of adolescents consisted of individual level, family level and community-level influence, traditional agriculture practice, and weak multi-sectorial collaboration for nutrition intervention (table 2).

Table 6. Barriers domain, category and specific barriers that influence diversified dietary habits of the adolescents, North West Ethiopia, 2021.

Domain category	Barrier category	Reported barriers	Implication on a diversified dietary habit of adolescents
Individuals level influence	Low consumption of animal sources foods, fruit and vegetables	✓ Poor appetite on animal source food consumption ✓ skipping breakfast, and snack daily meals ✓ lack of access to fruit and vegetables	Inadequate consumption of diversified diet for daily recommended dietary allowance (RDA)
Family level influence	Lack of accessibility, and availability of diverse diets at the household level Lack of family support for adolescent diet Lack of alternative income High cost of animal sources diet, and fruit	✓ Selling of quality animal sources food like eggs and poultry, sheep and milk products like butter instead of consumption. ✓ Low family income ✓ Family do not give priority to adolescent's diet ✓ Low attention for a diversified diet ✓ Food provision preference for male adolescents ✓ Lack knowledge on fruit and vegetables plants cultivation. ✓ Poor home gardening practice	Adolescents are dependent on their families for their daily meals and they are not autonomies to consume diversified food items. Family food environment directly influenced adolescent dietary habit to low dietary consumption of animal source foods, fruit, and vegetables.
Community-level influence	Cultural and religious influence of community on diversified diet	✓ less value for diversified dieting ✓ Religious food taboos ✓ Cereal-based diet feeding habit of community as common practice ✓ No preference for adolescent diet	This cultural tradition, value on diet, and fasting influence limit adolescents to eat animal sources food. It also influences and shapes current and future adolescent dietary habits and norms to eat only cereal-based diet all the times.

Agricultural practice	Low production of diversified food items due to dominant cereals based food production habit in the area.	✓ Lack of irrigation water and scheme ✓ Lack of agro ecologically adapted fruit and vegetables producing plants in the area. ✓ High desire of farmers to plant eucalyptus trees instead of agro forestry plants which produce fruit and vegetables. ✓ Climatic (seasonality) influence to cultivate diversified food items	Lack of access and availability of diversified food consumption at households and markets directly influence adolescents' diversified food items year-round.
Multi-sectorial collaboration and lack self-standing structure to implement nutrition intervention	Poor collaboration, and coordination among health, education and agricultural and other sectors Absence of nutrition human power or officer assigned in health, education, and agricultural sector. Lack of self-standing structure to implement nutrition interventions programs for adolescents and other target groups in health, education, and agricultural sector.	✓ Lack of trained nutrition profession at all level ✓ Work load for assigned profession at Woreda, Zonal and Region level ✓ There are no monitoring and evaluation mechanisms for implementation of multi-sectorial action for nutrition. ✓ Lack of budget/finance for nutrition ✓ Lack of nutrition education at school and village label. ✓ Lack of school-based nutrition intervention. ✓ Lack of non-governmental organization (NGO) support on adolescent nutrition and diversified food items production.	Poor adolescent knowledge on diver's dietary practice forced adolescent's to eat monotonous food item. Lack of accessibility and availability of diversified food items. Brings limited consumption of diversified diet.

3.3. Emerging conceptual framework of barriers for diversified dietary feeding habit of Adolescents

An inductive content analysis was conducted to explore adolescents lived experiences on their diversified dietary habits and barriers. After categorizing similar contents 5 themes were identified with 3 major layers of barriers for diversified dietary feeding habit of adolescents (figure 4). The emerging conceptual framework indicates diversified dietary feeding habit of adolescents was influenced by socio, cultural and ecological factors. The emerging model is called socio-cultural-ecological model. It was developed based on the identified major barriers for diversified dietary feeding habit. This theoretical framework showed that dietary habits of adolescents are complex issues influenced by multiple levels ranges from the individual, to environment factors. This model indicates that adolescent nutritional intervention should be taken this model into account.

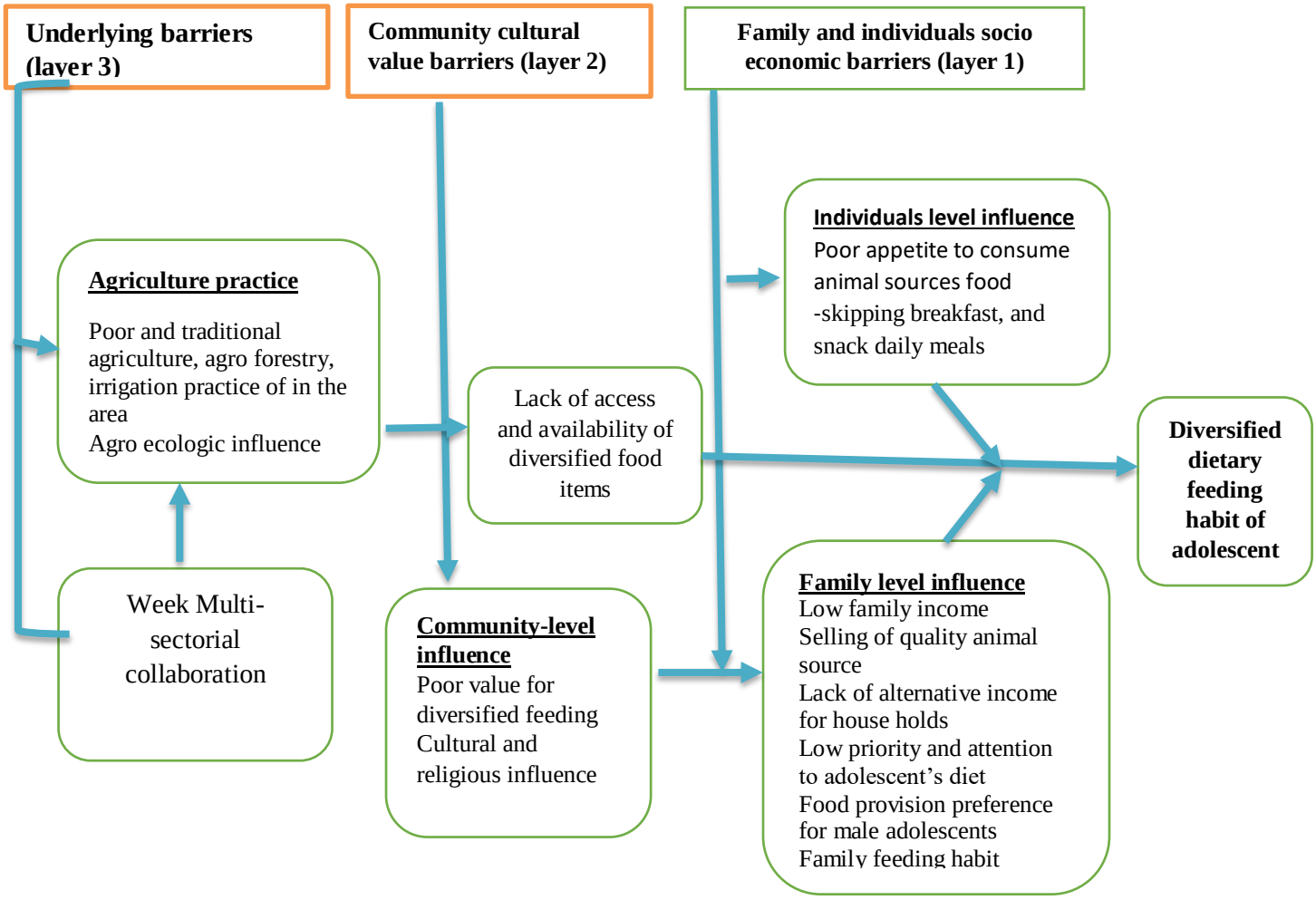

Figure 7. Socio-cultural-ecological model of barriers for diversified dietary feeding habit of Adolescents, 2021.

3.4. Individual level influence on diversified dietary habit of the adolescents

Adolescents were aware of the importance of eating a diversified healthy diet and its long-term consequences for a latter age. If they have sufficient nutritional knowledge, including nutritional recommendations and information on benefits and risks related to dietary behaviors, the adolescents could possibly make healthy dietary choices.

A 16 years old male participant said "*I prefer food items like potato, legumes, fruit, and vegetables, but I do not get access to these foods at home since we do not have access to the variety of food items" (IDI, male, 16 year).*

Adolescents perceived that consumption of animal sources food had health benefits but they ignored it on their daily meals. This was due to poor appetite to animal sources food items, especially girls who had a poor appetite to eat animal's sources food such as meat, eggs, and dairy products.

This statement was supported by IDI of 17 years old female adolescents who stated that "*I do not like to eat animal source foods like eggs, milk and meat since my child hood. I am not comfortable psychologically to eat animal source foods" (IDI, female, 17 years).*

In addition, meal skipping mainly break-fast practices were the major berries for adolescent's dietary habits. A 14 year female adolescents report that "*I do not have eating habit of breakfast due to shortage of time to prepare my breakfast; during morning time I first wash my hands and face, then immediately go to school" (IDI, female, 14 year).*

Adolescents stated that they consume cereals-based diet despite awareness of diversified dietary habits. This indicated that there was a clear gap between knowledge, and actual practice of diversified dietary feeding habits of adolescents.

This is supported by IDI of 16 years old male adolescent that stated that "*I know a healthy diet, but due to limited food items I do not consume diversified food. I have a preference to eat fruit and vegetables" (*IDI, male, 16 years). The same idea was forwarded by another adolescents as follows *"I prefer to eat vegetables, and animal source food items like milk, egg,*

and meat. The barriers that prevent me from eating a diversified diet were family problems, lack of access to different food items at home" (IDI, male, 16 year).

3.5. Family level influence on diversified dietary habit among adolescents

Family feeding behavior was considered to have both positive and negative influences on adolescents eating habits. Availability and accessibility of food items like; fruits, vegetables, and animal source foods were the major barriers to adolescents' diversified dietary habits. Family dietary habits were identified as an important factor influencing adolescents' feeding habits. Many adolescents reported that their food intakes were limited to what is available at home and fixed family meal frequency.

This finding was narrated by IDI of 17 years old male adolescent as follows "*My feeding habit is similar to my family, in my family; there was no priority for adolescent diet mainly quality diet was given for young children and sick individuals. We eat a large portion diet but the quality of the diet is low since it is predominantly cereal-based such as injera and wote" (IDI, male, 14 years).*

At family level, there was no special diet consideration for adolescents at household level. Most of the time, nutritious diet was provided for young children and sick individuals.

This was supported by 14 years old male adolescent "*My family does not give attention to a balanced diet*; *we eat what we get" (IDI, male, 14 year)*. The same idea was forwarded by another adolescent as follows "*even though animal source foods are available in the family, our feeding habit is poor due to lack of awareness, Also, my family does not give attention to consumption of diversified diet" (IDI, female, 16 year).*

Adolescent's diversified dietary habit was influenced by availability and accessibility of diversified foods at home. The adolescent's diversified feeding habit was influenced by their home food environment because they eat what was served and was available at home.

This is supported by 36 year adolescent's mothers as "*I have knowledge on the importance of consumption of diversified foods and how to prepare it at home, but due to availability of limited food items, I did not provide diversified food to the family. We did not give special attention while*

feeding the adolescents, we provide them with what the whole family eats daily" (IDI, Adolescent mother 32 years).

There was relatively good availability and accessibility to poultry and eggs, few of them had access to meat, dairy, and dairy products. But, adolescents and other family members did not consume these foods frequently; rather, they take the poultry products to the local market for money.

This statement was supported by 36 year adolescent mothers by stating that *"we have eggs at home, but we sell it to the local market to buy agricultural inputs like fertilizer to the cultivated cereals as we have no any other alternative income source "(IDI, Adolescent mother 36 year).*

3.6. Dietary tradition of community influence on diversified dietary habit of adolescents

The usual diet of the community is predominantly cereal-based with limited consumption of animal source foods. The community had long tradition on consumption of animal source foods only at time of religious festivals and during local cultural ceremonies like wedding.

A 14 years male adolescent reported that "….*I only eat animal source foods during religious and in some cultural ceremonies" (IDI, male, 14 year*).

There was consumption habit of animal source foods at time of cultural and religious ceremony. Regarding vegetable consumption, there is a seasonal consumption of cabbage during the rainy season.

This was supported by 14 years male adolescents by narrating as "*We eat large portion but low-quality diet which is predominantly cereal based. Our community does not give attention to balanced diet, we did not worry about its quality" (IDI, male, 14 year).*

The existing dietary practice of the community was almost monotonous. The community does not give value for quality of food that should be consumed at a household level.

A 16 years old female adolescent narrated that "*The rural community does not consider to eat diversified food items" (IDI, female, 16 year).* Similar finding reported from other adolescent by narrating as "*Even if we have animal source foods at home, our feeding habit is poor due to lack of awareness"(IDI, male, 14 year).*

3.7. Agricultural and agro forestry practices of community

The community livelihood strategy was agriculture with predominant production of cereals (*teffe, maize,* barley, and wheat), legumes (beans and pea), and tubers (mainly potato) in the study setting. Three agro ecological zones were identified in the areas that were suitable to produce different fruits and vegetables. However, the farmers were mainly dependent on rain fed agriculture. Cereal crops were produced once in a year and irrigation facility was not available in the area to practice year round production.

This finding was supported by 53 years old farmer "some farmers produce fruit trees like mango, and avocado but apple tree plantation was not practiced by the local farmer"(IDI, male farmer, 53 years).

The production of fruits and vegetables was limited in the study areas; this is due to lack of knowledge about the importance of agro forestry plantation among the farmers, low agricultural extension services, and lack of access to agro forestry plant trees for farmers.

A 38 years old farmer said that "*Our agricultural system is dominantly traditional due to lack of agricultural extension support on how to cultivate locally adaptable fruit and vegetables" (IDI, male farmer, 38 years).*

Limited agricultural sector support on development of irrigation facility, and lack of access to fruit and vegetable producing agro forestry plants were the major barriers identified in the study area that keeps farmers from producing diversified fruits and vegetables for consumption.

A 29 years old male agriculture extension worker said that "…*The agro ecology Zone is dry and there is no access to irrigation facility. In addition, there was no access to agro forestry plants in the area. There was no agricultural office and non-governmental organizations (NGO) support for agro forestry fruit and vegetables production" (IDI, male, agriculture extension, 29 year).*

The agricultural land was covered by eucalyptus tree in all agro ecology area. This tree cannot be consume as fruit or vegetable. In contrary, the tree reduces land size and soil fertility that ultimately reduces cereal, fruit and vegetable production in the area. This trend of eucalyptus tree plantation expansion was due to lack of alternative agro forestry plants that were adapted for local area.

This finding is supported by 53 years old farmer "*I have interest to cultivated plants that can produce fruit and vegetables, due to lack of access to agro ecologically adaptable plants species" (IDI, male, farmer, 53 year). Further, there was no regulatory enforcement on farmers to prevent this massive plantation of farm land by eucalyptus tree. The same finding was reported by 29 years agricultural extension worker "… due to the fact that eucalyptus tree is easily accessible at local area, the tree do not need much water for growth" Now, this is a time of rainy season but almost all farmers plant Eucalyptus tree (IDI, male, agricultural extension worker, 29 year).*

3.8. Weak multi-sectorial collaboration and poor implementation nutrition strategy

There was a gap in improving dietary diversity of adolescents in the study setting. There was no planned nutrition education to be delivered regularly for adolescents at household and school levels. Absence of organizations which support adolescent diet, school-based nutrition intervention to promote adolescent diet, and lack of integrated agricultural and health sectors support were the identified multi-sectorial collaboration barriers for production of diversified food items. These poor multi-sectorial collaborations contributed to the poor availability and of diversified food items in the area.

This finding is supported by 35 years school directors *"…… These days, there is no any school based nutrition intervention for adolescents like nutrition education and school garden demonstration" (IDI, school director, 35 years).* Similar idea was reflected by a 48 years old farmer *".....the agricultural extension workers do not fully support on how to cultivate locally adaptable fruits and vegetables at school and village level" (IDI, male, farmer, 48 year).*

In Ethiopia, there has been a proven strategy for implementation of nutrition sensitive and nutrition specific interventions. However, most of the interventions have been implemented for under five children and pregnant and lactating women. There was a fruit and vegetable production promotion program at schools some years back but it has interrupted after sometime, due to lack of inputs, nutrition education, and coordination. This finding supported by elementary school director as follows *"We are unable to implement school gardens to demonstrate vegetable production in our school because of lack of access to water" (IDI, male, 29 year, school director).*

The other barriers that influenced adolescents diversified diet consumption was lack of nutrition professionals in required number at all levels of health facilities (Regional, Zonal, Woreda, Health centers, and Hospitals). At all level of the health-care delivery in Ethiopia nutrition programs were implemented mainly with the integration of maternal and child health services (like immunization, and child health). This approach of health care delivery brings overload for health care workers to deliver.

4. Discussion

Almost all interviewed adolescents frequently reported limited consumption habits of animal sources food like eggs, meat, dairy and dairy products as well as fruit and vegetables. Breakfast is the most important daily meal, but neglected more by children and adolescents (Hosseini, Gharghani, Mansoori, Aghamolaei, & Nasrabadi, 2015).

In addition, adolescents had meal skipping habits of breakfast and snack due to fasting time influence and lack of accessibility of prepared food items to eat in the morning at house hold level. This feeding habit of adolescents exposed them to macro and micronutrient deficiency. Similar feeding habit of adolescents were practiced among adolescents who live in developing countries (Akseer et al., 2017; Alangea et al., 2018; Kotecha et al., 2013).

In this study; diversified dietary habits of adolescents were influenced by complex and interrelated barriers. This study identified five major themes of barriers which consist of individual, family level of influence, community-level influence, poor agricultural practice (lack of agroforestry and irrigation, and agro ecologic influence to produce year-round diverse food items and week multi-sectorial collaboration for nutrition intervention. Similar results were identified in others studies as dietary feeding habits of adolescents were influenced by multiple and interconnected factors which consist of socio-economic and environmental barriers (Monge-Rojas et al., 2005; Verstraeten et al., 2016).

Among these factors, individual-level influences like sex and socio-economic status of adolescent families were the major barriers that influence diversified dietary habits. This is due to the influence of gender as one of the social norms for intra-household food distribution (Aranceta, Perez-Rodrigo, Ribas, & Serra-Majem, 2003; Cutler et al., 2011; Gittelsohn & Vastine, 2003). Similar evidence was indicated that food choice in general is a complex process that depends on the culture and can be influenced by different factors such as personal, social, economic, and emotional factors (Contento et al., 2006). Sociocultural and socio-demographic factors were playing a crucial role in shaping the dietary patterns of adolescents (Ambrosini et al., 2009; Borges et al., 2018; Islam et al., 2019). In addition, socio-cultural, and economic factors play an important role in determining food preferences and dietary habits of adolescent girls (Hassan, Kalsoom, Sheikh, & Humayun, 2020).

Adolescents perceived that consumption of animal sources food had a health benefit, but they ignored on their daily meals. This was due to religious fasting influence, the food price, in accessibility (physical and economic access of animal sources food items) (Sosanya ME, 2024).

Family dietary habits were identified as important influencing factors for adolescents' feeding habits. Many adolescents were reported that their food choices were limited based on family meal frequency and type of food items. Eating is a social act, social networks of the family can affect their food choices (Contento et al., 2006). Other family-level influences lack of priority given for adolescent diet were influenced dietary habit of adolescents. At the household level, women were given preference to give quantity and/or quality of food items for their husbands. This leads to low caloric and insufficient micronutrient intake for adolescent girls and adult women (Gulema H, 2024.). These family-level barriers influence adolescent feeding habits negatively as they are dependent on their family. This is due to the effect of family control, counseling, and involvement in dietary patterns was crucial to influence adolescent eating behavior (Tiedje et al., 2014; Verstraeten et al., 2016).

Adolescent's dietary habit was influenced by accessibility and availability of diversified food items at home. Adolescents eat what is served and available at home. As a result, the feeding habit of whole family was influenced by food accessibility of a variety of food items. This is due to the effect of access to the food environment playing a critical role in the diets of low-income populations (Hanson, Neumark-Sztainer, Eisenberg, Story, & Wall, 2005; Martínez Pérez & Pascual García, 2013; Zanello et al., 2019).

At the community level, diversified dietary feeding influence such as traditional consumption habit of monotones cereal-based dietary practice, lack of awareness of community towards diversified diet, fasting influence on diversified diet and meal frequency, selling of nutritious diet to market due to lack of alternative income, high cost of quality diet (meat, eggs, and fruit) were directly affected the diversified dietary habit of adolescents in the current study setting. This is due to the price influences adolescent's food choice, due to limited household income (Bellow, Hudson, & Nair, 2008; Dammann & Smith, 2009). Certain healthy foods were preferred by adolescents but, there were no frequent consumption habit due to high prices of these foods (Hassan et al., 2020).

The community consumed animal source foods mostly at the time of religious festivals and in some cultural ceremonies such as wedding. Religious dietary rules affect food and nutrition security, and health by affecting the quantity of food consumed, dietary diversity, and the intake of nutrient-rich foods (Hays, Power, & Olvera, 2001; Meyer-Rochow, 2009). In addition to community cultural, environmental setting modified adolescent's dietary feeding practices. This is due that the fact that cultures will evolve parallel patterns of food behavior and diet under similar environmental settings were influence adolescent dietary practice (Gittelsohn & Vastine, 2003; Sogari, Velez-Argumedo, Gómez, & Mora, 2018).

Local agricultural practices of the community were the major barriers that influence adolescents' diversified dietary habits, due to low cultivation of diversified food items. The community livelihood was agrarian with predominantly production of cereals crops with seasonal cultivation of some vegetables like cabbage, chilies and onions. This traditional cereal crop-based agricultural practice of community brings to low accessibility of fruit and vegetables for adolescents. Due this, the feeding habit of the whole family was influenced by home food availability (Martínez Pérez & Pascual García, 2013; Monge-Rojas et al., 2005).

There was limited agricultural practice for cultivation of fruit and vegetable production in the study area. This is due to poor knowledge of farmers on the importance of agroforestry plantation, lack of agricultural support, and lack of access to agroforestry plant trees for farmers. Fruit tree-based agroforestry system has a great role for the small holder farmers in improving the livelihood and generating income (Bhaskar et al., 2017).

There was no nutrition education regularly delivered for adolescents at household and school level. In addition there is no none–governmental organization support for promoting adolescent diet, lack of school based nutrition intervention, and lack of integrated agriculture and health sectors support for the community to cultivate diversified food items to enhance diversified dietary habit of adolescents and family members as well. This poor multi-sectorial collaboration brings poor access and availability diversified food items in the area. As a result, the dietary practice among adolescents are compromised (Özdenk & Özcebe, 2018; Pearson & Biddle, 2011).

5. Strengths and limitations of study

As strengths it is the first kind which explore multi-level barriers on diversified food item consumption among under studied and overlook population group in area of nutrition intervention and investigation. The study address barriers from different layers of influencing factors starting form micro level factors up to agricultural and multi-sectorial factors. As limitation since it purely qualitative study, so it does not quantified the prevalence of diversified food item consumption.

6. Conclusion

Diversified dietary habit of adolescents in the study area was predominantly plant-based cereals with low animal sources food, fruit and vegetables consumption. As a result, adolescent's had suboptimal intake of micro- nutrients and proteins that are crucial for this fast stage of growth. Multiple layers of influence or barriers were identified on a diversified dietary habit of adolescents in the study setting. These multiple and interconnected barriers ranges from individuals level barriers up to multi-sectorial collaboration for nutrition intervention.

7. Recommendation

❖ **For Health and Education sectors**

✓ Promoting plant sources protein food items substitution to consume during religious fasting time.

✓ Develop local customized (tailored) and whole family approach social and behavioral change communication (SBCC) to improve diversified dietary habit.

❖ **For Agricultural sectors**

▪ Improving household agricultural practice to grow and cultivate a variety of food items

✓ Implementing home gardening and agroforestry practice to enhance fruit and vegetable accessibility and availability.

Abbreviations

IDI-In-depth interviews

NCD-non-communicable disease

Acknowledgments

We would like to thanks for study participants for substantial contributions to participate in the study. In addition, we would like to thank the Dembecha Woreda Health and educational office who give support during data collection.

Author Contributions

E. A. conceived and designed the study, did data analysis, draft and prepare manuscript. Z.W and A.A contributed on designing methodology and editing manuscript.

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Chapter 4-Causal Analysis of Determinant of under Nutrition among Adolescents in the context of Agrarian Community of North West Ethiopia: General structural equation modeling approach

Abstract

Introduction: Adolescent stunting and wasting are persistent nutritional problems in developing countries. The cause of under nutrition is multifaceted and complex in nature. Multi-causal determinant of under nutrition evidence was lacking in the study area.

Objective: This study was conducted to assess causal Analysis of determinant of under Nutrition among Adolescents in the context of Agrarian Community of North West Ethiopia.

Methods: A community based case-control study was conducted among 149 cases, and 297 controls adolescents in agrarian communities of North-West Ethiopia. A pre-tested structured interviewer-administered questionnaire was used to measure the study variables. Dietary data was collected using contextualized food frequency questionnaire for none consecutive two week days and one weekend day over one week recall period. Adolescents' anthropometric data on weight and height were measured using standard procedure to minimize measurement error. Nutritional status was determined by using WHO Anthro plus 2010 software. Generalized structural equation modeling approach was used to determine multi-causal analysis of under nutrition. Significant direct and mediated effect was identified with a p-value < 0.05.

Result: Adolescent who had lower consumption habit of traditional dietary habit with adjusted $\beta = 0.13$, 95% CL (0.29, 0 .23) and mixed diet (MD) $\beta = 0.41$, 95%CL (0.15, 0.66), who are female $\beta = -0.219$, 95% CL (-0.031, -0.13), and who were dewormed $\beta = -0.12$, 95% CL (-0.202, -0.028) had direct effect on stunting. In addition break-fast eating frequency had direct effect on thinness with adjusted $\beta = -0.015$, and mediation effect via dietary patterns for both stunting and thinness.

Conclusion: Dietary patterns and breakfast eating frequency had direct and mediating effect on Adolescent under nutrition. Public health interventions should be implemented to reduce stunting and thinness by improving dietary feeding habit and breakfast consumption habits of adolescents and strengthening the national deworming programs in study areas and similar settings.

Keywords: Nutritional status, Generalized structural equation, Agrarian community, Adolescents, Ethiopia

1. Introduction

Adolescence is a transitional period characterized by physical, cognitive, emotional, and social changes that lay the foundation for later life, health, and well-being (Abdulai et al., 2023; Abizari & Ali, 2019a).

Adolescent under nutrition is a significant public health problem in developing countries, particularly in Asian and African countries (Aguayo & Paintal, 2017; Darling et al., 2020) . Thirty-six percent of adolescent in South Asia, 5% adolescent in Europe and Central Asia were under nutrition. Similarly, in Ethiopia, about 12.5–33.1% of adolescents were stunted, and 12.60%-58.30% of adolescents were thin (Amha & Girum, 2018; Gebregyorgis et al., 2016; Tariku et al., 2019; Tegegne et al., 2016). This figure indicated that under nutrition of adolescents were one of the most important public health problems in Ethiopia (Berhe et al., 2019a; De, 2017).

Adolescents under nutrition affected by multi-faceted and complex interrelated factors which range from basic, underlying and immediate causes (Raza et al., 2020; Tamiru et al., 2016). Studies which were conducted in different settings identified various factors for under nutrition among adolescents. Some of the commonly reported determinants of under nutrition are rural residence, early age, household food access and availability, household wealth status, inadequate meal frequency, lack of safe water for drinking, lower diversified dietary feeding, and sub-optimal access to nutrition and health information (Gagebo, Kerbo, & Thangavel, 2020; Gebregyorgis et al., 2016; Tegegne et al., 2016).

During a priority setting exercise on nutrition related problems in the country in 2019 adolescent undernutrition was identified as one of the priority areas which requires immediate response. There was lack of a comprehensive study on multi-causal determinant of under nutrition in the study setting (Endalifer et al., 2021; Tamiru et al., 2016). Identifying the direct and indirect contributions of individual, household and community-level determinants of adolescents under nutrition would allow policymakers to design integrated public health interventions (Tamiru et al., 2016; Yallew, Tadesse, Noor, Fawzi, & Berhane, 2022). Therefore, this study was conducted to identify causal determinants of under nutrition in the study area to generate evidence for public health action.

2. Materials and methods

2.1. Study settings and target population

A community-based case-control study was conducted among adolescents of agrarian communities in randomly selected kebeles of Dembecha District, North-West Ethiopia. The data was collected from 10 January to 30 February 2022. The study area consists of three Agro ecology Zones (low, mid and high lands) which is conducive for diversified agricultural production.

Adolescents aged 10 to 19 years who lived in Dembecha District were the source population of while adolescents who lived in the randomly selected kebeles of Dembecha District were the study population. These age range populations were overlooked for nutrition intervention in developing countries, including Ethiopia, as well as in the current setting. Therefore this study was conducted to generate evidence for designing nutrition intervention for Public Health action. Adolescents with spinal curvature who could not stand properly and walked with a wheelchair were excluded from the study.

2.2. Sample size determination and procedures

The required sample size was determined by a double population proportion formula using Epi info version 7 by assuming : 95% confidence level, 59.7% proportion of control exposed in low wealth index category for stunting (Gagebo et al., 2020), ratio of case to control 1:2, and adding a 10% non-response rate. The final sample size was 149 cases, and 297 controlled with a total sample of 446.

The study area was purposely selected due to its unique three Agro-ecologies (low, mid, and high land), which is representative for the North-West region of the country. Next, two research settings or Kebeles (lowest administrative unit in case of Ethiopia) were randomly selected from each Agro-ecology for data collection.

In each study setting, eligible households which had at least one adolescent were survey and registered, and sampling frame was prepared. Before conducting case control study first cross sectional survey was conducted to determine nutritional status in order to identify cases and controls among adolescents. Then one case of stunting and two consecutive controls were selected from each study setting for further interviews.

2.3. Data Collection tools and measurement

A pre-tested structured interviewer-administered questionnaire was used for data collection. The tool was adapted and customized to the local context from peer-reviewed articles, and also from UNICEF Conceptual frame work (Black et al., 2020). This questioner was organized to collect basic, underlying, and immediate factors for adolescent under nutrition.

In addition data on dietary patterns of adolescents was collected using a validated food frequency questionnaire (FFQ) contextualized to the setting. To develop the FFQ assessment tool, a list of local food items that were consumed at different times of meals and snacks were collected by conducting a pilot study on 30 adolescents for three nonconsecutive two weekdays, and one weekend day (FAO, 2017). The FFQ was organized in semi-quantitative ways, and administered 24-hrs dietary recall methods.

Adolescents' anthropometric data weight and height of participants (while wearing light-weight clothing without shoes) were assessed using a standard weighing and height scale, respectively using the WHO protocol (World Health Organization, 2005).

2.4. Data quality control

To insure data quality the data collection tool was translated from English to Amharic version (local language). A one day training was given for data collectors and supervisors on the objective, procedures and data collection technique by the principal investigator. Pre-test was done on 5% of study participants out of the study area and amendment on questioner was performed based on the finding of the pretest. In addition, before conducting the actual dietary data collection from each sample, the FFQ was tested for internal reliability among 30 adolescents. The reliability test for actual dietary tool was done using Cronbach's Alpha coefficient (α) which was 0.79. This Cronbach's Alpha coefficient (α) indicated that the FFQ internal reliable to measure the dietary pattern of adolescents. During the measurement of anthropometric data of weight and height, frequent calibration of instruments was done at the end each measurement. In addition, local food-colored pictures were used to minimize recall bias.

2.5. Operational definition

Adolescents' Stunting (Case): Determined using height for age (HA) and computed using WHO Anthro Plus software (World Health Organization, 2010). To classified nutritional status HA Z-scores < -2SD were categorized as "stunted" and <-3 SD categorized as "severe stunting (World Health Organization, 2010).

Adolescents Thinness: Determined based on body mass index (BMI) for age z-scores BMI for age z-scores < -2SD were categorized as "thinness", and > +1SD was categorized as "overweight/obese" using the WHO cut-off points (World Health Organization, 2007).

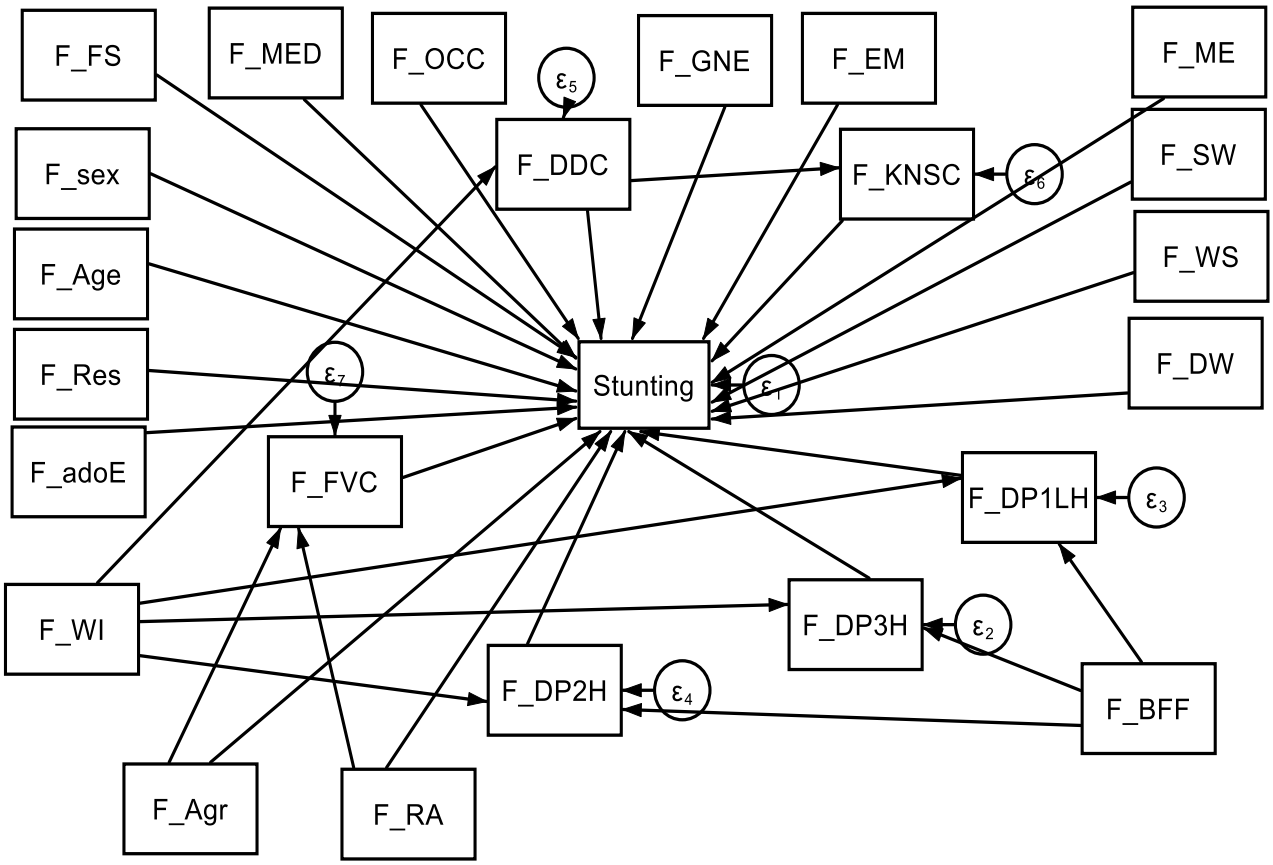
Dietary pattern: Exploratory factor analysis was conducted to determine key dietary patterns from consumption data based on its factor load. Based on the score, different dietary patterns were developed (Kabir et al., 2010; McNaughton et al., 2008). Then each dietary pattern was classified into quartiles (Q) based on their contribution to each pattern and assuming an increasing order from Q1 to Q4 (Zhen et al., 2018). Finally Q1 and Q2 was combined to represent low consumption habit (0) while Q3 and Q4 represent high consumption of dietary habit (1) (Abizari & Ali, 2019a).
Dietary diversity: Was assessed based Food and Agricultural Organization tools that measure women's dietary diversity. Food consumed by adolescents was assessed through a 24-h recall method and then food items were categorized into ten food groups. Dietary Diversity Score (DDS) was created as a summary measure of dietary intake (Italy et al., 2014).

2.6. Data Analysis

Data was entered and cleaned using SPSS version 25 software and exported STATA version 17 for further analysis. Descriptive frequency was conducted to describe the study population with relevant variables. Exploratory data analysis was conducted to check the potential outliers and normality distribution for continuous variables. Wealth index of household was measured using principal component analysis. Modal assumption was checked and finally classified in to thirds for categorization (Gautam et al., 2015).

Adolescents stunting and thinness was determined based on height of age (HA) and body mass index (BMI) for age Z-scores were computed using WHO Anthro Plus respectively (World Health Organization, 2007, 2010). Exploratory factor analysis (EFA) were conducted to derive major dietary patterns based on the consumption data after checking for basic assumptions.

Due to a multi-causal factors that influence under nutrition, and factors which affect under nutrition mixed nature of distribution and mediation effect for each other. Factors which influence in this study had count, continuous, ranked, and categorical in their type with Gaussian, Binomial, Ordinal, and Poisson distribution. The way in which these factors operate to influence adolescents' nutritional status is complex and multifaceted in a structural way. Therefore, General structural equation modeling (GSEM) is an appropriate approach used to determine multi-causal analysis of under nutrition. The GSEM model was fitted in steps to identify direct, indirect and total effect of factors that affect under nutrition. The first hypothesized model was constructed as showed (Fig.1) and the final fitted mode was also shown in (Fig.2 and 3). To select fitted GSEM modal adequacy was tested using Akaike's information criterion (AIC) and Bayesian information criteria (BIC). Based on score of AIC= 3271.532 and BIC 3524.346 for hypothesized model and in the fitted model AIC= 1712.498 and BIC=1769.585. As the score of AIC and BIC in hypothesized model and the fitted model reduced in score which indicates the modal fitted for analysis. Finally fitted GSEM modal was run to measure the direct, indirect or mediated effects of each factors on stunting and thinness in the final specified model based on their level of significance. Significant determinant factors were identified based on the p-value<0.05.



F-Letter represent factor, F_sex: Sex of adolescent, F_age: Age of Adolescent, F adoE: Adolescent educational status; F-Res: Residence, F_Agr: Agro ecology, F:MED: adolescent mother educational status, F_OCC: Adolescent family occupation, F_GNE: Getting Nutrition Education, F_FS: Family Size, F_DW: Deworming, F_ME: Having media exposure, F_RA: Irrigation land access, F_WS: Wearing Shoes, F_WI: wealth index, F_FVC: fruit and vegetable consumption, F_DP1LH:traditional dietary pattern, DP2H:mixed dietary pattern, F_KNSC: Knowledge of Nutrition, F_DP3H: Animal sources with traditional alcoholic drinking dietary pattern, F_BFF: Break Fast eating frequency, F_DDC: Dietary diversity

Figure 8. Hypothesized model on Causal Analysis of under Nutrition among Adolescents in the context of Agrarian Community of North West Ethiopia.

3. Result

3.1. Socio-demographic characteristics of study participants

The mean (±SD) age of the participants was 14.36 +1.76 years. Almost one fifth (18.3 %) of the adolescents were at the early adolescent stage (10-13 years), 69.5% of them were between 14-17 years and the remaining 12.20% were in late adolescent stage (18-19 years). There was no significant difference in the proportion of stunted adolescents across the different socio-demographic characteristics except adolescents sex and age (p-value<0.05) (table 7).

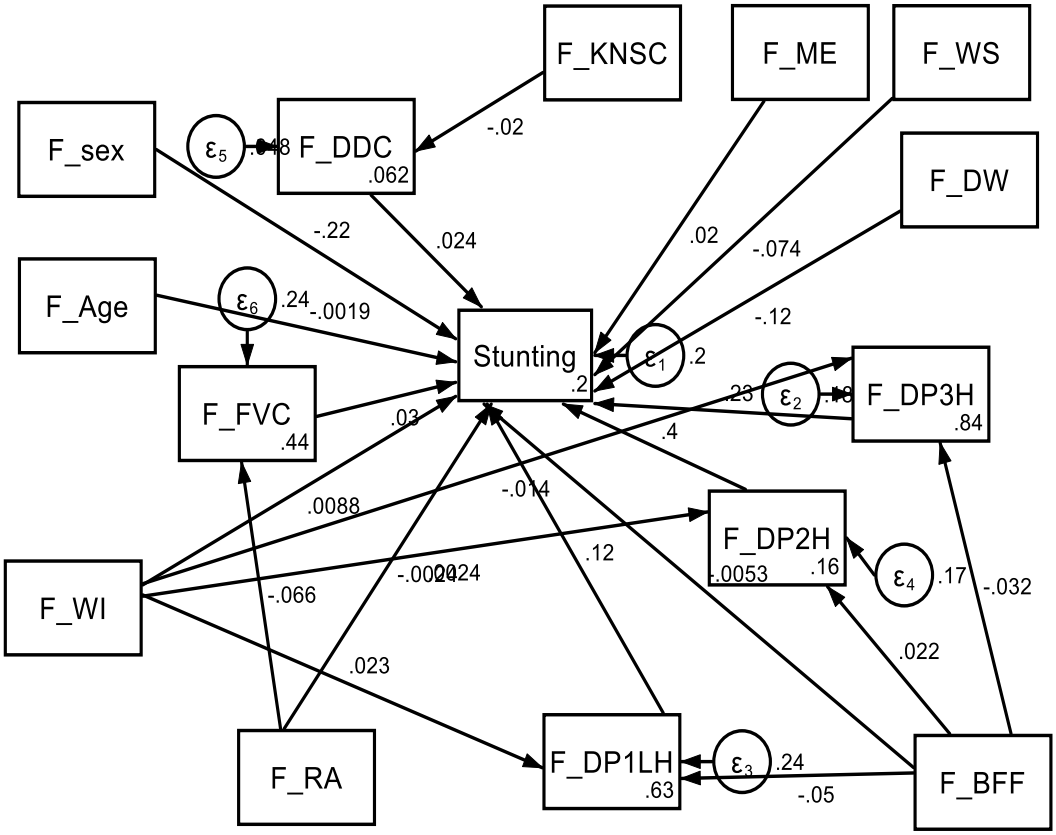
Table 7. Cross tabulation of socio-demographic characteristics of Adolescents and their families, with adolescents' nutritional status, North West Ethiopia.

Socio demographic	Variable Category	Nutritional status		Chi-Square	p-value
		Stunting	Normal		
Age of adolescent	From 10-13 Years	18 (4.10%)	62(14.20%)	5.952	0.051
	From 14-17 years	111(25.50%)	192(44.00%)		
	From 18-19 years	16(3.70%)	37(8.50%)		
Sex	Male	87(20.00%)	107(24.50%)	21.146	0.0001
	Female	58(13.30%)	184(42.20%)		
Residence	Urban	23(5.30%)	53(12.20%)	0.542	0.32
	Rural	122(28.00%)	238(54.60%)		
Adolescent education level	Enrolled	129(29.60%)	252(57.80%)	0.483	0.295
	Not Enrolled	16(3.70%)	39(8.90%)		
Family size	Below 3 family size	27(6.20%)	66(15.10%)	1.705	0.426
	4-6 family size	71(16.30%)	146(33.50%)		
	Above 7 family size	47(10.80%)	79(18.10%)		
Adolescents mother educational level	No formal education	75(17.20%)	143(32.80%)	0.342	0.843
	Can read and write	51(11.70%)	105(24.10%)		
	Elementary and above	19(4.40%)	43(9.90%)		
Adolescents family occupation	Farming	129(29.60%)	248(56.90%)	1.271	0.53
	Government workers	6(1.40%)	14(3.20%)		
	Merchants	10(2.30%)	29(6.70%)		
Wealth index	Low score	55(12.60%)	113(25.90%)	0.093	0.955
	Medium score	27(6.20%)	56(12.80%)		
	High score	63(14.40%)	122(28.00%)		

3.2. Causal analysis of determinant of Adolescents Stunting

The first GSEM model was fitted based on the hypothesized model to run causal analysis to identified determinants of stunting. In the direct fitting GSEM model, adolescents who had lower traditional and mixed dietary pattern consumption habits had a direct positive effect on stunting with adjusted β=0.012(0.027, 0 .22) and p-value 0.01, adjusted β=0.40, 95 CL (0.15, 0.62) with p-value 0.002 respectively. Break-fast eating frequency had a negative mediation effect on reduction of stunting via lower traditional, and higher consumption habit of animal sources with traditional alcoholic drinking habits with adjusted β=-0.05, 95% CL:(-0.07, -0.03), and β= -0.03, 95% CL(-0.05, -0.013) respectively. In addition break-fast eating frequency had a positive mediated effect on stunting via lower consumption of mixed dietary habits with adjusted β=0.02, 95% CL (0.004, 0.04).

From the adolescents inherent variables; adolescents who were female had negative effect on stunting with adjusted β=-0.22, 95 CL (-0.31, -0.13) and p-value of 0.0001. In addition, from heath service related factors adolescents who were de-wormed had direct negative effect on stunting with adjusted β=-0.12, 95% CL(-0.20, -0.03) and p-value of 0.008 (table 8).



F-Letter represent factor, F_Sex: Sex of adolescent, F_age: Age of Adolescent, F_WI: Wealth index, F_DW: Deworming, F_ME: Having media exposure, F_KNSC: Knowledge of Nutrition, F_RA: Irrigation land access, F_WS: Wearing Shoes, F_FVC: fruit and vegetable cultivation, F_DP1LH: Traditional dietary pattern, DP2H: Mixed dietary pattern, F_DP3H: Animal sources with traditional alcoholic drinking dietary pattern, F_ANSC: Animal source food consumption, B_BFF: Break Fast eating frequency, F_DDC: Dietary diversity

Figure 9. Fitted model for causal analysis determinant of stunting among adolescents in the context of Agrarian Community of North West Ethiopia, 2021.

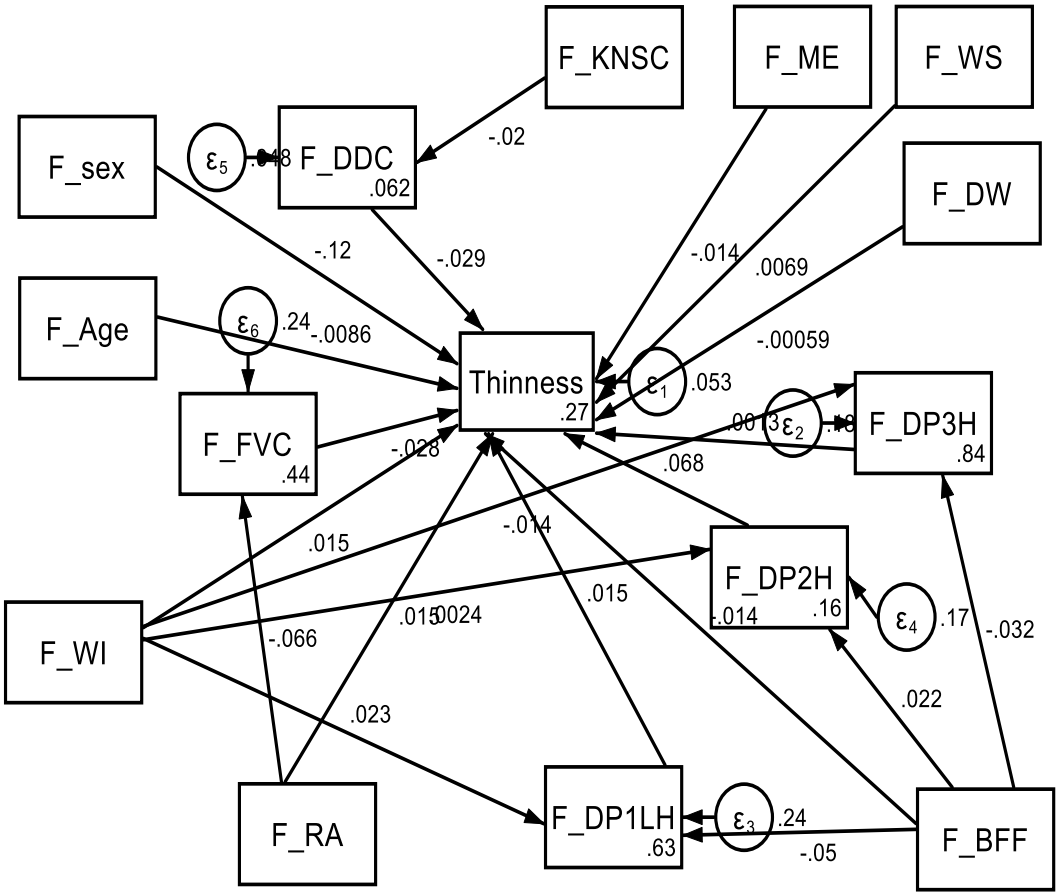
Table 8. Direct and mediating effects of factors affecting stunting among adolescents in the context of Agrarian Community, North West Ethiopia, 2021.

	Stunting	β-Coefficient	P-Value	[95% conf. interval]	
Direct effect	F_DP3H	0.231307	0.057	-0.00706	0.46967
	F_DP1LH	**0.124488**	**0.013**	**0.026255**	**0.222722**
	F_DP2H	**0.400238**	**0.002**	**0.147892**	**0.652585**
	F_FVC	0.030147	0.498	-0.05697	0.117267
	F_DDC	0.024342	0.809	-0.17251	0.221198
	F_Age	-0.00194	0.882	-0.02767	0.023784
	F_sex	-0.21715	0.0001	-0.30667	-0.12763
	F_WI	0.008797	0.718	-0.03903	0.056625
	F_RA	-0.00238	0.958	-0.09066	0.085894
	F_DW	**-0.11811**	**0.008**	**-0.20496**	**-0.03125**
	F_ME	0.020047	0.66	-0.06932	0.109419
	F_WS	-0.07366	0.22	-0.19138	0.044062
	F_BFF	-0.00532	0.61	-0.02576	0.015132
Mediated effect	**F_DP3H**				
	F_WI	-0.01439	0.53	-0.05929	0.030517
	F_BFF	**-0.03174**	**0.001**	**-0.05038**	**-0.01311**
	F_DP1LH				
	F_WI	0.022773	0.38	-0.0281	0.073646
	F_BFF	**-0.05013**	**0.0001**	**-0.07124**	**-0.02902**
	F_DP2H				
	F_WI	0.002384	0.913	-0.04061	0.045376
	F_BFF	0.021931	0.016	0.004089	0.039774

3.3. Causal analysis of determinants of adolescents thinness

The first GSEM model was fitted based on the Hypothesized model to identified determinants of thinness. Then, based on the model assumptions, a test of a fitted model for causal analysis of thinness was constructed in steps and the final best fitted model was run to measure the direct, indirect (mediating effect) and total effect of the variables separately (figure 9).

Adolescents' lower break-fast eating frequency had a direct negative effect on reduction of thinness with adjusted β=-0.02, 95% CL (-0.025,-0.0039) and with a P-value of 0.001. In addition, adolescents' break-fast consumption frequency had a negative mediating effect on thinness via lower consumption habits of traditional dietary pattern, with adjusted β= -0.05, 95 CL (-0.07, -0.029), and with higher animal source food with traditional alcoholic drinking pattern with adjusted β=-0.03, 95 CL (-0.05, -0.013). But it had a positive mediation effect on thinness via a lower mixed dietary pattern with an adjusted β=0.02, 95% CL (0.004, 0.039). Adolescents who were female had a direct protective effect on thinness with an adjusted β= -0.12, 95% CL (-0.16, -0.07) and with a p-value of 0.001 (table 9).



F-Letter represent factor, F_Sex: Sex of adolescent, F_Age: Age of Adolescent, F_WI: Wealth index, F_DW: De-worming, F_ME: Having media exposure, F_KNSC: Knowledge of Nutrition, F_RA: Irrigation land access, F_WS: Wearing Shoes, F_FVC: fruit and vegetable cultivation, F_DP1LH: Traditional dietary pattern, DP2H: Mixed dietary pattern, F_DP3H: Animal sources with traditional alcoholic drinking dietary pattern, F_ANSC: Animal source food consumption, B_BFF: Break Fast eating frequency, F_DDC: Dietary diversity

Figure 10. Fitted model for causal analysis of thinness among adolescents in the context of Agrarian Community of North West Ethiopia, 2021.

Table 9. Direct and mediating effects factors affecting thinness among adolescents in the context of Agrarian Community, North West Ethiopia, 2021.

	Thinness	β-Coefficient	P-value	[95% conf. interval]	
Direct effect	F_DP3H	0.001266	0.984	-0.12103	0.123558
	F_DP1LH	0.0146	0.57	-0.0358	0.064999
	F_DP2H	0.067886	0.304	-0.06158	0.197353
	F_Age	-0.00863	0.2	-0.02183	0.004569
	F_Sex	**-0.12004**	**0.001**	**-0.16596**	**-0.07411**
	F_WI	0.015264	0.223	-0.00927	0.039803
	F_RA	0.015197	0.511	-0.03009	0.060487
	F_DW	-0.00059	0.979	-0.04515	0.043975
	F_ME	-0.01377	0.556	-0.05962	0.032086
	F_WS	0.006913	0.822	-0.05348	0.067311
	F_BFF	**-0.01447**	**0.007**	**-0.02496**	**-0.00398**
Mediated effect	F_DP3H				
	F_WI	-0.01439	0.53	-0.05929	0.030517
	F_BFF	**-0.03174**	**0.001**	**-0.05038**	**-0.01311**
	F_DP1LH				
	F_WI	0.022773	0.38	-0.0281	0.073646
	F_BFF	**-0.05013**	**0.0001**	**-0.07124**	**-0.02902**
	F_DP2H				
	F_WI	0.002384	0.913	-0.04061	0.045376
	F_BFF	**0.021931**	**0.016**	**0.004089**	**0.039774**
	F_FVC				
	F_RA	-0.06552	0.169	-0.15878	0.027742
	F_DDC				
	F_KNSC	-0.01968	0.356	-0.06147	0.022122

4. Discussion

Adolescent dietary habits, and breakfast eating frequency were the key directed and mediated determinant factors for stunting and thinness in the study setting. Adolescents who had lower traditional and mixed dietary consumption habit had the most substantial causal effect on stunting with a path coefficient of adjusted β =0.13, and 0.41 respectively. This finding is congruent with other previous studies as frequently consumption of diversified food items and breakfast skipping were related to nutritional status (Amadi & China, 2024); which reveals that the lower consumption habit of daily dietary habits did not satisfy the required daily requirement of nutrients for adolescents' physical growth and development. This inadequate intake of macro and micro nutrients, poor quantity and quality of vitamins, minerals and protein directly causes adolescents to be stunted and thinner (Borges et al., 2018). This finding was supported by other related studies that indicate adolescents fail to meet dietary recommendations for overall nutritional status and for specific nutrient intakes (Hormenu, 2022).

Adolescents who had lower breakfast consumption habits had direct and mediated effects on adolescents' stunting and thinness. In this study, adolescents who were frequently eat a breakfast had a mediated effect in reduction of stunting with adjusted β= -0.049, and β=0.0217 in adolescents who had lower traditional and mixed dietary pattern consumption habits. In the same way, this type of dietary habit positively influences reduction of stunting with adjusted β= -0.032 among adolescents who had higher consumption of animal sources with traditional alcoholic drinking habits. As adolescents eat break-fast daily, they had a better overall dietary pattern on a nutrient and food group level than consumers of a low-quality breakfast (Abdulai et al., 2023).

Further, this finding was supported by various studies which reveal the association between the frequency of dietary intake and the nutritional status of adolescents. In the same way, adolescents who had a meal frequency of two or fewer per day had increased odds of stunting than those reporting a higher frequency per day (Ashebir Kebede & Yimer Ayele, 2021; Tamrat et al., 2020).

This is due to the effect of frequent breakfast eating habits improving daily macro and micro-nutrients and preventing adolescents from stunting and thinness. Adolescents who ate break-fast

frequency have superior nutritional profiles than their breakfast skipping peers (Amadi & China, 2024; Saraswati & Hidayanti, 2024).

Adolescents who were dewormed for intestinal parasite had direct negative effect on stunting with adjusted β=-0.12. This finding confirmed that adolescents who had access to health and nutrition services such as deworming had positive effect on minimizing intestinal parasite infection which cause under nutrition. If the adolescent were no dewormed the parasite directly sucks nutrients from the gut and causes malnutrition, and poor growth (Jardim-Botelho et al., 2008; Wordofa et al., 2022). Parasite infections affect linear growth and nutritional status through several mechanisms including decline in food intake (Chakrabarti et al., 2024).

Being female adolescents had a negatively influencing effect on stunting and thinness with adjusted β= -0.219, and β= -0.12 respectively as compared to males. This finding was supported by related studies conducted. Similar findings were observed in different parts of Ethiopia and Nigeria (Ashebir Kebede & Yimer Ayele, 2021; Y. A. Melaku et al., 2015; Mesfin, Berhane, & Worku, 2015; Senbanjo, Oshikoya, Odusanya, & Njokanma, 2011). The reason why female adolescents are less likely to be stunted and thin as compared to males might be related to biological, hormonal, behavioral, and sociocultural mechanisms.

5. Strengths and limitations of the study

This is the first study in Ethiopia, particularly in a study context that assesses causal analysis of under nutrition with advanced statistical methodology. This study focused on adolescents who are an understudied and overlooked population group in nutrition intervention in developing countries. As a limitation of this study, the inability to identify all food items that are used to prepare the local traditional diet as adolescents were not involved in food cooking at home might lead to under-reporting food items like spices.

6. Conclusion

Dietary pattern and breakfast eating frequency are key determinates, and have direct and mediating effect on adolescent stunting and thinness. In addition, deworming had a direct effect on stunting, whereas being a female adolescent had a negative effect on both stunting and thinness. Public health interventions should be implemented to reduce stunting and thinness by improving dietary and breakfast consumption habits and strengthening the national deworming programs in study areas and similar settings.

7. Recommendation

For Health and Education sectors

- Public health interventions should be implemented to reduce stunting and thinness
- By Improving adolescents and entire family breakfast consumption habits, and consumption of locally available healthy dietary pattern.
- Strengthening deworming programs in study area.

For researcher

- Further study will be conducted using biomarker nutritional assessment methods to determine level of micronutrients and its relation with identified dietary pattern.

Abbreviation

EEA-Exploratory factor analysis
FFQ-Food frequency questionnaire
GSEM-General structural equation modeling
IDA- iron deficiency anemia
IDD-iodine deficiency disorders
MNDs-Micronutrient deficiencies
VAD-vitamin-A deficiency

Acknowledgments

We would like to thank for study participants for their substantial contributions to participate in the study. In addition, we would like to thank our data collectors and field facilitators for their

support to collect the data. Lastly we give appreciation and heartfelt thanks for my data collectors, study participants, and Keble administrators for their holistic support.

Author Contributions

Eskezyiaw Agedew-Conceived and designed the study, did data analysis, drafted and prepare a manuscript. **Zeweeter Abebe** and **Abebe Ayelign**-Contributed to designing the methodology and editing the manuscript.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflict of interests

The authors declare that they have no conflict of interest related to this article.

Founding information

This research was founded by Addis Ababa University with Grant Number of CNCSDO/188/14/2021.

Chapter 5. General Conclusion and Recommendation

Dietary habit of adolescents in the study area was predominantly plant-based with high intake of cereals and low consumption of animal source foods fruits and vegetables which showed low dietary diversity practice. As a result, adolescent's had suboptimal micro-nutrient and protein intake that are crucial to fulfil the nutrient demand for their fast growth. Multiple layers of barriers that hinder the diversified dietary habit of the adolescents were identified in the study setting and the barriers range from individual's level to multi-sectorial level.

The emerging conceptual framework indicated, diversified dietary feeding habit of adolescents was influenced by socio, cultural and ecological factors which needs to consider these factors into accounts. Poor feeding habit among adolescents and their entire family member was shaped by socio-cultural and ecological factors.

There was accessibility of oil-seeds like sunflower seeds, sesame seeds and Niger seeds in the study area, but almost this food items were not consumed by adolescents and the entire family members. Even though oilseeds are very good sources of vitamins with anti-oxidative properties such as vitamin E and beta-carotene, healthy fats (unsaturated fatty acids), fiber, vitamins and minerals. In addition, teenagers and the family as a whole did not have a habit of consuming seafood because of limited access. This may results in a deficiency of antioxidants and important healthy fatty acids like omega-3.

The burden of stunting was significantly higher among adolescents who had lower consumption of traditional, and mixed dietary patterns and higher consumption of animal sources with alcoholic drinks.

Even-though animal source foods are considered as healthy; due to the effect of the alcohol intake, following its consumption in the study setting, it leads to poor nutrient metabolism and absorption. This habit exposed to deficiency of micro- and macronutrients that might lead to under nutrition; and this could be an explanation for the observed high stunting burden in this food surplus area.

The result of the causal analysis to identified factors for determining under-nutrition indicated traditional alcoholic drinking habit, lower consumption of mixed and traditional dietary pattern and breakfast eating frequency were key determinates, and had direct and mediating effect on adolescent stunting and thinness.

- To improve adolescents dietary practice and nutritional status

✓ The intervention –should take into account socio-cultural-ecological factors ranges individuals to community level (socio –economic and behavioral based).

✓ Promotion of local accessibly and available healthy diet; it helps to intervene all form of mal-nutrition (dietary approach).

✓ Reducing traditional alcoholic drinking-which is culturally deep rooted habit in all life cycle of individuals.

✓ Promoting the missed and underutilized oil-seeds in adolescents and entire family diet (Focusing to our food items what we have).

✓ Improving agricultural practice–from cultivation of creel based production to mixed farming, home gardening and agroforestry plantation instead of eucalyptus tree plantation (sustainable approach).

✓ Developing legal strategies to minimize massive plantation of eucalyptus tree

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Annex I: English Version Participant Information Sheet and Informed Consent form

My name is _____. I am working as a data collector for the study being conducted in your village by Eskezyiaw Agedew who is a PhD student at Addis Ababa University. I kindly request you to be part of the study participants in this study.

The study title: to explore barriers for diversified dietary consumption, determining of dietary patterns, and causal analysis of under nutrition among adolescents in Northwest Ethiopia

Purpose of the study: The findings of this study can be important to explore barriers for diversified dietary consumption, to determine dietary patterns and its effect on nutrition out-come and to identify causal analysis of under nutrition among adolescents.

Procedure and duration: I will be interviewing and in addition I take measurement of your height and weight using a questionnaire, height and weight scale to take pertinent data that is helpful for the study. The interview and measurement will take about 40 minutes. So, I kindly request you to spare me this time for the interview and measurement.

Risk and benefits: The risk of participating in this study is very minimal, only taking few minutes from your time. There would not be any direct payment for participating in this study. But the findings of this study may reveal important information for the policy makers and health officials to fill the gaps identified through this study.

Confidentiality: The information you provide for me will be confidential. There will be no information that will identify you in particular. The findings of the study will be general for the study area and will not reflect anything particular of individual persons. The questionnaire will be coded to exclude showing names. No reference will be made in oral or written reports that could link participants to the study.

Rights: Participation for this study is fully voluntary. You have the right to declare to participate or not in the study. If you decide to participate, you have the right to withdraw from the study at any time and this will not label you for any loss of benefits which you otherwise are entitled. You do not have to answer any question that you do not want to answer.

Contact address: Contact address: If you have any questions about the study, the procedure or anything else related to the study, please contact through the following address:

Investigators: Eskezyiaw Agedew, Mob:-0934624484

Declaration of informed voluntary consent: I have read/was read to me the participant information sheet. I have clearly understood the purpose of the research, the procedures, the risks and benefits, issues of confidentiality, the rights of participating and contact address for any queries. I have been given the opportunity to ask questions for things that may have been unclear. I was informed that I have the right to withdraw from the study at any time or not to answer any question that I do not want. Therefore, I declare my voluntary consent to participate in this study with my initials (signature).

Name of participant or _____ Signature_____Date _____

Name of data collector: _____Signature_____Date_____

Annex II. Ethical clearance

COLLEGE OF NATURAL & COMPUTATIONAL SCIENCES

Addis Ababa University

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OFFICE OF THE DEAN

Ref. No.:- CNCSDO/188/14/2021

Date:- October 25, 2021

To Whom It May Concern

The College of Natural & Computational Sciences Institutional Review Board Committee in its meeting held on **28/09/21 Minute No. IRB/04/14/2021** has examined the project proposal entitled **"DIETARY PATTERNS AND ITS EFFECT ON NUTRITIONAL STATUS AMONG ADOLESCENTS IN AGRARIAN COMMUNITY, NORTH WEST ETHIOPIA"** by **Eskezyiaw Agidew from the Addis Ababa University.**

The proposal is **Conditionally Approved** for implementation.

With regards.

Addisalem Abathun (PhD)
Dean, College of Natural & Computational Sciences
Addis Ababa University

Addis Ababa University College of Natural Sciences Dean's Office

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Please Quote our reference number in you correspondence

"Examine all things; hold fast that which is good"

Annex III: English version tools

Date of interview(date/month/year):_____		
Name of the study site: _____		
Code number of the questionnaire: _____		
Interviewer's name & signature:	Name:_____	Signature_____
Supervisor's name & signature:	Name :_____	Signature_____

Part I. Socio, demographic, and economic variables mother

S.No	Category of questioner	Response	Skip
101	Age of adolescents	----------year	
102	Address adolescents	1. Rural 2. Urban	
103	Agro ecology of adolescents resides	1. Low land 2. Mid land 3. High land	
104	Grade	----------Grade	
105	Educational level of adolescents mother	1.Illiterate 2.Can read and write 3.Primaryschool 4.Secondary school 5. technical school 6.College graduate or above	
106	Educational level of adolescents father	1.Illiterate 2.Can read and write 3.Primaryschool 4.Secondary school 5. technical school 6.College graduate or above	
107	Occupational status adolescents mother	1. Farmer 2. Government worker 3. House wife 4. Merchant 5. Others specify----------	
108	Occupational status adolescents fathers	1. Farmer 2. Government worker 3. Merchant 4. Others specify----------	
109	Religion of respondent	1.Orthodox 2.Protastant 3.Muslims 4. Others specify----------	
110	Marital status of adolescents	1.Single 2.Married	

Questions to assess the current family wealth index.		
Asset type		**Response option**
Domestic animals		
Ox	Yes (1)	No (0)
Cow	Yes (1)	No (0)
Calf	Yes (1)	No (0)
Sheep	Yes (1)	No (0)
Goat	Yes (1)	No (0)
Horse	Yes (1)	No (0)
Donkey	Yes (1)	No (0)
Cock and Hen	Yes (1)	No (0)
Durable assets		
Television	Yes (1)	No (0)
Radio	Yes (1)	No (0)
Electricity	Yes (1)	No (0)
Solar light	Yes (1)	No (0)
Refrigerator	Yes (1)	No (0)
Computer	Yes (1)	No (0)
Mobile phone	Yes (1)	No (0)
Car/Bajaj	Yes (1)	No (0)
Motorcycle	Yes (1)	No (0)
Cycle	Yes (1)	No (0)
Cart	Yes (1)	No (0)
Money deposited/ bank account	Yes (1)	No (0)
Ownership of owned living house	Yes (1)	No (0)
Ownership of agricultural land	Yes (1)	No (0)
Productive assets		
Modern beehive	Yes (1)	No (0)
Traditional beehive	Yes (1)	No (0)
Housing characteristics		
Indoor plumping/ pipe water	Yes (1)	No (0)
Cemented floor house	Yes (1)	No (0)
Other household materials		
Bed	Yes (1)	No (0)
Table	Yes (1)	No (0)
Chair	Yes (1)	No (0)
Stove	Yes (1)	No (0)

S.No	**Part II. Adolescents knowledge on nutrition**		
	Questioner	**Option**	**Skip**
201	Which foods contain more carbohydrates?	1. Meat 2. Butter 3. Bread **4.** Chees 5. I do not know	

202	Which foods are less rich in fat?	1. Enjera 2. Food oil 3. Legumes 4. Fruit and vegetables 5. I do not know	
203	Which foods are richer in protein?	1. Legumes 2. Bread 3. Pasta 4. Butter 5. I do not know	
204	What are the functions of vitamins and minerals?	1. For body building 2. To provide energy 3. For disease prevention 4. I do not know	
205	Which foods items contain dietary fiber?	1. Bread made from whole creels 2. Pasta 3. White bread 4. Meat 5. I do not know	
206	According to you, what is 'a balanced diet'?	1. A diet rich in protein 2. a diet poor in fat 3. a diet without carbohydrates 4. a diet containing all nutrients in proper quantities 5. I do not know	
207	Causes of malnutrition	1. Lack of a balanced diet 2. Infection 3. I do not know	
208	List the cause of anemia	1. Lack of balanced diet 2. Hook worm infection 3. Excess menstruation bleeding 4. I do not know	
209	Do you know the symptom of anemia	1. Week-ness 2. Shortness of breath 3. Difficulty to climb up to mountain stars 4. I do not know 5. Others ----------	
210	How anemia is treat	1. Taking food that contains iron 2. Treating illness like malaria and parasites 3. Iron tablet supplementation 4. I do not know 5. Others----------	
	Part III. Individuals, family level factors and media exposure		
301	Do you have the ability to choose or modify any food by yourself to eat?	1. Yes 2. No	
302	If your answer is No, what is the reason?	1. Lack of variety food in our house 2. My food choice is based on my family or mother order 3. I have no right to decides and choose my diet	

		4. Others----------	
303	Do you have access to nutrition advice aimed at improving your dietary habits?	1. Yes 2. No	
304	Do you have family influence on choosing food at home?	1. Yes 2. No	
305	Do you have peer influence to eat a variety of food items at home?	1. Yes 2. No	
306	Do you have access to radio and television in your house?	1. Yes 2. No	
307	Do you get nutrition education about diet in your school?	1. Yes 2. No	
308	If yes, by which mechanism you get nutrition education	1. In class by our teachers 2. In our school-by--by-school multimedia 3. In school by health professional 4. Others----------	
	IV. Adolescents Food Habits		
401	How many days you eat breakfast in this week?	1. ----------days	
402	List food you eat during breakfast?	----------	
403	Which beverage do you drink at breakfast on a day?	1. Tea 2. Water 3. Milk 4. Coffee 5. Alcohol 6. Others ----------	
404	List food you eat at lunch	----------	
405	Which beverage do you drink at lunch?	1. Tea 2. Water 3. Milk 4. Coffee 5. Alcohol 6. Others ----------	
406	List types of food you eat at time of snacks yester day	----------	
406	List food you eat at dinner	----------	
407	Which beverage do you drink at lunch?	1. Tea 2. Water 3. Milk 4. Coffee 5. Alcohol 6. Others ----------	

711 408	Do you usually eat breakfast, lunch and dinner every day	1. Yes 2. No	
811 409	If you are not usually eat breakfast, lunch, and dinner every day, what is the reason?	1. Lack of prepared food 2. Lack of time 3. Lack of family support 4. Lack of food access at home 5. Due to fasting time 6. Others ----------	
911 410	What is your diet composition?	1. is different every day 2. is different only sometimes during a week 3. is different only during the weekend days 4. is very monotonous 5. others ----------	
?11 413	How frequently your eggs eating habits	1. always 2. often 3. sometimes 4. never	
.11 414	How frequently your egg eating habits drink milk or you eat at least one cup of yogurt?	1. Always 2. Often 3. Sometimes 4. Never	
5.	Part –VI- Access to resources and variety food item		
501	Do your family had access to irrigation land	1. Yes 2. No	
502	If yes, how much in hectare or timed (local measurement)	----------	
503	Does your family involve in production of fruits like	1. Banana 2. Papaya 3. Mango 4. Avocado 5. Oranges 6. Lime 7. Apple 8. Others----------	
504	Does your family grow vegetable like	1. Cabbage 2. Carrot 3. Kosta 4. Selata 5. Key ser 6. Chilly 7. Others----------	
505	Do your family rare a time animal like	1. Hen 2. Got 3. Sheep 4. Ox and cow 5. Others-----	
506	What do you do the egg you get from a hen	1. We sell It 2. We eat It 3. Other ----------	

507	What do you do with the milk you get from your family cow	1. We drink eat 2. We eat it as form of butter and yogurt 3. We sell It 4. Others ----------	
508	Sources of water for drinking	1. Pipe water 2. Whole water 3. Protected Spring water 4. Un protected spring water 5. Directly from river	
509	Does your school had water access	1. Yes 2. No	
510	If yes, what is the sources of water	1. Pipe water 2. Whole water 3. Protected Spring water 4. Un protected spring water 5. Directly from river	
511	Do you wear shoes ever day	1. Yes 2. No	
512	If not wear what is the reason	1. Lack of shoes 2. I fear to wear shoes 3. Lack of to buy it 4. Others ----------	
513	Do you have malaria illness in last 1 year	1. Yes 2. No	
514	If yes, how many times you sick during 1 year	----------times	
515	Do you frequent abdominal pain	1. Yes 2. No	
516	If yes do take medication	1. Yes 2. No	
517	Do you take deworming drugs at school	1. Yes 2. No	
518	If yes, how many times you take	----------times	
519	When you take the deworming drugs	----------year/ ----------months ago	
520	Do you get malaria infection in last 2 weeks	1. Yes 2. No	
521	If yes what do you do for your illness	1. I take drug from health facilities 2. I do not take any medication	
522	For female do you have excess menstruation	1. Yes 2. No	
523	If yes, how many sanitary pad you consume	----------pads	
524	How many days your menstruation stay	----------days	
525	What type of pad you use during menstruation	1. Factory made 2. I prepare from clothes at home 3. Others----------	
526	Do you have difficulty to get menstruation sanitary pad	1. Yes 2. No	

527	What is the challenges you face to get sanitary pad	1. Lack pocket money to buy 2. Lack access to get commercial sanitary pad 3. Others ----------	

	Section-VI. Food frequency Questioner	**Days of 24 hours recall**			
S.No	Food items in local area	Mon-day	Wen-day	Sat-days	Do not eat
601	*Injera, Injera with Wot (*Shiro stew added salt, **spices**, and oils)				
602	Legumes (Peas, Beans) consumed in form of whole grain as Bokelit), lentils consumed as shiro stew				
603	Nuts and oilseeds (Flax seed, groundnuts, sunflower seeds, sesame seeds and Niger seeds)				
604	Milk and milk products (milk, yoghurt and cheese)				
605	Whole grain consumption (Roasted wheat, barley, maize consumed as *kollo*, high-fiber sliced bread, mixed-grain)				
606	White bread and sweet potato				
607	Tea, coffee				
608	Pasta , mekoreni				
609	Tubers (Potato and sweet potato)				
610	Alcohol –*modern beer* Traditional-*Tella* (traditional home-fermented alcoholic beverage) *areki or katicala* (traditional distilled alcoholic beverage)				
611	Poultry (Egg, poultry meat)				
612	Animal meat (raw and cooked meat) beef, lamb				
613	Fruit (orange, pumpkin, Banana, orange, pumpkin…).				
614	Vegetables (cabbage, green pepper, lettuce, carrot, tomato…).				
615	See-food (fish)				

Annex. V. Amharic version tool

ክፍልአንድ -ማህበራዊእናኢኮኖሚያዊመረጃዎች			
ተ.ቁ	መጠይቅ	አማራጭመልስ	ማሳለፊያ
101	እድሜ	----------አመት	
102	የሚኖሩበትአድራሻ	3. ገጠር 4. ከተማ	
103	የሚኖሩበትየአየርንብረትአካባቢ	4. ቆላ 5. ወይናደጋ 6. ደጋ	
104	ስንተኛክፍልነህ/ሽ	1. ----------ክፍል 2. አልማርም	
105	የእናትህ/ሽየትምህርትደረጃ	1. ምንምያልተማረ 2. ማንበብናመጻፍብቻየሚችል 3. የመጀመሪያደረጃ 4. ሁለተኛደረጃ 5. ኮሌጅናዩኒቨርሲቲ	
106	የአባትህ/ሽየትምህርትደረጃ	1. ምንምያልተማረ 2. ማንበብናመጻፍብቻየሚችል 3. የመጀመሪያደረጃ 4. ሁለተኛደረጃ 5. ኮሌጅናዩኒቨርሲቲ	
107	የቤተሰብህ/ሽስራዘርፍ	1. ግብርና 2. መንግስትሰራተኛ 3. የቤትእመቤት 4. ነጋዴ 5. ሌላአማራጭ----------	
108	የምትከተለው/ይውህይማኖት	1. ኦርቶዶክስ 2. ፕሮቴስታንት 3. ሞስሊም 4. ሌላአማራጭ---------- ----------	
109	የጋብቻሁኔታህ/ሽ	1. አላጋባሁም 2. አግብቻለሁ 3. ሌላ አማራጭ----------	
110	የቤተሰብህ/ሽ ብዛት	----------	

የቤተሰብየሀብትመግለጫ		
ያላቸውሀብት	አማራጭመልስ	
በሬ	አለን(1)	የለንም (0)
ላም	አለን(1)	የለንም (0)
ጥጃ	አለን(1)	የለንም (0)
በግ	አለን(1)	የለንም (0)
ፍየል	አለን(1)	የለንም (0)
ፈረስ	አለን(1)	የለንም (0)
አህያ	አለን(1)	የለንም (0)
ዶሮ	አለን(1)	የለንም (0)
ቴሌቭዥን	አለን(1)	የለንም (0)
ራዲዮ	አለን(1)	የለንም (0)
የአሌክትሪክመብራት	አለን(1)	የለንም (0)
ሶላርመብራት	አለን(1)	የለንም (0)
ሞባይል	አለን(1)	የለንም (0)
መኪናወይምባጃጅ	አለን(1)	የለንም (0)
ሞተርሳይክል	አለን(1)	የለንም (0)
ሳይክል	አለን(1)	የለንም (0)
ጋሪ	አለን(1)	የለንም (0)
ባንክተቀማጭብርቤተሰብህ/ሽአለው	አለን(1)	የለንም (0)
ከቆርቆሮየተሰራቤትለቤተሰቦችህአላችሁወይ	አለን(1)	የለንም (0)
ቤተሰቦችህ/ሽየእርሻቦታአላቸውወይ	አለን(1)	የለንም (0)
ዘመናዊየንብቀፎ	አለን(1)	የለንም (0)
ባህላዊየንብቀፎ	አለን(1)	የለንም (0)
ግቢውስጥየቧንቧውሃአላችሁ	አለን(1)	የለንም (0)
የቤታችሁወለሉከሲሚንቶየተሰራነውወይ	አለን(1)	የለንም (0)
የምኝታአልጋ	አለን(1)	የለንም (0)
የመመገቢያጠረጴዛ	አለን(1)	የለንም (0)
የመቀመጫወንበር	አለን(1)	የለንም (0)
የምግብማብሰያእስቶቭ	አለን(1)	የለንም (0)

ተ.ቁ.	ክፍልሁለት. ስለስነ-ምግብአፍላልጆችያላቸውእውቀት		
	መጠይቅ	**አማራጭመልስ**	
201	ከተዘረዘሩትምግቦችውስጥየትኛውሀይልሰጭምግብነው·	1. ስጋ 2. ቅቤ 3. ዳቦ **4.** አትክልት 5. አላውቅም	
202	የስብነትናዘይትነትይዘትያለውምግብየቱነው·	1. እንጀራ 2. ቅቤ 3. ባቄላ 4. አትክልትናፍራፍሬ 5. አላውቅም	
203	በሰውነትገንቢነቱየትኛውምግብይታወቃል	1. ባቄላ 2. ፓስታ 3. ቅቤ 4. አላውቅም	
104	ከሚከተሉትየምግብዝርዝሮችውስጥበሽታተከላካይንጥረ ምግቦችንየያዙየትኞቹናቸው·	1. ቃሪያ 2. እንጀራ 3. አረንጓዴአትክልትናፍራፍሬ 4.አላውቅም	
205	ሻይ,ታሚንናሜኔራሎችለምንለምንይጠቅማሉ	1. ሰውነትንለመገንባት 2. ለሀይልሰጭነት 3. በሽታለመከላከል 4. አላውቅም	
206	አሰርነትይዘትያለውየምግብዝርዝርየቱነው·	1. ሙሉበሙሉአሰራቸውካልተፈተኩጥራጥሬዎችየተሰራዳ ቦ 2. በማሽንየተመረተነጭዳቦ 3. ስጋ 4. አላውቅም	
207	የተመጣጠነምግብሲባልምንማለትነው·	1. በገንቢምግብየበለጸገ 2. ምንምስብናቅባትየሌለው 3. ምንምሀይልሰጭያልሆነ 4. ሁሉንምየምግብይዘቶችንእናንጥረነገሮችንየያዘ 5. አላውቅም	
208	የምግብእጥረትበሽታበምንምክንያትይከሰታል	1. ያልተመጣጠነምግብበመመገብ 2. በተላላፊበሽታበመታመም 3. አላውቅም	
209	ስለደምማነስበሽታታወቃለህ/ሽ	1. አዎ 2. አላውቅም	
210	አዎከሆነየደምማነስምልክቶችምንምንናቸው·	1. የድካምስሜት 2. የትንፋሽመቆራረጥ 3. አቀበትእናደረጃለመውጣትመቸገር 4. ሌላአማራጭመልስ---------- 5. አላውቅም	
211	በምንምክንያትነውየደምማነስየሚከሰተው·	1. ባልተመጣጠነምግብ 2. በጥገኛትላትልህመም 3. በከፍተኛየወርአበባደምመፍሰስ 4. በእግዚያብሔርቁጣ/በሰይጣንልክፈት 5. አላውቅም	

212	የደምማነስንእንዴትመከላከልይቻላል	1. የደምማነስንሊያስተካክሉየሚችሉምግቦችንመመገብ 2. ተላላፊበሽታዎችንእንደወባእናየአንጀትጥገኛትላትሎችን መታከም 3. የደምማነስእንክብሎችንመውሰድ 4. በፀበልበመጠጣትናበመጠመቅ 5. ሌላአማራጭመልስ---------- 6. አላውቅም	
	ክፍል 3. ግላዊ፣ቤተሰባዊእናመገናኛብዙሃንበአመጋገብሁኔታያላቸውንተፅዕኖመጠይቅ		
301	በቤትህ/ሽየምትፈልገ/ጊውንምግብለመመገብየመወሰንአቅ ምአለህ/ሽ	1. አዎ 2. የለም	
302	የለምከሆነምክንያትህ/ሽምንድንነው	1. የተለያዩምግቦችበቤታችንአለመኖሩ 2. የኔምግብምርጫበቤተሰቤላይየተመሰረተስለሆነ 3. የምፈልገውንምግብመርጦለመመገብመብትየለኝም 4. ሌላአማራጭመልስ----------	
303	ስለምትመገቢውምግብየስነ-ምግብምክርአግኝተሽታውቂያለሽ/ህ	1. አዎ 2. የለም	
304	ቤተሰብህ/ሽስለምትመገቢውምግብምርጫተፅኖይደረግብ ሀል/ሻልወይ	1. አዎ 2. የለም	
305	የቅርብጓደኛህ/ሽበምትመገቢውምግብላይየአቻ/ጓደኛተፅ እኖወይምግፊትያደርጉብሀል/ሻልወይ	1. አዎ 2. የለም	
306	በቤትህ/ሽራዲዮ/ቴሌቭዥንየማዳመጥእድሉአለህ/ሽ	1. አዎ 2. የለም	
307	በምትማርበትትምህርትቤትወይምሰፈርስለስነ-ምግብትምህርትተምረህ/ሽታውቃለህ/ሽወይ	1. አዎ 2. የለም	
308	አዋከሆነስለስነ-ምግብትምህርትየተማርኸው/ሸው	1. ክፍልውስጥበመምህራኖቻችን 2. በት/ትቤትመልቲሚዲያአማካኝነት 3. ቤትለቤትበጤናባለሙያዎች 4. ሌላአማራጭመልስ----------	
309	በዚህሳምንትውስጥስንትቀንጠዋትቁርስህን/ሽንበልተህል/ ሻል	1. ---------- ቀኖች	
310	ጠዋትቁርስሰዓትላይየበላኸውን/ሽንምግብዘርዝር /ሪ	---------- ---------- ---------- ----------	
311	ጠዋትቁርስሰዓትላይየጠጣኸውን/ሸውንመጠጥአይነትዘር ዝር/ሪ	1. ሻይ 2. ጠላ 3. ውሃ 4. ወተት 5. ቡና 6. ሌላአማራጭመልስ----------	
312	ትናንትምሳላይየበላኸውን/ሸውንምግብዘርዝሪ/ር	---------- ---------- ---------- ---------- ----------	
313	ምሳሰዓትላይየጠጣኸውን/ሸንመጠጥአይነትዘርዝር /ሪ	1. ሻይ 2. ጠላ 3. ውሃ	

		4. ወተት 5. ቡና 6. ሌላአማራጭመልስ----------	
314	ትናንትመከሰስላይየበላኸውን/ሽውንምግባአይነትዘርዝር /ሪ	1. ---------- 2. ምንምአልበላሁም	
315	ትናንትእራትሰዓትላይየበላኸውን/ሽውንምግብአይነትዘርዝር /ሪ	----------	
316	ሁልጊዜአዘውትረህ/ሽቁርስ፣ምሳእናእራትአዘውትረህ/ሽትመገባለህ/ሽወይ	1. አዎ 2. የለም	
317	ሁልጊዜአዘውትረህ/ሽቁርስ፣ምሳእናእራትየማትመገብ/ቢከሆነምክንትህ/ሽምንድንነው (ከአንድበላይመልስይቻላል)	1. የተዘጋጀምግብአለመኖር 2. ጾምስለምጾም 3. የመመገቢያጊዜእጥረት 4. የቤተሰብድጋፍአመኖር 5. ቤትውስጥየምግብእጥረትበመኖሩ 6. ሌላአማራጭመልስ----------	
318	የምትመገበውምግብይዘቱ	1. በየቀኑተመሳሳይምግቦችንእመገባለሁ 2. በየቀኑየተለያዩምግቦችንእመገባለሁ 3. ሌላአማራጭመልስ----------	
319	እንቁላልየምትመገበው/ቢው	1. ሁልጊዜ 2. አልፎአልፎ 3. በአመትበዓል (ለምሳሌለፋሲካናገና) 4. ምንምአልመጉበም	
320	ወትትእናየወተትተዋጾአችንየምትመገበው/ቢው	1. ሁልጊዜ 2. አልፎአልፎ 3. በአመትበዓል (ለምሳሌለፋሲካ) 4. ምንምአልመጉበም	
	ክፍል-አራትየተለያዩምግቦችስለማግኘት		
401	ቤተሰቦችህ/ሽ**በመስኖውህ**የሚለማመሬትአላቸውወይ	1. አዎ 2. የለም	
402	አወከሆነምንያህል**ሄክታር/ጥማድ**ይሆናል	----------ሄክታር----------ጥማድ	
403	ቤተሰቦችህ/ሽከተዘረዘሩት**ፍራፍሬዎች**የትኞችንያመርታሉ (ከአንድበላይመልስይቻላል)	1. ሙዝ 2. ፓፓያ 3. ማንጎ 4. አቮካዶ 5. ብርቱካን 6. ሎሚ 7. አፕል 8. ሌላአማራጭመልስ----------	
404	ቤተሰቦችህ/ሽከተዘረዘሩት**አትክልቶች**የትኞችንያመርታሉ (ከአንድበላይመልስይቻላል)	1. ጎመን 2. ካሮት 3. ቆስጣ 4. ሰላጣ	

		5. ቀይስር 6. ቃሪያ 7. ሌላአማራጭመልስ----------	
405	ቤተሰቦችህ/ሽየሚያመርቱትን**አትክልትናፍራፍሬ**በአብዛኛው ለምንያውሉታል	1. ለሽያጭ 2. ለምግብነት	
406	ቤተሰቦችህ/ሽከተዘረዘሩት**የቤትእንስሳ**ያላቸውንጥቀሽ/ስ	1. ዶሬብዛት------ 2. ፍየልብዛት------ 3. በግብዛት------ 4. በሬብዛት------ 5. ላምብዛት------ 6. ሌላአማራጭመልስ----------	
407	ቤተሰቡየሚያገኘውን**እንቁላል**በአብዛኛውለምንያውሉታል	1. ለሽያጭ 2. ለምግብነት	
408	ቤተሰቦችህ/ሽየሚያመርቱትን**ወተት**በአብዛኛውለምንያውሉታል	1. ለሽያጭ 2. ለምግባነት	
409	ለመጠጥየሚያውሉት**ዉሃ**ከየትያገኛሉ	1. ከቧንቧዉሃ 2. ከጉድጓድውሃ 3. ንፅህናውከተጠበቀምንጭውሃ 4. ከወራጅውሃ 5. ሌላካለይጠቀስ ----------	
410	ከምንጭ፣ከወራጅ፣ውሃእናከጉድጓድውሃንለመጠጥየሚጠቀሙከሆነበምንበምንዘዴቤተሰቡ**አጣርቶ**ይጠቀማል	1. በማፍላት 2. በጨርቅበማጥለል 3. ውሃኢጋርበመጠቀም 4. ሌላካለ------	
411	ዘወትር**ጫማ**ትለብሳለህ/ሽ	1. አዎ 2. የለም	
412	**የማይለብሱ**ከሆነምክንያቱምንድንነው	1. ጫማቤተሰቤስላልገዛልኝ 2. ጫማለመልበስእፈራለሁኝ 3. ለመግዛትገንዘብማጣት 4. ሌላአማራጭመልስ----------	
413	ባለፉት 1 አመትውስጥ**ወባ**ታመህ/ሽታውቃለህ/ሽ	1. አዎ 2. የለም	
414	ታመህ/ሽከሆነ**ስንትጊዜ**ነው	---------- ጊዜ	
415	ባለፈውሁለት**ሳምንትበወባበሽታ**ታመህ/ሽነበር	1. አዎ 2. የለም	
416	ታመህ/ሽከነበርምንአደረግህ/ሽ	1. ወደህክምናተቋምበመሄድህክምናአደረግሁኝ 2. ቤትውስጥሳልታከምዳንሁኝ	
417	ተደጋጋሚየሆድ**ህመምቁርጠት**ያምህል/ሻል	1. አዎ 2. የለም	
418	አዎከሆነወደህክምናሂደህ**መድሃኒት**ወስድህል	1. አዎ 2. የለም	
419	በት/ትቤትየሚሰጠውን**የአንጀትጥገኛትላትል**መድሃኒትወስደህ/ሽታውቂያለሽ	1. አዎ 2. የለም	

420	አዎከሆነስንትጊዜወስደሀል/ሻል	----------ጊዜ	
አካላዊልኬት		**መጠን**	
1	ክብደት	**----------ኪ.ግ**	
2	ቁመት	**----------ሳ.ሜ.**	

ተ.ቁ	የአፍላወጣቶችሳምንታዊየምግብአመጋገብልምድመጠይቅ				
	ምግብአይነቶች	ሰኖ	ረቡዕ	ቅዳሜ	ምንምአልተመገብሁም
601	እንጀራእናእንጀራበወጥማብያ (ማጣፈጫንእንደጨው፣ዘይትእናቅመማ-ቅመም)				
602	ከእፅዋትየሚገኙት (ባቄላአተር) በቆልትመልክእናሽሮመልክ ምስርበወጥማብያመልክመመገብ				
603	ቅባታማጥራጥሬዎች (ለውዝ፣ሱፍ፣ሰሊጥእናኑግ) ተፈጭቶበፍትፍትመልክእናከቆሎጋርመመገብ				
604	ወተትእናየወተትተዋጽኦ (ሙሉየተፈላወተት፣በአይብእናእርጎመልክ)				
605	ጥራጥሬዎች (በቆሎእናበቂጣመልክከስንዴ፣ ከገብስእናከበቆሎቤትውስጥተዘጋጅተውመመገብ)				
606	በፍብሪካከተመረተዱቄትየተዘጋጀዳቦ				
607	ሻይእናስኳርያለበትቡና				
608	ፓስታእናመኮረኒ				
609	ግንዳቸውየሚበሉ (ድንችእናስኳርድንች)				
610	አልኮልዘመናቀዊ -ቢራ፣ኡዞእናነጭአረቂ ባህላዊመጠጦች ጠላእናካቲካላ (አረቂ) መጠጣት				
611	የዶሮእንቁላልእናስጋ				
612	የከብትስጋ				
613	ፍራፍሬ (ሙዝ፣ብርቱካን፣ዱባ …				
614	አትክልት (ጎመን፣ቃሪያ፣ቆስጣ፣ሰላጣ፣ቲማቲም…				
615	የባህርምግቦች -አሳ				
616	ሌላካለይገለፅ				

እመስግናለሁ

Annex VI. Qualitative study in-depth and key informant interviews guide

IDI guide for farmers and Extension workers

1. What are existing agricultural varieties of food production by farmers? (Probe-is there agroforestry plants growing ---awareness practice challenges?
2. Do you have knowledge about agroforestry plants? Probe- list it in advance?
3. What type of trees you frequently plant in your plot of land? Probe- list tree commonly cultivated?
4. Why you plant trees that have dual purpose in your plot of land? Probe to list plant that provide fruit and vegetables?
5. Do you get extension support to plant an agroforestry tree in your plot of land? (Probe to list type of support?

IDI-Guide for mothers and adolescents

1. What is your food preference and eating habit? (Probe to list which food item you prefer to eat more?
2. What type of animal sources food do you have access and your consumption habit?
3. What is healthy diet for you? (Probe-to list healthy and healthy diet in your home?
4. Who get primarily food from your family member?
5. Does your family and peer influence your dietary choice?
6. Why do not you consume various food items?
7. Do you have food consumption habit outside your home?

IDI- Guide on Culture, beliefs, Gender difference and its effect of dietary habits of adolescents

1. In your community is there difference in food distribution among family member
2. Which food items gives for adolescents mostly?
3. In your culture, which diet is more respected? Why?
4. What is belief of community on dietary practice?
5. What is the eating practice of adolescents in your culture?
6. Is there a priority in dietary practice in between male and female adolescents in your community?
7. Is there food taboo, which was restricted to adolescents in your culture?

KII Guide for Expert who are working at coordination and facility level

1. What are the interventions done on adolescent nutrition?
2. What are the strategy you implement for adolescents nutrition interventions?
3. Who are the collaborators working on adolescent's nutrition?
4. What type of intervention implemented with adolescents and the level of success?
5. What is the existing challenges you face for the implementation of an adolescent nutritional strategy?