Improving the Inclusion of Animal Source Foods in Diets for Better Nutritional Status of Women and Children: A Longitudinal Study

PhD Dissertation

By: Alemneh Kabeta Daba (MSc)

Submitted to School of Graduate Studies, Hawassa University for Partial Fulfillment of the Requirements for Degree of Doctor of Philosophy (PhD) in Human Nutrition

Hawassa, Ethiopia

November, 2021

Improving the Inclusion of Animal Source Foods in Diets for Better Nutritional Status of Women and Children: A Longitudinal Study

PhD Dissertation

By Alemneh Kabeta Daba (MSc)

Team of Advisors:

Professor Mary Murimi (PhD)

Kebede Abegaz Ali (PhD)

Dejene Hailu Kassa (PhD)

Submitted to School of Graduate Studies, Hawassa University for Partial Fulfillment of the Requirements for Degree of Doctor of Philosophy (PhD) in Human Nutrition

Hawassa, Ethiopia

November, 2021

HAWASSA UNIVERSITY

PhD DISSERTATION APPROVAL SHEET

This is to certify that the PhD Dissertation on "**Improving the Inclusion of Animal Source Foods in Diets for Better Nutritional Status of Women and Children: A Longitudinal Study**" submitted in partial fulfillment of the requirement for the Degree of Doctor of Philosophy (PhD) specialization in Human Nutrition, the Graduate Program of the School of Nutrition, Food Science and Technology has been carried out by "ALEMNEH KABETA DABA"ID No. PhD009/10 under our supervision. Therefore, we confirm that the PhD candidate has fulfilled the requirements and hence can submit the dissertation to the School of Graduate Studies.

Alemneh Kabeta Daba	_____	_____
Name of Student	**Signature**	**Date**
Approved by:		
Prof. Mary Murimi		9/8/2021
Name of Major Advisor	Signature	Date
Dr. Kebede Abegaz Ali	_____	_____
Name of Co-Advisor I	Signature	Date
Dr. Dejene Hailu Kassa	_____	_____
Name of Co-Advisor II	Signature	Date
_____	_____	_____
Head of Department	Signature	Date
_____	_____	_____
Name of SGS Coordinator	Signature	Date

Declaration

I, Alemneh Kabeta Daba, hereby declare that this PhD dissertation is my original work and has not been submitted or presented for a degree in any other institute for academic requirement purpose and all sources materials used in this PhD dissertation are duly acknowledged and cited appropriately.

Name: **Alemneh Kabeta Daba**

Signature: _____

Date: **24/11/2021**

Dedication

I dedicate this work first to my kind, humble and determined to education father "**Hamisa Aleqa***"* Kabeta Dhaba Mengesha whom I lost by my age of adolescence. I would be happier if he would have seen while his second son achieved the education he used to dream.

The three years through which I passed through a lot of challenges to realize this PhD Research Project has not been peaceful for my lovely country Ethiopia and the citizens. There were a lot of instabilities almost throughout the country. Also, there have been a considerable number of citizens in my country Ethiopia used to worry about their dinner, with its scientific phrase '*food insecure*'. Sometimes, I feel as if I was and I am too selfish to do this work in that entirely scarifying environment in the country. Thus, all the happenings obliges me secondly to dedicate this work to Ethiopians who sacrificed their irreplaceable life due to the instabilities irrespective of reasons they lost their life and to those who used to worry about their dinner. Let the almighty God help me and all of us to contribute to the buildup of peace in the country and to the down fall of all rounded insecurities including food and nutrition insecurity.

General Information on Publication and Participation in Scientific Workshops/Conferences

Part of this PhD dissertation is published on a peer-reviewed and reputable journal and presented at international and national scientific workshop/conference.

- **Published Paper**:
    - Daba A.K., Murimi M., Abegaz K., and Dejene H., (2021). Determinants and constraints to household-level animal source food consumption in rural communities of Ethiopia. JNS 10:e58. doi:10.1017/jns.2021.52

- **Conference Presentation**

    - Daba A.K., Murimi M., Abegaz K., and Dejene H. (2021). Determinants and constraints to household-level animal source food consumption in rural communities of in Ethiopia. Third National Research Conference, Jinka University, Jinka, Ethiopaia. May 2021

    - Daba A.K., Murimi M., Abegaz K., and Dejene H. (2021). Facilitators, Constriants and Determinants to Household-level Animal Source Food Consumption in Rural Communities of Ethiopia. Sixth Internation Agriculture, Nutriton and Health Academy Week (Online). June 2021.

Table of Contents

Acknowledgments

I accomplished this PhD Research Project (PRP) work by the help of the almighty God and by the support from different organizations and many individuals. Here is the first Thank you! going out to the almighty God!

I would also like to acknowledge the supervisory team members namely Professor Mary W. Murimi, Dr. Kebede Abegaz Ali, Dr. Dejene Hailu Kassa for their valuable contribution throughout my PhD study. I also acknowledge Professor Adugna Tolera and Dr. Jessie L. Vipham for coordingating the overall project that partly supported my PhD research project.

Dear Dr. Dejene, I hope that you receive my heartfelt thanks with no reservation as you received my request to advise me for my PhD study with no reservation, while you are not a member of the big project (*Linking Cattle Nutrition with Human Nutrition*) to support us, the graduate students for PhD research project expenses. Your doors were open widely to let me enter to you as I desired and too your communication channels to receive my concerns. I am very lucky to be supervised by you. I pray to God to bless you with peace and to keep you safe, healthy and productive.

Dear Dr. Kebede, it is not acceptable not to mention that you were my invisible and magical shoulder to lug academic and extra academic challenges I was obliged to face throughout the process of my PhD study. I must also give recognition to the role you played in shaping my communication. I used to enter to your office as your first child. Asking Mr. Anbissa, who shared office with me, where I am and calling to me when I am absent from office for days were your usual checkups about me. Who sacrifice to support his/her student while suffering from shortness of breath and complicated medical condition? Only Dr. Kebede, about whom I witness! Thank you for your fatherly approach. As you sacrificed for me and dreamed me in your day to day life and in your night nightmare, it is must for me to shoulder to let your academic legacy continue. I will be teaching you to my attendees may be throughout the rest of my academic and non-academic life. I am very lucky to be supervised by you. I pray to God to bless you with peace and to keep you safe, healthy and productive too.

Next to be addressed are my kind wife Tibka Haile; lovely sons Kiya and Nati; my mother Wube Siyum; my brothers Dr. Azimera, Mr. Andualem, Mr. Anteneh, Mr. Alemtsega, my sister Helen; my second father Haile Kotacho and second Mom Bogalech Regassa; and other members of the

extended family I have. Thank you for understanding the reasons why I failed to give the time that I am supposed to give you. Thank you for understanding me and not blaming me for not being involved in the happy and sad events of the family physically. Your usual question and concerns "*How was the day*?; *How is the study going*?"; "*Take care of your field travel*!" and the like were really the positive energy I had for the progress I demonstrated and I will have to demonstrate more and more achievements in the future.

I am proud of having you friends: Mr. Zemenu Yohannes, Mr. Zelalem Tenawu, Mr. Yonas Alemayehu, Mr. Abebe Tamirat, Mr. Rekiku Fikre, Mr. Alemu Tamiso, Mr. Yirgu Fekadu, Mr. Kefyalew Muleta, Mr. Agegnehu Tsegaye, Dr. Beruk Berhanu, Mr. Anbissa Muleta, Mr. Andarge Zelalem, Mrs. Selam Fantahun, Mr. Fikadu Reta, Mr. Gezahegn Nigusse and Mr. Tona Zema and all those I might have missed to mention. You were too collaborative not only for my PhD related works; rather you also shouldered my life burdens.

It is a must requisite to convey my heartfelt thanks to Professor Sheleme Beyene, Professor. Alemayehu Chala, Dr. Terekegn Yoseph, Dr. Sintayehu Yigrem, Mr. Tamene Oromo, Mr. Wondwosen Tadesse, Mr. Wendafrash Negash, Mr. Anteneh Admasu, Mr. Alemayehu Bekele, Mr. Bezu Belete, Mr. Tafesse Mersha, Mr. Legesse Lambebo and Mr. Bergene Boshe for your kindness and for the friendly logistic support you facilitated for me. This PRP would not be realized without your personal sacrifice and if you would have not smoothen the institutional system to give responses to my requests.

I have also to mention Dr. Samson Gebremedihin for being a positive energy to overcome the challenges I faced. Dear Dr. Samson Gebremedihin, what I can only say is Thank you! for the brotherly academic advice you provided to me to enrich my PRP. I want also to use this opportunity to document your diplomatic "No!" response when I asked you saying "*Should I abort the PhD study I started?*" mentioning that I was obliged to shoulder unnecessary challenges and forced to experience unhealthy communications. Mr. Wegene Jemebere is my former teacher during my BSc study from 2006-2009, and currently my work colleague at Hawassa University whom I must also acknowledge for his vote for my MSc study in Human Nutrition. **Congratulations, Wegene!** Your vote for my MSc study gave birth to a PhD! Thank you for supporting the foundation I must plant for my PhD study. Mr. Wegene? Let the good you did for me, my family, my beloveds and my country pay back to you, to your family, to all your beloveds and to you country!

I would also like to forward my thanks to Professor Stoecker J. Babara, Professor Daniel J. Hoffman, Professor Martha Archuleta and Professor Getachewu Dagne for the academic help they provided by reviewing manuscripts I drafted.

Jinka University from Ethiopia, Agriculture, Nutrition and Health (ANH) academy and Collective for Social Science Research, Dow University of Health Sciences, Institute for Global Health and Development at Aga Khan University and University of Agriculture Faisalabad (UAF) from Pakistan are duly acknowledged for providing me research presentation opportunities in the conferences they organized so that I widen audiences for my PhD study finding and meet the academic requirement to successfully accomplish my PhD study. I am grateful to Hawassa University of Ethiopia and Kansas State University of USA for the collaboration they made for a research project and for the opportunity they to me to involve in the project. I am thankful to College of Agriculture, Hawassa Univrsity for supporting me by providing vehicle for the field work. College of Medicine and Health Sciences also deserve thanks for granting me a study leave with pay. This PhD research project is partly funded by USAID. Lastly, I forward my appreciations and acknowledgments to the School of Nutrition, Food Science and Technology in Hawassa University for managing PhD in Human Nutrition academic program with challenges being defeated and to be defeated more.

Abbreviations and Acronyms

ANH:	Agriculture, Nutrition and Health Academy
AOR:	Adjusted Odds Ratio
ASF:	Animal Source Foods
AU:	African Union
BAZ:	Body Mass Index for Age
BCC:	Behavioral Change Communication
BMI:	Body Mass Index
CSA:	Central Statistical Agency of Ethiopia
DD:	Dietary Diversity
DDS:	Dietary Diversity Score
DHS:	Demographic and Health Survey
EPHI:	Ethiopia Public Health Institute
ETB:	Ethiopian Birr
FAO:	Food and Agriculture Organization
FDRE:	Federal Democratic Republic of Ethiopia
FMoH-E:	Federal Minitry of Health of Ethiopia
FNTA:	Food and Nutrition Technical Assistance
HAZ:	Height for age
HDDS:	Household Dietary Diversity Score
HHFS:	Household Food Security
ID:	Iron Deficiency
IDA:	Iron Deficiency Anemia
IFPRI:	International Food Policy Research Institute
IQR:	Inter-quartile Range
IYC:	Infant and Young Children
LHLANE:	Low Health Literacy Approach Nutrition Education
MDD:	Minimum dietary diversity of Infant and Young Children
MDDW:	Minimum Dietary Diversity of Women
MDDW:	Minimum Dietary Diversity of Women
MUAC:	Mid-Upper Arm circumference
SD:	Standard Deviation
UAF:	University of Agricultural Faisalabad
UN:	United Nations
USDA:	Unites States Development Agency
VIF:	Variance Inflation Factor
WAZ:	Weight for Age
WDD/S:	Women Dietary Diversity/Score
WHO:	World Health Organization
WHZ:	Weight for Height

List of Tables

List of Figures

Summary

General Outline of the Dissertation: The dissertation consists of six chapters for main sections and annex for supportive materials. **Chapter One** consists of an introduction and general and specific objectives of the PhD research project. **Chapter Two** is review of literatures relevant to the study. **Chapter Three** comprehensively describes materials and methods organized for the PhD research project. **Chapter Four** is on Papers or Manuscripts produced from the PhD research project, and there are four papers in the chapter. **Chapter Five** is focused on general discussion on the results, and conclusions and recommendations from the results. **Chapter Six** is a policy brief based on major findings of the PhD research project.

Background: Animal source foods contain quality nutrients important for growth, development, immunity and healthy behavioral outcomes**.** Plant-based foods also provide the nutrients, but with lower bioavailability than animal source foods. Animal source foods also have added values when they are added to plant-based food dominated dishes. They are recommended to be part of healthy diversified diets. The first 1000 days, period from the first day of pregnancy to the second birth day of a child, of life are critical for children and for the mothers who breastfeed and care for the children. During this period, lactating mothers need special nutritional care given that their dietary practices positively impact their nutritional status coupled with growth, development and health of their babies. They are recommended to have two additional meals in a day, eat diversified diets every day including animal source foods and keep a healthy nutritional status. The first two years of life, long portion of the 1000 days, are important for growth and development of infants and young children. During this period, infants and young children (6-23 months old) are also recommended to consume a diversified complementary food, as 180th day after birth, including animal source foods. Missed developmental and growth milestones during this period as a result of inadequate nutrition may not be reversible later in life and is more likely to negatively affect their overall health and productivity in later life. However, findings from Ethiopia documented that women and infants and young children do not consume diversified diets animal source foods being the limited food groups and to some extent fruits and vegetables. Despite that the studies recommended for identification and implementation of feasible interventions to improve the situation, they have not investigated for determinants of low animal source food consumption practice on which proposing solutions has to base. Evidence on household-level animal source food consumption frequency and

its facilitators, constraints and determinants is also limited, almost null, for Ethiopia. Therefore, this study was conducted to determine the dietary behavior related to the consumption of animal source foods; to identify facilitators, constriants and determinants to the consumption of ASF; and to improve the consumption of ASF by women and children through promotion of the inclusion of animal source foods in diversified diets.

Materials and Methods: This longitudinal study employed cross-sectional and cluster randomized controlled community trial study designs. Two community based cross-sectional studies were conducted on 422 households and on 606 mother-child pairs (lactating mothers and infant and young children) in three districts from Oromia (Arsi Negele district) and Sidama regional states (Dale and Wondo Genet districts) of Ethiopia. Data were collected through interviewer-administered questionnaire. Household-level animal source food consumption frequency was assessed using a food frequency screener over thirty days retrospectively. Twelve statements with Likert scale response options were used to identify facilitators and constraints of animal source food consumption. Ordinal logistic regression was used to identify determinants of household-level animal source food consumption frequency. Nutritional status of the lactating mothers was assessed using body mass index (BMI) and mid-upper-arm-circumference (MUAC). WHOAnthro was used to generate Z-scores for weight-for height, height-for-age, weight-for-age and MUAC status of infant and young children. Simple logistic regression analysis was used to identify predictors of number of meals in a day for mothers; predictors of minimum dietary diversity of women (MDDW) and children (MDD); predictors of nutritional status of lactating mothers and infant and young children; and predictors of animal source food consumption practice of women and children. A cluster randomized controlled trial was conducted on 190 randomly selected mother-child pairs. Nutrition education sessions were delivered with Low Health Literacy Approach (LHLANE). Data were collected on nutrition of lactating mothers and infant and young children at baseline and after the intervention. Between group differences for proportion of mothers and children who consumed animal source foods, mean scores for dieatary diversity of mothers and children and nutrional status indicators were tested using Chi-square and independent samples t-test.

Results: this sub-section of the summary is organized paper by paper. **PaperI in Chapter Four** presents an analysis on *Facilitators, Constraints and Determinants of Household-level Animal Source Food Consumption in Rural Communities in Ethiopia*. About a quarter (26%) of the

households consumed milk 1-2 times per-week. One out of five households consumed eggs 1-2 times per-week (20%) or 1-2 times per-month (19%). Poultry and meat were never consumed in a month period by 92% and 60% of the households, respectively. Unavailability, unaffordability, limited animal source food consumption tradition and income generation priority from livestock rearing were constraints identified. Food insecure households were less likely to consume poultry (P = 0.035), meat (P <0.001), eggs (P <0.001), milk (P =0.035) and milk products (P =0.005) than food secure households. Households that did not own chicken were less likely to consume eggs (P <0.001) than households that did own chicken. Households that did not own donkey were less likely to consume poultry (P =0.017) and meat (P =0.008) than households that did not own donkey (P <0.05). Households that did not own cow were less likely to consume milk (P <0.001) and milk products (P <0.001) than households that did own cow. Households that did not produce cash crops were more likely to consume milk (P =0.003) products than households that did produce cash crops (p. <0.05). Households with more family size were less likely to consume poultry (P =0.002), meat (P =0.007) and eggs (P <0.03). Lesser household income was associated with lesser probability of meat (P <0.001), eggs (P <0.013) and milk product (P =0.017) consumption. Hoseholds with women who never attended school are less likely to consume eggs (P =0.012) than households with women who attended school. **Paper-II in Chapter Four** presents results on *Determinants of Animal Source Food Consumption practice, Minimum Dietary Diversity, Meal Frequency and Nutritional Status of Lactating Mothers in Rural Districts of Ethiopia.* Almost all of the lactating mothers consumed four or less meals in a day (92.1%) and from four or less food groups (90%). One out of five lactating mothers consumed eggs (5.4%) and meat (5.1%). Slightly more than a quarter (27.6%) of the lactating mothers consumed dairy. Lactating mothers were also identified being undernourished using BMI (12.6%) and MUAC (10.7%). Cash crop production and food insecurity were associated with meal frequency (p. <0.05). Root crops production, maternal educational status, household annual income and chicken ownership predicted MDDW (P < 0.05). Hand washing practice of the mothers after cleansing child's bottom, household food insecurity and child age were associated with nutritional status of the lactating mothers (P <0.05). Lactating mothers who lived in food secure households were more likely to consume meat (P =0.009), eggs (P =0.009) and dairy (P =0.014) than mothers who lived in severely food insecure households. Meat consumption was four times (P =0.009) more likely for lactating mothers from cash crop producing households than mothers from households that did not produce cash crops. Lactating mothers who lived in households that did produce root crops were more than three times (P =0.012) likely to

consume eggs than mothers who lived in households that did not produce root crops. Lactating mothers from households with estimated annual income of 10,001-15000 Ethiopian birr (ETB) were more than two times more likely to consume at least one of the ASF (P =0.014) than mothers from households with ≤5000 ETB estimated annual income. Lactating mothers who lived in households that owned cow (P =0.003) or chicken (P =0.041) were about two times more likely to consume at least one of the ASF than mothers who lived in households that did not own cow or chicken. Lactating mothers who were merchants in occupation were four times more likely (P <0.001) to consume at least one of the ASF than mothers who were housemakers. **Paper-III in Chapter Four** presents findings on *Determinants of Growth Failures, Dietary Diversity and Animal Source Foods Consumption among Six to Twenty Three Months old Children from Rural Ethiopia*. Stunting, underweight and wasting were 25.8%, 13.6% and 5.6%, respectively. Less than a quarter of the infants and young children (16%) achieved MDD. Dairy, eggs and meat were consumed by 41.2%, 16.4% and 1.8% of the children, respectively. Children who lived in food secure households were two times more likely to consume dairy (P =0.006) or eggs (P =0.002) and five times more likely to consume meat (P =0.039) than children who lived in food insecure households. Children from households that owned cow (P =0.001) or donkey (P =0.024) or chicken (P =0.027) were about two times more likely to consume dairy than children from households that did not own the respective animals. Children with mothers who achieved grades five up to eight (P =0.028) or grades nine or above (P <0.001) education were two and three times more likely to consume dairy than children with mother who never attended school, respectively. Children who lived in households with estimated annual income of twenty to thirty thousands were about two times more likely to consume dairy than children who lived in households with ten thousand or less estimated annual income (p. =0.017). Children from households that owned chicken were three times more likely (P <0.001) and children from households that produced root crops were two times more likely (P =0.031) to consume eggs than their counters. Children who lived in households that owned cow (P =0.001) or chicken [P =0.001] were more likely to consume at least one of the animal source foods than children who lived in households that did not own cow or chicken. Children from households with estimated annual income in ETB in the range of 10,001-20,000 (P =0.028) or 20,001-30,000 (P =0.047) or >30,000 (p. =0.005) were more likely to consume at least one of the animal source foods than children from households with ≤10000ETB estimated annual income. Children from households that did not produce vegetable had lower odds of stunting (P =0.024) and underweight (P =0.01). Children with mothers who achieved grade five up to eight education (P =0.004) were

more likely to consume at least one of the animal source foods than children with mothers who never attended school. **Paper-IV in Chapter Four** presents on the *Effect of Nutrition Education Intervention with a Low Health Literacy Approach mainly on the consumption of animal source foods by lactating mothers and infant and young children*. Effect of the nutrition education intervention on dietary diversity of lactating mothers and infant and young children and their nutritional status were also considered in this sub-section. Accordingly, after the nutrition education intervention, proportions of mothers who consumed eggs (P =0.016) and dairy (P =0.042) were higher for mothers in the treatment group than proportions of mothers in the control group. Proportions of infant and young children who consumed dairy (P =0.001) and eggs (P =0.015) were also higher for infant and young children in the treatment group than proportions infants and young children in the control group. Mean scores for dietary diversity of mothers (P <0.001) and infant and young children (P <0.001) were significantly higher for lactating mothers and infant and young children in the treatment group than in the control group. Mean scores for Z-scores of weight-for-height (P =0.003) and weight-for-age (P =0.022) were significantly higher for infant and young children in the treatment group than infant and young children in the control group.

Conclusions: Rural households in Ethiopia do not consume animal source foods on regular basis. Poor sociodemographic and economic conditions as determined by food insecurity, property ownership, estimated household annual income, women educational achievement, family size, unavailability and unaffordability of animal source foods and limited animal source foods consumption tradition contributed to lower consumption frequency of animal source foods by households in rural Ethiopia. But religion and related fasting practice do not constrain consumption of animal source foods in the study setting. Undernutrition among the lactating mothers remains as a medium-level public health problem in the study setting. Majority of the lactating mothers do not meet the recommended number of meals in a day and MDDW. Eggs, meat and nuts were least consumed food groups by the lactating mothers. Proportion of lactating mothers who do not consume dairy is also considerable. Consumption of animal source foods by lactating mothers was predicted by food security, maternal education and occupation, livestock ownership, crop production and household income. This can be summarized as low livelihood conditions hindered lactating mothers from animal source foods. For the infants and young children, stunting and underweight are medium level public health problems in the study setting. Low proportion of children met MDD and consumed animal source foods. Household food security, livestock

ownership, household income and maternal education contributed to animal source food consumption practice of infant and young children. This can also be summarized as low living conditions contributed to low animal source food consumption practice of infants and young children. A low health literacy approach nutrition education (LHLANE) improved animal source food consumption and dietary diversity of lactating mothers and infant and young children. It also improved weight-for-height and weight-for-age of the children. Nutrition policy and programs should focus on nutrition sensitive agricultural extension, livelihood improvement activities and intervention to empower women economically and with education that are integrated with nutrition education with LHLANE to improve particularly animal source foods consumption in rural settings and generally nutrition of women and children. Looking for strategies to avail ASF in the local markets of rural setting of Ethiopia on program basis may also benefit to improve the low animal source food consumption, especially for meat. More researches are warranted to further understand the inverse relationship between vegetable production practice and stunting and underweight; to clarify the mixed relationship between cash crop production and household, maternal and child nutrition outcomes; and to positively impact stunting status of children and nutritional status of lactating mothers through a multisectral nutrition intervention that should be conducted for a longer period than this study.

CHAPTER ONE: INTRODUCTION

1.1. Background

Malnutrition is a global concern (IFPRI, 2016) that requires collaborative interventions from multiple stakeholders (USAID, 2014; UNICEF, 2015). Worldwide about 750 million people are not meeting their daily energy requirement (IFPRI, 2014), 2 billion people are micronutrient deficient for which animal source foods (ASF) are beneficial and about 155 million under-five children are chronically undernourished for which ASF can positively contribute for corrective measure (Reinhardt and Fanzo, 2016). Africa is home to about 59 million stunted and 14 million wasted children in the world. Regionally, countries located in East Africa share 4.1% of wasting and 24% of stunting (UNICEF, 2019). Inline, Africa has given due attention to the problem, and developed a continent wide strategy to reduce the magnitude of historic food and nutrition insecurity, especially in the Sub-Saharan (SSA) region (AU, 2005; UNDP, 2012). It is pointedout that ASF have an important role in combating the double burden of malnutrition in low-income countries where diets are predominantly cereal based with very low intakes of ASF. In the settings where maternal and childhood undernutrition is highly prevalent, affordable ASF should be explicitly promoted as a part of guidelines on infant and young child feeding. But, it is recommended to couple nutrition education and counseling with activities to enhance affordability and accessibility of ASF by integrating interventions through macro- and micro-level policy and program analysis (Dasi *et al.*, 2019).

Ethiopia is one of the SSA countries with high burden of malnutrition among women and children (UN, 2010). In Ethiopia, with a slight decreament in half a decade from 2010 to 2015, 38% of under-five children are stunted, 10% wasted and 24% underweight (CSA, 2016b). More than half (56%) of children and about quarter (23%) of women also had iron deficiency anemia (IDA) for which regular and adequate intake of ASF is identified to be beneficial (Hall *et al.*, 2017; Headey, Hirvonen and Hoddinott, 2018). The concordance of growth failure and anemia is also reported to be prevalent (18-25%) and discussed to worsen each other (Malako *et al.*, 2019; Mejia *et al.*, 2019; Mohammed, Larijani and Esmaillzadeh, 2019; Tran *et al.*, 2019; Orsango *et al.*, 2021) by studies from Ethiopia and other countries.

Dietary diversity score (DDS) is an important indicator for nutritional quality of food groups consumed by women and infant and young children and the adequacy of nutrients that diets provide

(Nguyen *et al.*, 2013). It can be assessed through a standard dietary diversity assessment tool with list of food groups for households, for women and for infant and young children, children six to twenty three months old. Four out of nine or three out of ten food groups in the tool for women are ASF (Martin-prevel *et al.*, 2017). Four out of twelve food groups in the tool for households are ASF. Three out of seven food groups in the tool for infant and young are ASF (FAO, 2010). Along with the Ethiopian national food consumption report (EPHI, 2013), studies conducted at different parts of the country consistently reported that low proportion (not more than 16%) (Aemro *et al.*, 2013; Beyene, Worku and Wassie, 2015; Dangura and Gebremedhin, 2017) of infants and young children (IYC) achieved minimum dietary diversity (MDD). In addition, the studies commonly mentioned ASF (mainly fish, flesh/meat, organ meat and egg) and vitamin A rich fruits and vegetables being most limited food groups (Gatahun, 2015; Solomon, Aderaw and Tegegne, 2017). Evidence from a comprhensive analysis of merged data of multiple countries (Arimond and Ruel, 2004) and country specific surveys (Rah *et al.*, 2010; Hooshmand, 2013; Busert *et al.*, 2016; Getachew and Argaw, 2017) showed a positive linear association beteewn dietary diversity (DD) and child growth, especially height.

Womens are also vulnerable to undernutrtion. The nutritional status of childbearing age women in Ethiopia is not well studied as compared to women in the other developing countries (Ahmed *et al.*, 2014; Bhandari *et al.*, 2016; Mtumwa, Paul and Vuai, 2016). A national report (27%) (CSA, 2016b) and a regional state specific study from oromia region of Ethiopia (35%) (Taddese, Larson, & Hanley, 1997) figuredout that a quarted to one-thirds of women suffer from undernutrition. Another study conducted on adult urban dwellers, with 71% female and 29% male sample, found a 13% undernourishiment. The report also described that the mean energy intake of women was lesser and the mean energy intake of men was higher than the recommended intake. In addition, intakes of nutrients mainly found in ASF (Neumann, Harris and Rogers, 2002; Murphy and Allen, 2003; Whaley *et al.*, 2003b; Hoffman and Falvo, 2004; Schmid and Walther, 2013; Schönfeldt, Pretorius and Hall, 2013) were below the recommended (Amare *et al.*, 2012) levels: protein (11.2%), calcium (90.4%) and retinol (100%). According to Weldehaweria *et al.*, (2016) 27% and 56% of the lactating mothers lived in food insecure households and they were with low women dietary diversity score (WDDS), respectively. Less than a quarter of the mothers consumed selected ASF (meat and fish-17%, eggs-18% and dairy products-12%). Cross-sectional studies by Mekuria *et al.*, (2017)-(21%) and Misikir *et al.*, (2016)-(34.3%) reported that only a quarter to one-thirds of households in Awabel and Mirab Abaya districts of Ethiopia achieved acceptable household dietary

diversity score (HDDS). Diets in more than 90% of the households were cereal based with minimal inclusion of ASF (Workicho *et al.*, 2016).

Achivement of minimum recommended dietary diversity with the inclusion of ASF was observed to be associated with reduced risk of child undernutrition (both anthropometric and micronutrient) (Savy *et al.*, 2006; Dickson A Amugsi *et al.*, 2016), adverse pregnancy outcomes (Dickson A Amugsi *et al.*, 2016) and improved breastmilk nutrient concentrations (Huang and Hu, 2020). Nutritonal status of the mothers was also observed to be associated with weight for height (WHZ), height for age (HAZ) and BMI for age (BAZ) Z-values of their children (Savy *et al.*, 2006; Negash *et al.*, 2015; Zerfu, Umeta and Baye, 2016; Zhang and Kang, 2016), while dietary quality as measured by dietary diversity determined maternal nutritional status and their child caring performance. In addition of describing the concordance of maternal and child undernutrition, evidences suggest nutrition education intervention to target both women and children together to reflect the expected positive effect specifically on the mothers and childrens themselves and widely on the household (Rahman *et al.*, 1993; Tigga and Sen, 2016). Inline to this, in Ethiopia, improving nutrtion and health of women (FDRE, 2016, 2018) is also among the listed nutrition intervention priorities with ultimate goal of breaking cyclic/intergenerational nature of malnutriton and creating malnutrition free future generation (FDRE, 2019).

Animal source foods that includes milk, eggs, meat, poultry, fish, organ meat and others are rich sources bioavailable macro- and micro-nutrients (Schönfeldt, Pretorius and Hall, 2013). They also complement plant-based nutrients and have a potential to enhance nutritional performance of plant-based food dominated diets, like in the Ethiopian dietary pattern. However, in Ethiopia despite the high livestock population, consumption of ASF is low, even considered as food for ceremony, food used to consumed when there are holidays and other happy or sad events (Nguyen *et al.*, 2013; Seleshe, Jo and Lee, 2014; Kemkem *et al.*, 2015) by when people/communities can come together. But they are recommended to be regular components of diversified diets of households, women and children (FAO, 2010). Strengthening ASF consumption gap in Ethiopia, a media has broadcasted that the per-capita meat consumption for an Ethiopian is one-tenths of meat consumed by a citizen in developed nations (BBC Amharic, no date). The need to improve ASF consumption pattern for Ethiopia was also boldly mentioned in a document describing Ethiopia's commitment to end hunger and dramatically reduce stunting by 2030 (FDRE, 2019). To strengthen and support the commitment, filling knowledge gap about the cause and consequences of malnutrition, better

understanding of its relation with the agriculture and environment and intervening with multi-stakeholder involving innovative ideas including working to improve the consumption of ASF are pointed out to be beneficial (Reinhardt and Fanzo, 2016).

Given the conflicting facts of high livestock population and low ASF consumption in Ethiopia, and the limited nutrition sensetive interventional studies conducted to posetively impact the situation (Ayele and Peacock, 2003; Weldehaweria *et al.*, 2016), it is critical to assess behaviors related to the consumption of ASF in depth; to identify facilitatrs, constriants and determinants to the consumption of ASF; and to evaluate the effect of nutrition sentive gender based intervention like nutrition education on the consumption of ASF in particular and nutrition of women and children at large. Therefore, the purposes of this study are primarly to assess behavior related to the consumption of ASF; identify the facilitators, constriants and determinants to the consumption of ASF, and to evaluate the effect of promotion of inclusion of ASF in diversified diets on the consumption of ASF and nutritional status of women and children.

1.2. Objective

1.2.1. General Goal

- To identify facilitators, constriants and determinants to the consumption of ASF and improve consumption of ASF by women and children through promotion of inclusion of animal source food in dieversified diets.

1.2.2. Specific Objectives

1. To determine the exsisting dietary behaviors related to the consumption of ASF
2. To identify facilitators, constriants and determinants to the consumption of ASF at households, and by women and children
3. To determine the nutritional status of women and children
4. To evaluate effect of nutrition education intervention on the consumption of ASF by mother and children
5. To evaluate effect of nutrition education intervention on nutritional status of mothers and children

1.2.3. Research Hypothesis

Promotion on the inclusion of ASF in diversified diets to mothers with 6-23 months old children can improve consumption of ASF by lactating mothers and IYC.

CHAPTER TWO: LITRATURE REVIEW

2.1. Nutritional Values of Animal Sources Foods

Animal source foods (ASF) are important sources of multiple nutrients that are limited or not found commonly and significantly in monotonous and vegetarian diets (Whaley *et al.*, 2003a). Eggs, fish, flesh/meat, organ meat and dairy products are commonly mentioned animal source foods (ASF) while there are number of food items (FAO, 2018) under the big umbrella of ASF from diverse sources (FAO, 2004; Cawthorn and Hoffman, 2014) because of communities' dietary culture differences (de La Peña and Lawrance, 2011).

Egg is self-feed ready encapsulated cell (Vieira, 2007; Yadgary *et al.*, 2010). Eggs from chicken are the commonest type depending on consumers' acceptance, thogh it can be sourced from different birds like Turkey, Goose, Duck, Common Quail and Helmented Guineafowl (Smith, 2014; M Chepkemoi *et al.*, 2017). Egg is ready to feed the embryo for its growth, differentiation and development untill it gets hatched, and this natural preparedness makes eggs full of nutritional importance (Kovacs-Nolan, Phillips and Mine, 2005; Włodarski, Brodzikowska and Kuzaka, 2014). It is the internal part, the part next to the shell, commonly edible; anatomically the egg white, chalazae, vitelline membrane and egg yolk (Réhault-Godbert, Guyot and Nys, 2019). But, there are trials conducted in Ethiopia and other countries to make the whole egg edible including the shell and egg shell membranes through the promotion of different food processing techniques and blending mechanisms for different benefits (Brun *et al.*, 2013; Bartter *et al.*, 2018; Omer *et al.*, 2018).

Nutrient composition of egg may show slight variation for the different anatomical sections of an egg (Herron and Fernandez, 2004; Roe *et al.*, 2013; Kuang *et al.*, 2018). In addition, evidence also discussed that nutritional value of egg depends on several factors including hen feed/nutrition (Attia, Al-Harthi and Shiboob, 2014; Wang *et al.*, 2017; Heflin *et al.*, 2018; Onyenweaku *et al.*, 2018). In terms of proximate composition, on average an egg from a chicken is 76.1% water, 12.6% protein, 9.5% fat, 0.7% carbohydrate and 1.1% ash (USDA, 2018). Egg is also a considerable source of both fat-soluble and water-soluble vitamins (Aletor, 2017) with a limitation in its vitamin C concentration. The fat soluble vitamins (vitamin A, D, E and K) and some of the water soluble vitamins (vitamin B_1, B_2, B_5, B_6, B_9, and B_{12}) are concentrated in the egg yolk. High amount of vitamins (vitamin B_2, B_3, and B_5) is found in the egg white. In addition to the diverse variety of

vitamins it provides, egg is rich in public health important minerals like zinc, iron, calcium, selenium and other not in public health important list, but nutritionally significant minerals; phosphorus, potassium, magnesium and manganese (Goran *et al.*, 2010).

Milk is the third, next to egg and through placenta feeding, natural food that offspring from mammals experience. Milk is the best nutritious food that is naturally designed to meet the nutritional requirements of respective offspring from mammals for the first few months. Similarly, in the case of human being a proportion of lucky newborns (UNICEF and WHO, 2018) experience colostrum (the first breast milk) with in the first one hour or later and they continue being fed by hind and mature milk in the days to continue. Human being continues to be fed by dairy products sourced from different animals early in life and later. Cow, goat, camel and others like buffalo are commonly mentioned animals as a sources of dairy (Bornaz *et al.*, 2009; El-Hatmi *et al.*, 2015).

Nutritional composition differences are also observed for dairy products from different animals from different countries including Ethiopia (Soliman, 2005; Yoganandi *et al.*, 2014; Legesse *et al.*, 2017). A range of factors contributs to the difference including nutritional status of the animals, feed and animal health (Zahraddeen *et al.*, 2007). Concentration of fat, protein, energy and water in goat and cow milk are almost equal. Both cow and goat milk contain minerals and vitamins, though cow milk is more concentrated in sodium while goat milk is reach in calcium, magnesium and phosphorus (Park, 2006; Arora, Bhojak and Joshi, 2013). They are also good sources of vitamins like vitamin A, ascorbic acid (Vit. C), pantothenic acid (Vit. B_5) and pyridoxine (Vit. B_6) (Chandan, Attaie and Shahani, 1992; Claeys *et al.*, 2014) (Chandan *et al.*, 1992; Clayes *et al.*, 2014).

An aquatic animal fish also plays important roles in human health and nutrition (Mohanty *et al.*, 2019). Fish is a food item through which international organizations are trying to address nutritional requirements of ASF needy communities (Belton and Thilsted, 2014; Gurung, 2016; FAO, 2018; Obiero *et al.*, 2019) despite all the challenges (Chan *et al.*, 2019).

Nutritional values of fish varies (Dhaneesh, Noushad and Ajith Kumar, 2012; Bogard *et al.*, 2015; Jim, Garamumhango and Musara, 2017; Marques, Botelho and Guiné, 2019) based on the species variety (Vijverberg *et al.*, 2012; Kasozi *et al.*, 2014; Grapci-Kotori *et al.*, 2019) and other conditions. A proximate composition analysis report of Nile Tilapia (*Oreochromisniloticus*) fish from Lake Hawassa and fish pond in the surrounding showed 62-76% moisture, 13-23% crude protein, 2-4% crude fat and 2% ash (Desta *et al.*, 2019) concentration. Fish is a considerable source

of essential fatty acids (Osman, Suriah and Law, no date; Devadason *et al.*, 2016; Njinkoue *et al.*, 2016) and amino acids (Dhaneesh, Noushad and Ajith Kumar, 2012). It also provides vitamin A (Kasozi *et al.*, 2014), vitamin D, selenium, phosphorus, calcium (Khalili Tilami and Sampels, 2018), potassium and magnesium (Shehawy, Gab-Alla and Mutwally, 2016).

Like the other ASF, meat is an excellent source of both macro- and micro-nutrients (Ahmed, Imran and Hussain, 2016). The concentration of nutrients in meat is multiple times higher than plant based food items (Calloway, Murphy and Woerner, 1994). Thus, ASF can fill multiple micronutrient gaps at a lower amount of intake than can plant-based foods (Pereira and Vicente, 2013). Just a 100 g of cooked beef provides an entire day's recommended intake of protein, vitamin B_{12} and zinc and contributes substantially to meeting the riboflavin and iron recommendations (Torun *et al.*, 1996; IOM, 2000, 2001). Meat also shares the added nutritional importances of ASF. It is rich in essential amino acids for which plant-based foods are limited, and because that it adds value to plant-based diets (FAO, 1992; Krajcovicova-Kudlackova *et al.*, 2000). In addition to better bioavailability of nutrients in it, the inclusion of flesh products in diets improves the bioavailability of nutrients from other plant based food items for mechanisms to be investigated through scientific rigors (Schönfeldt, Pretorius and Hall, 2015).

2.2. Animal Source Foods Consumption Practice

The existing country specific food-based dietary guidelines (FBDG), (MoH-N, 2006; National Counsel for Nutrition, 2011; Departmnet:Health Republic of South Africa, 2013; USDA, 2015; Ministry of Health, 2017; Canada Health, 2019) FBDG summarizing documents (WHO, 2003; Altamirano Martínez *et al.*, 2015; Montagnese *et al.*, 2015; Tee, 2015; I.van 't *et al.*, 2017) and other generic view on eating behavior (Herforth *et al.*, 2019) recommend the regular inclusion of ASF in diversified/balanced diets. Animal source foods are not-to-miss food group from diets of anyone in general and from diets of infant and young children (IYC) and lactating mothers in particular (Cervera and Ngo, 2001; FAO, 2011; WHO, 2012), though practicing the recommendations (Black, Makrides and Ong, 2016) is with deep rooted gaps to be filled through scholarly approaches. The consumption of ASF is lower in Ethiopia as compared with the global trend and consumption pattern in developed countries. The average per-capita meat consumption of an Ethiopian is estimated to be about seven kilogram, which is much than less than one-tenths of meat consumed by citizens in developed countries (BBC Amharic, no date). In general, diets in

more than 90% of the households in Ethiopia are cereal dominated with minimal inclusion of ASF (Workicho *et al.*, 2016). Animal source foods are also identified as food group to focus on to dramatically reduce the magnitude of double burden of malnutrition in low-income countries including in the African region (Dasi *et al.*, 2019).

Dietary diversity score (DDS) is a useful indicator of nutritional quality of food groups consumed and adequacy of nutrients that diets provide to the consumers (Moursi *et al.*, 2008). Analysis of data from the national DHS and pocket studies conducted at different parts of Ethiopia consistently reported that low proportions (notmore than 16%) (Aemro *et al.*, no date; Beyene, Worku and Wassie, 2015; Dangura and Gebremedhin, 2017) of IYC children met the MDD with the mostly mentioned limiting food groups being ASF (Meat, organ meet and egg) and vitamin A rich fruits and vegetables (Gatahun, 2015; Solomon, Aderaw and Tegegne, 2017), along with the Ethiopian National Food Consumption Survey (EPHI, 2013). According to a survey that was conducted using a single 24 hours consumption recall assessment techniques, the proportion of lactating mothers who ate ASF was also low (meat and fish-17%, egg-18% and dairy products-12%) (Weldehaweria *et al.*, 2016).

2.3. Facilitators and Constraints to the Consumption of Animal Source Foods

The global level ASF consumption is increasing. This is due to improved livestock production, better wealth, reduction on the price of livestock derived foods, and changing dietary preferences associated with urbanization and modernity (Delgado *et al.*, 1999). In contrary to the global trend and observation in economically well to do countries, for low and middle income countries (LMIC), the inclusion of ASF in diets and their contribution to energy and nutrient intake is limited. Consumption patterns also vary across regions and countries, and different ASF are preferred by different communities (Grace *et al.*, 2018). However, evidences on reasons for the inadequate contribution of ASF are limited. In addition, there is lack of trial documented to improve these situations. Culture-directly in terms of consumption behavior and indirectly through different mechanisms, is one of the factors that can influence not only intake of ASF, but also other food groups. Nutrition conscious individuals are expected to choose what they have to eat, and their decision is highly influenced by consumption tradition of the community in which they grew up (McMahon, 2016). A case study from five countries (Mexico, Peru, Haiti, Senegal, and Ethiopia) identified poverty, animal health, and land degradation at the community level, ASF price and

limited livestock holdings at the household level and perception of caregivers to feed ASF to children at the individual level as the most common constraints to the consumption of ASF by IYC (Pachón *et al.*, 2007). A study from Ghana conducted using participatory rapid appraisal method tried to investigate constraints to the consumption of ASF in view of availability, access and utilization. The study identified low income, lack of access to technology and markets, inequitable household food allocation, inadequate knowledge and beliefs as bottlenecks (Colecraft *et al.*, 2006). A mixed method study (quantitative and qualitative) has analyzed factors contributing to ASF consumption and identified having low income or limited income streams, high levels of small livestock morbidity and mortality leading to small or unstable flock or herd sizes, reserving livestock for sale and ceremonies, and living far from forest areas or where hunting is not allowed as barriers. Enabling factors reported were location of villages being near forest areas with wild animal populations, large number of ceremonies of long duration, households with a greater number of small livestock, and where women are able to make autonomous decisions about livestock assets (Johanna T. Wong *et al.*, 2018). A research from Uganda aimed at answering to a question - "*Does Livestock Ownership Affect Animal Source Foods Consumption and Child Nutritional Status?*" explored whether the type and number of livestock owned increase ASF consumption and improve child nutritional outcomes. The results clearly indicated significant high differences in ASF consumption patterns between by livestock owners than and non-owners. Number of large ruminants had a positive effect on dairy consumption, but insignificantly affected meat consumption. Poultry ownership increased the consumption of chicken (Azzarri *et al.*, 2015). A qualitative study on barriers and facilitators to the consumption of eggs and other protein rich foods listed sensations, the properties of the food, preparation convenience, physical environment, variety, physical health/ability, nutrition and health knowledge, food safety, social environment, morality, emotions, and habit as contributing characteristics (Heuvel, Murphy and Appleton, 2015). An interventional research that focused on evaluating the effect of the intervention on the amount of ASF consumed by IYC also identified barriers and strengthened the results. Lack of knowledge, lack of awareness on protein deficiency, obstacles from the senior members of the family, myth like fish intake create worm, food taboos, financial crisis and unavailability of the food products in local market were the hindering factors (Mukta *et al.*, 2015). A cross-sectional analysis from Kenya on the assessment of drivers to the consumption of ASF mentioned price of ASF as primary self-reported barrier, while taste and perceived nutritional value as facilitators. Access to ASF and ASF consumption tradition were also among the reasons for the less utilization of less commonly

purchased animal source foods like pork, sausages, sheep and goat meat and offal (Cornelsen *et al.*, 2016).

2.4. Consumption of Animal Source Foods in View of Health and Nutritional Status

A number of reviews discussed the contribution of ASF to betterment of nutrition status, health and human livelihood (Neumann, Harris and Rogers, 2002; Smith *et al.*, 2013; Yalçin and Yalçin, 2013; Visioli and Strata, 2014; Miranda *et al.*, 2015; Lesnierowski and Stangierski, 2018). On the other side, there are also documents with views on what aspects to be careful with regard to the consumption of ASF under the broad umbrella health (Zelalem *et al.*, 2019; Taddese, Larson and Hanley, no date; Teo, 2010). Accordingly, these days the globe has become concerned with the inter-relationship between human and animal health and has started to work on it naming the theme as "***One Health***" in which the communal planet has also to be in consideration (Evans and Leighton, 2014; Destoumieux-Garzón *et al.*, 2018; Mackenzie and Jeggo, 2019).

Consumption of ASF has been associated with better growth, cognitive function, overall activity, pregnancy outcome, and low burden of morbidity in three longitudinal observational studies from different countries (Egypt, Kenya and Mexico) with different ecology, culture and may be economic performance (Allen *et al.,* 1992; Kirksey *et al.,* 1992; Neuman *et al.,* 1992). A school based randomized controlled trial conducted by Neumann *et al.,* (2007) aimed at evaluating the causal link between ASF intake and changes in micronutrient status and growth, cognitive, and behavioral outcomes on school children. The study added animal source foods (Meat, Milk or Fat) to the plant-based dishes (*Githeri*), which they used to have, of school children on the treatment arm and provided nothing to children on the control arm. Outcome indicators analysis was computed between *Githari* only, meat added and milk added dishes and control. The *Githeri* only and meat groups performed better over time than the milk and control groups. The meat group showed the greatest increase in percentage time in high levels of physical activity and in initiative and leadership behaviors compared to all the other groups. For growth, in the milk group only younger and stunted children showed a greater rate of gain in height. The meat group showed near doubling of MUAC and the milk group a smaller degree of increase. Similarly, in another study milk and meat were provided to Kenyan school children for about two years. Meat and milk supplemented children gained 0.33cm and 0.19cm in MUAC as compared to the children who were in the control wing, respectively. In their mid-upper-arm muscle area, children who received the meat supplement

gained 30% to 80% more than the other children, and those who received the milk supplement gained 40% more than children who did not receive any supplement (Neumann *et al.*, 2007). The consumption of ASF, though through the support of a project that integrated research and development, affected the vitamin status of children. The provision of meat and milk reduced the prevalence of vitamin B_{12} deficiency (McLean *et al.*, 2007).

Milk consumption contributed to the nutritional status of children (Chen, 1989) and nutritional status and breast milk performance of lactating mothers. A total of 83 lactating Zairian mothers suffering from protein malnutrition were provided with cow milk for two months. The mother's nutritional status significantly improved after two months of receiving the milk supplements (Donnen *et al.*, 1997). Another milk based school feeding program in Malaysia was evaluated for its effect on physical growth of children. Growth fallacies were observed to reduce. Underweight (15.3% to 8.6%) and stunting (16.3% to 8.3%) come down almost by half, and wasting reduced from 2.6% to 1.7% with two years of intervention (Chen, 1989). Supplying ASF (Milk and Egg) was also ended with a positive effect on the anthropometric indices of already malnourished children. Weight, height and MUAC were significantly ($p. <0.001$) different both for milk and egg fed children as compared to the controls after an intervention that lasted for six months (Ihab *et al.*, 2014). Animal Source Foods are recommended foods to food-based approaches, including dietary diversification, designed to enhance content and bioavailability of micronutrient in diets (Gibson and Hotz, 2001).

2.5. Health and/or Nutrition Literacy as an Approach for Nutrition Education Intervention

The concept literacy is more complex and has been defined in different ways (Keefe and Copeland, 2011). With all the complexities and differences, literacy is defined in two ways: (i) conventional: involving simple reading and writing skill, and (ii) functional: where complex sets of skills and proficiencies are used as standards (Langer, 1986; Read, 1987; Roberts, 2005). Functional literacy has got importance in literacy researches and researches interested with the application of literacy constructs to improve human livelihood including nutrition (Krause *et al.*, 2016; Vettori *et al.*, 2019). Literacy is also classified in to different forms that includes financial, computer, vernacular, digital, visual, school, media, emotional, cultural, moral, health and others literacies. To the orientation of this work, it is worthy to highlight on vernacular literacy and discuss more about health and health related literacies. Vernacular literacy is defined as acquisition of knowledge in

terms of language skills (Kaphur, 2019). Literacy and educational levels are guides in designing appropriate messages adjusted according to the audiences' level of comprehension and language facility/capability. They also guides planners in choosing interpersonal and mediated approaches (Stuart and Achterberg, 2018). Accordingly, vernacular type of literacy helps to think over education strategies for communities with low literacy or educational achievement to impact their livelihood. As a result education strategies for communities with vernacular literacy should consider their mother tongue, their sociocultural conditions; should allow them to learn limited key messages verbally in their usual environment; should allow them verbally to repeat the key messages for rehearsal; and should help them on ways how to put the key messages in to practice. The other type of literacy on which to emphasize is **Health Literacy. Health Literacy** is defined as the degree to which individuals have the capacity to obtain, cognitively process, and understand health information to make informed health-related decisions (Fineman, 2005). Don (2009, 2015) also described health literacy as ''the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health.'' It is also defined as people's knowledge, motivation and competencies to access, understand, appraise, and apply health information in order to make judgments and make decisions about their everyday life concerning healthcare, disease prevention and health promotion, and to maintain or improve quality of life during the life course (Sørensen *et al.*, 2012). From the different definition and descriptions given to the concept Health Literacy, anyone can understand that it is also as complex as defining literacy; and that it is context specifi and comprehensive with multiple components (Nutbeam, 2000). With this understanding, health literacy gives itself to a health promotion approach by stimulating desired knowledge, positive attitudes, healthy practices and healthy behaviors that extend beyond individual level healthy outcomes to impact social development (Velardo, 2015). The context specific nature of healthy literacy lead to the emergency of nutrition and/or food specific forms of literacy: **Nutrition Literacy and Food Literacy**. Authors have described Nutrition Literacy as a specific health literacy sphere that reveals individuals ability to access, interpret, and use nutrition information so that he/she can lead a healthy and productive life (Blitstein and Evans, 2006; Neuhauser, Rothschild and Rodríguez, 2007; Silk *et al.*, 2008; Carbone and Zoellner, 2012; Watson *et al.*, 2013). It has been also classified in to functional, interactive and critical levels (Velardo, 2015). Functional level nutrition literacy encompasses the ability to obtain factual dietary information and develop an understanding of factors that can enhance or inhibit good health (Berman and Lavizzo-mourey, 2008). Interactive nutrition literacy

focuses on the ability to translate declarative knowledge into positive dietary choices (Blitstein and Evans, 2006). Nutrition education and communication programs have evolved from a one-way flow of communication, that is, a mere dissemination of information to persuade target groups to change food beliefs, attitudes, and habits in to a two-way modality. A two-way process of sharing is preferred, where participants in a nutrition program can freely exchange knowledge, values, and practices on nutrition, food, and related issues. This view of nutrition education as a mechanism for interaction ensures the active involvement of those who could and should take part in decision making, and in motivating and providing users with easy access to nutrition-related information, resources, and services. Critical nutrition literacy encompasses critical appraisal skills alongside increased awareness and critical/emancipatory action to address barriers to good nutrition (Guttersrud, Dalane and Pettersen, 2014). The other construct of literacy which might be considered as equal as Nutrition Literacy is Food Literacy. A lot has been said about it. Among those, some scholars tried to use it to link nutrition information with people's practical use of food to meet their day-to-day needs (Murimi, 2013; Brooks and Begley, 2014). Vidgen and Gallegos (2014) also broadly related it with knowledge, skills, and behaviors required to accessing, selecting, preparing, and eating foods, and planning for meals. The specific competencies ranged from the ability to choose foods in a timely manner, knowledge of food use and storage, knowledge of food preparation across core food groups, skills in using kitchen equipment, and knowledge of food hygiene practices.

Education is one of the tools for literacy through which communities are used to be capacitated to contribute to the quality of life they have to enjoy. It can happen formally or informally (formal, non-formal and informal education) being conducted throughout the life course or at specific time period for a specific interest. Consequently, specific nutrition related problems are in need of nutrition solutions that are broadly categorize in to nutrition specific or nutrition sensitive intervention (Arnold, 2016; Aiga *et al.*, 2020). They encompass activities implemented for nutrition education/communication, for dietary diversification, for food fortification and for nutrient supplementation. Nutrition education, be it for health and/or nutrition and/or food literacy, can be considered as an education to be conducted at specific period of time for specific interest. As specific formal education has to base on evidences to serve as a stepping stone, identifying and analyzing priority nutrition issues and behavior determinants is part of baseline assessment. The assessment encompasses (i) an epidemiological analysis of the specific nutrition issues; (ii) a policy analysis of national nutrition priorities and resources; and (iii) a behavioral analysis to identify the

barriers for adopting the desired behaviors, as well as factors that favor change is nutrition education intervention is requires (WHO and FAO, 1992). Unicef (1991) has also emphasized on the need for the same process for nutrition education intervention designing using a "Triple A: Assessment, Analysis and Action" notation. Assessment determines the priority issues, problems, local power structures, supporting institutions, communication resources, as well as relevant policies, and the degree to which these affect the state of nutrition and health of the community. Analysis studies the underlying factors that impinge on the issues, problems, structures, resources and policies. Action, in terms of community out-reach strategies, includes: consultations with decision makers at different levels to find out their needs for information; planning and preparation of easily understood messages and materials; and social mobilization of the community as a way of motivating people to cooperate and share limited resources and of empowering community decision makers, be they the local leaders, teachers, mothers, or school children. In designing appropriate community out-reach strategies, nutrition education planners need two major types of information. These are (i) information about people and (ii) information about local resources (Stuart, 1991). The information types include nutritional status, food consumption patterns, medical information, education, media access and exposure, economic status, cultural information, food and nutrition information networks, studies on functional classification, information about local resources, water supply, food production and usage, food storage, food market, housing, local institution, policy, programs and support services, and education and information resources (Stuart, 1991; Vettori *et al.*, 2019). In summary, researchers have reported that health and/or nutrition literacy status were associated with dietary intake of adults (Spronk *et al.*, 2014), unhealthy/healthy dietary patterns (Taylor *et al.*, 2019), low likelihood of sever stunting and sever underweight among children (Johri *et al.*, 2016), adherence to nutrition recommendations (Carrara and Schulz, 2018). A randomized controlled trial that aimed to improve maternal nutrition literacy had also reported improvement on stunting status of children from mothers who attended the nutrition literacy nutrition education intervention (Sirajuddin *et al.*, 2021). In addition, authors had emphasized on the need for collaborative works to improve health and/or nutrition literacy for a better livelihood (Sanders *et al.*, 2009; Carbone and Zoellner, 2012; Truman, Bischoff and Elliott, 2020). Kountz (2009) had also recommended effective strategies to overcome the barriers to health literacy (Aihara and Minai, 2011) to achieve a relatively better status. These includes conveying a few key points at session, jargon-free communication, use of pictures to clarify concepts, and confirmation of participants

comprehension through the "show-me" or "teach-back" method. He suggested that implanting the effective strategies would improve participants' comprehension.

2.6. Effect of Nutrition Education Intervention on Nutrition of Women and Children

Malnutrtion is an intergenerational or cyclic problem that need interventions at different points in the circle (Ramakrishnan *et al.*, 1999). In the cycle, the first two years of life are critical for children and too important for lactating mothers who naturally and physically care for the growing children (UNDP, 2012; Hoddinott *et al.*, 2013; Martorell, 2017). So, nutrition interventions are highly encouraged to focus on maternal and child nutrition in the first 1000 days of life, period from first day of pregnancy to second birth day of a child, to prevent and correct nutrition related problems and to sustain positive outcomes. In line to the recommendations, Ethiopia, a country with significant proportion of undernourished population (CSA, 2016a; EPHI, 2019), have framed a national nutrition policy (FDRE, 2018) and nutrtion program (FDRE, 2016) in which due attention has been given women and children nutrition.

There are nutrition education intervention conducted in Ethiopia and other countries to impact nutrition of children. Studies from Ethiopia documented that nutrition education intervention improved dietary diversity of children (Negash *et al.*, 2014; Teshome *et al.*, 2020). These studies reported statistically significant improvements on statistical mean scores of dietary diversity of the children. Regarding effect on the consumption of animal source foods, a study conducted in Burkina Faso reported increase in consumption of egg for children whose mothers received behavioral change communication (BCC) than children whose mothers did not receive it (McKune *et al.*, 2020). A research conducted in south Ethiopia discussed that a nutrition education intervention significantly improved weight-for-height and weight-for-age of children, but not height-for-age (Tariku *et al.*, 2015). Similarly, a research from Malawi documented that a community based nutrition education intervention did not make a positive difference on children's height-for-age z-scores (Kuchenbecker *et al.*, 2017).

There are also investigations with which researchers tried to impact nutrition of women. Dietary diversity was one of the central interests of nutrition interventional studies. Studies conducted in Ethiopia (Diddana *et al.*, 2018; Demilew, Alene and Belachew, 2020) documented that the interventions had positively improved dietary diversity of women participated in the respective researches. In addition, nutrition interventional studies from North-Ethiopia (Demilew, Alene and

Belachew, 2020) and Iran (Goodarzi-Khoigani *et al.*, 2018) reported improved animal source foods consumption pattern for women who attended a nutrition education intervention. But a nutrition education interventional study conducted in Kenya to evaluate its effect on nutrient intake of the women reported no significant change on the proportion of women who ate eggs and diary (Colleen *et al.*, 2017).

Agriculture is a critical focus area for food and nutrition security of rural communities like in Ethiopia. The role agriculture plays directly by servng as a source of food and source of income for food and non-food investment, its effect on food price and market, and indirectly by the opportunity it creates for nutrition sensitive interventions like nutrition education or behavioral change communication allied with other agricultural intervention are among the pathways through which it impact nutrition (Wordofa and Sassi, 2020). These pathways through which agriculture and nutrition are related increase the need for implementation of collaborative activities to improve food and nutrition conditions. Thus, aliening nutrition education/communication with results generated from assessment and analysis of environment, in view of nutrition, of agrarian communities in Ethiopia may effectively impact specific nutrition gap/s.

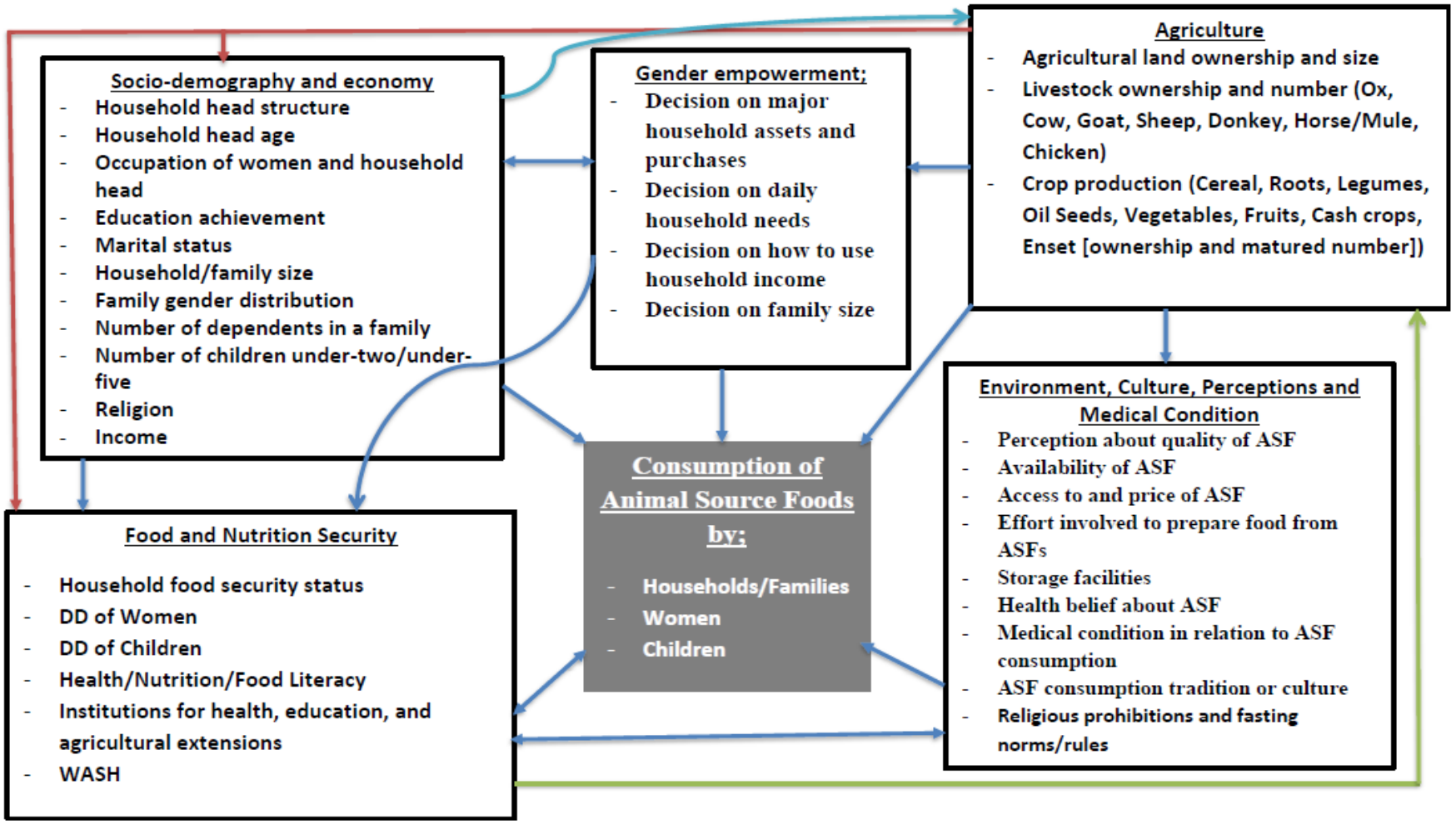

Figure 1 Conceptual framework on constructs that influence the consumption of animal source foods by households, women and children

CHAPTER THREE: MATERIALS AND METHODS

3.1. Study Area and Period: the selected study area was Hawassa Milkshed (Arsi Negele, Dale and Wondo Genet districts) (Brandsma *et al.*, 2012). Dale and Wondo Genet districts (Woreda in administrative structure of Ethiopia) are from Sidama Regional state, and Arsi Negele district is from Oromia Regional state of Ethoipia. The areas are interest locations for a collaborative research project titled "***Linking Cattle Nutrition with Human Nutrition***" (Feed the Future, no date) that was based at Hawassa University which funded this PhD research project. The study period was from May 2018-Feb 2021. Below are details on the backgrounds of Arsi Negele, Wondo Genet and Dale districts.

Arsi Negele (or **Negele Arsi**) is a town in southeastern Ethiopia located in the West Arsi Zone of the Oromia Region. The town has a longitude and latitude of 7°21′N 38°42′E and an elevation of 2043 meters above sea level (Wikipedia, no date e). Based on figures from the Central Statistical Agency of Ethiopia in 2005, Negele Arsi has an estimated total population of 42,054, of whom 21,120 are men and 20,934 are women. It is located about 215 kilometers away from Addis Ababa to the South and about 60 kilometers away from Hawassa to the North. Arsi Negele town is the administrative center of Arsi Negele district(CSA, 2007a).

Arsi Negele woreda is one of the districts in the Oromia Region of Ethiopia. It is named after its administrative center, Arsi Negele town. Arsi Negele is bordered on the south by Shashemene Zuria, on the southwest by Lake Shala which separates it from Shala, on the west from the Sidama Region, on the north by Misraq Shewa with which it shares the shores of Lake Abijatta and Langano, and on the east by the Arsi Zone. The altitude of this woreda ranges from 1500 to 2300 meters above sea level (Wikipedia, no date a). Data of the land in the woreda shows that 29.9% is arable or cultivable, 4.3% pasture, 5.2% forest, and the remaining 60.6% is considered swampy, degraded or otherwise unusable. Based on figures published by the Central Statistical Agency of Ethiopia (2007), this woreda has an estimated total population of 198,307, of whom 100,626 are men and 97,681 are women. About 21% (42,054) of its population are urban dwellers. The estimated area of the woreda is 1,400.16 square kilometers. The majority of the inhabitants were Muslim (68.86%) followed by Ethiopian Orthodox Christian (20.2%), Protestant (8.99%) and Catholic (1.04%). The four largest ethnic groups in Arsi Negele are the Oromo (85.92%), the Amhara (7.69%), the Kambata (2.73%), and the Sodo Gurage (1.08%); all other ethnic groups

made up 2.58% of the population. Oromiffa was spoken as a first language by 83.65%, 11.89% spoke Amharic, and 2.44% spoke Kambata; the remaining 2.02% spoke all other primary languages reported. There were 33 Farmers Associations with 21,777 members and 12 Farmers Service Cooperatives with 11,430 members. Arsi Negele has 48 kilometers of dry-weather and 85 all-weather road (CSA, 2007a). About 22% of the total population has access to drinking water.

Wondo Genet is located southeast of Shashemene in the Sidama Region, with a latitude and longitude of 7°1′N 38°35′E and an elevation of 1723 meters(Wikipedia, no date d). Based on figures from the Central Statistical Agency of Ethiopia (2007), Wondo Genet has an estimated total population of 5,792 consisting of 2,857 men and 2,935 women. It is located 315 kilometers away from Addis Ababa to the south and about 40 kilometers from Hawassa to the East. Wondo Genete town is the administrative center for Wondo Genet Woreda/district

Wondo Genet Woreda is one of the woredas in the Sidama Region of Ethiopia. It is bordered on the south by Malga, on the west by Awash Zuria, and on the north and east by the Oromia Region. The administrative center is Wondo Genet town(Wikipedia, no date e). Based on the census conducted by the Central statistical Agency of Ethiopia, the woreda has a total population of 155,715, of whom 79,664 are men and 76,051 women. About 15% (23,125) of its population are urban dwellers. The majority of the inhabitants were Protestant (83.26%) followed by Muslim (7.4%), Ethiopian Orthodox Christian (6.69%) and Catholic (1.68%) (CSA, 2007b).

Irgalem (Amharic: ይርጋለም, *Yirgaläm*) locally known as Diko Dalle alternate names include **Yirgalem**, **Abosto**, **Dalle**) is a town in Sidama Region of Ethiopia. It is surrounded by Lakes Woyima and Gidawo. It is located 315 kilometers south of Addis Ababa and 40 kilometers south of Hawassa. The town has a latitude and longitude of 6°45′N 38°25′E and an elevation of 1776 meters above sea level (Wikipedia, no date c). Based on figures from the central Statistical Agency of Ethiopia (2005), Yiragalem has an estimated total population of 43,815 of whom 21,840 are men and 21,975 women. Yirgalem town is the administrative center of Dale woreda/district(CSA, 2007b).

Dale is one of the woredas in the Sidama Region of Ethiopia. It is bordered on the south by Aleta Wendo and Chuko, on the west by Loka Abaya, on the northwest by Boricha, on the north by Shebedino, and on the east by Wensho. The elevation of this woreda varies from about 1200 meters above sea level along the shores of Lake Abaya to about 3200 meters at its western most

point (Wikipedia, no date b). Report about land in Dale shows that 81.9% is arable or cultivable, 2.7% forest, and the remaining 15.5% is considered swampy, degraded or otherwise unusable. Important cash crops for Dale include corn, barley, haricot beans, local varieties of cabbage, and sweet potatoes. Coffee is also an important cash crop in Dale, with 15.38 square kilometers planted with this crop. Dale has 27 kilometers of asphalt roads, 166 kilometers of all-weather roads and 28 kilometers of dry-weather roads. Based on the census conducted by the Central Statistical Agency of Ethiopia (2007), the woreda has a total population of 242,658, of whom 122,918 are men and 119,740 women. About 13% (30,348) of its population are urban dwellers. The majority of the inhabitants were Protestants (79.98%) followed by Ethiopian Orthodox Christian (8.04%), Muslim (4.69%), Catholic (3.46%) and tradition religions (1.3%). The four largest ethnic groups in Dale were the Sidama (91.29%), the Amhara (3.98%), the Oromom (1.16%), and the Welayta (1.01%); all other ethnic groups made up 2.56% of the population. Sidaamu Afoo is spoken as a first language by 92.57% of the inhabitants, 5.93% speak Amharic, less than 1% Welayta or Oromiffa; the remaining 0.71% spoke all other primary languages reported. Only 22% of the inhabitants have access to drinking water (CSA, 2007b).

3.2. Population

- Source Population**:** All households and lactating mothers and six to twenty three months old children (mother-child pairs) in Hawassa Milkshed.
- Study Population**:** Households and mother-child pairs selected following probability sampling technique to participate in this study.
- Study Unit: A household (Specific Objective 1 &2) or a mother-child pair (Specific Objective 1, 2, 3, 4 and 5)

4.3. Inclusion and Exclusion Criteria

Inclusion Criteria

- ✓ Households and mother-child pairs living in the study districts.

Exclusion Criteria**:**

- ✓ Households and mother-chil pairs who are not permanent residents of the study area.
- ✓ Mothers and children with anomalies hindering anthropometric measurements
- ✓ Mothers and children with known abstainance from ASF consumption (for objective 4)
- ✓ Mothers with children who were with medical or non-medical problem which limit them from being interviewed.

3.4. Study Design: This is a longitudinal study that employed two forms of epidemiologic study designs: (I) a community based cross-sectional study design to adress the first three specific objectives; and (II) a cluster randomized controlled trial to evaluate the effect of nutrition education mainly on the consumption of ASF by lactating mothers and IYC. Two cross-sectional studies were conducted to consider households and mother-child pairs separately. The need for doing a cross-sectional study is in consideration of Unicef's Triple A: Assessment, Analysis and Action recommendation (Unicef, 1991) for in community nutrition interventions to impact nutrion of women and children. Both the two cross-sectional studies and the randomized controlled study are conducted in the same community. Districts and kebeles/clusters selected and used to conduct the cross-sectional studies and the randomized controlled study are similar.

3.5. Sample Size Determination and Sampling Technique

Sample Size Determination: Sample size was calculated for each the specific objective. Method papers were reviewed to come up with recommended sample size calculation formulas. Sample sizes for the first three objectives were calculated using single population proportion formula (Lemeshow *et al.*, 1991), and the sample size for the fourth objective was computed with the application of two population proportion formula recommended for cluster randomized controlled trial (Rutterford, Copas and Eldridge, 2015). The recommended formula was fed to excel worksheet to function as software (**Table 1**). The excel worksheet with formula set in was used to calculate sample sizes for the cluster randomized controlled trial considering proportion for mothers and children who consumed selected AFS (dairy, eggs, meat/flesh) from the cross-sectional data analysis. Details are below in **Table 2**.

Table 1 Table used as a software in excel worksheet to calculate the sample size for the randomized controlled trial

Excel Inserted Formula: (Z1-α/2 + Z1-β)2 [P1(1-P1) + P2(1-P2)]/Δ2*1 + (n-1)ρ									
Components in the Formula	Z1-α/2	Z1-β	P1	1-P1	P2	1-P2	Δ=P1 - P2		DE=1 + (n-1)ρ
Givens and Results from Excel Workout	1.96	0.84	0.414	0.586	0.614	0.386	-0.2		2
			IYC						
			Dairy						
Representations	A	B	C	D	E	F	G	Sample Size	Sample Size*DE
Components in the Formula	Z1-α/2 + Z1-β	(Z1-α/2 + Z1-β)2	P1(1-P1)	P2(1-P2)	P1(1-P1) + P2(1-P2)	Δ2	(Z1-α/2 + Z1-β)2 [P1(1-P1) + P2(1-P2)]	(Z1-α/2 + Z1-β)2 [P1(1-P1) + P2(1-P2)]/Δ2	Sample Size*DE
Results from Excel Workout	2.8	7.84	0.242604	0.237004	0.479608	0.04	3.760127	94.00317	**188.01**

Table 2 Sample size calculation for each of the specific objectives

#	Specific Objective	Variables	Statistical Assumptions for SS Calculation	Sample Size	Study Design
1	Determine the current dietary behaviors related to the consumption of animal source foods.	- ASF consumption frequency by HH - ASF in CDDS - ASF in WDDS	- Single Population Formula(Lemeshow *et al.*, 1991) - Proportions of ASF (Meat/Flesh, Diary and Eggs) Consumption by Women (17%, 12% &18 % for meat, Diary, and Eggs respectively) (Weldehaweria *et al.*, 2016) and Children (2.6%, 60.7% &2.6% Flesh/Meat, Diary and Eggs, respectively) (Dangura and Gebremedhin, 2017).	- 422*DE HHs - 252*DE women - 404*DE children - Design Effect (DE)=1.5 for mother-child pair	Cross-sectional
2	Identify facilitators, constraints (cultural, environment, and economic) and determinants to the consumption of animal source foods.	As there was no quantitative finding to base on to calculate the sample size for facilitators, constraints and determinants of ASF consumption, we assumed the maximum sample size identified for the first objective: n=422 for HH level and n=404 for mother-child pair.			Cross-sectional
3	Determine the nutritional status of children and women	- Women's Nutritional Status (BMI and MUAC) - Children's Nutritional Status (HAZ, WHZ and WAZ)	- Formula: Single Population Formula - National Prevalence of stunting (38%), wasting (10%) and underweight (24%) for children (Central Statistical Agency (CSA) [Ethiopia] and ICF, 2016a) and undernutriotn (BMI<18.5Kg/M^2) for women (27%) (Central Statistical Agency (CSA) [Ethiopia] and ICF, 2016b).	- 398*DE children - 333*DE women - Design Effect (DE)=1.5	Cross-section
4	Evaluate effect of nutrition education intervention on the consumption of animal source foods by women and children	- ASF in WDDS - ASF in CDDS	- Formula: Two Population Proportion Formula (Rutterford, Copas and Eldridge, 2015). - Proportions of eggs, dairy and meat/flesh consumption results from the baseline were used to calculate the sample size. We assumed a 20% change.	- 190 Mother – Child pairs: 90 to each arm - Design effect= 2	RCT
5	Evaluate effect/outcome of gender based nutrition sensitive interventions on nutritional status anthropometric status of women and children	- Women's Nutritional Status (BMI, MUAC) - Children's Nutritional Status (HAZ, WHZ and WAZ)	- Because the primary outcome is specific objective number-4, this specific objective (Obj. # 5) was adressed by the sample size determined for specific Obj. #4	- Considering this as a secondary outcone sample size for specific Obj. #4 was used.	RCT

BMI=Body Mass Index; CDDS=Children Dietary Diversity Score; HAZ=Height for Age Z-score; HH: Household; MUAC=Mid Upper Arm Circumference; RCT: Randomized Controlled Trial; SS: Sample Size; WDDS; Women Dietary Diversity Score; WHZ: Weight for Age Z-score; and Weight for Age Z-Score

Sampling Technique: The districts are included in this study as they were interest areas for a collaborative research project titled "***Linking Cattle Nutrition to Human Nutrition.***" Four clusters (Kebeles that are lowest unit in administrative structure of Ethiopia) were randomly selected from each district with equal proportional allocation. Multi-stage sampling technique was used to reach to the level of picking the study units: a household and a mother-child pair.

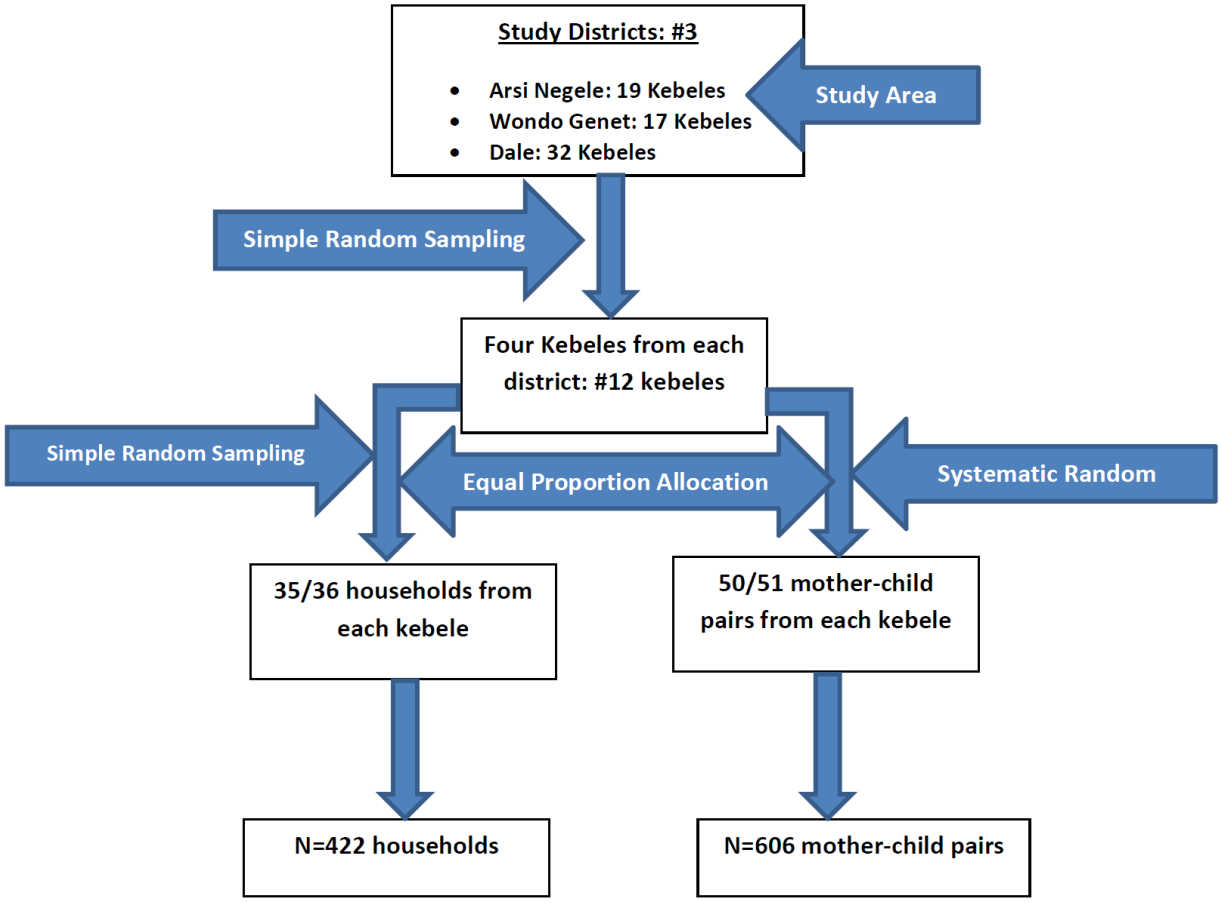

Figure 2 Diagrammatic representation of sampling procedure for the cross-section study

Participants of the cross-sectional assessments were selected with the application of simple random sampling technique for the household level assessment and using a systematic random sampling technique for the assessment done on mother-child pairs (**Figure 2**). List for all of the households in the selected kebeles was collected from respective kebele administrative unit, and list for eligible mother-child pairs was developed for each of the selected clusters through house-to-house census, with the help of health extension workers and volunteer in the respective kebele. List of households

and list of mother-child pairs were used as sampling frames. Equal proportion allocation was used to pick required number of households and mother-child pairs from each of the kebele.

The randomized controlled trial was conducted by identifying new, because of the time lost to analyze the assessments and Covid-19 lockdown, eligible mother-child pairs from the same clusters where the cross-sectional assessments were done. New list of mother-child pair was developed through a second round house-to-house census. Participants for the cluster randomized controlled trial were selected using simple random sampling technique from the newly developed sampling frame with equal proportion allocation (**Figure 3**).

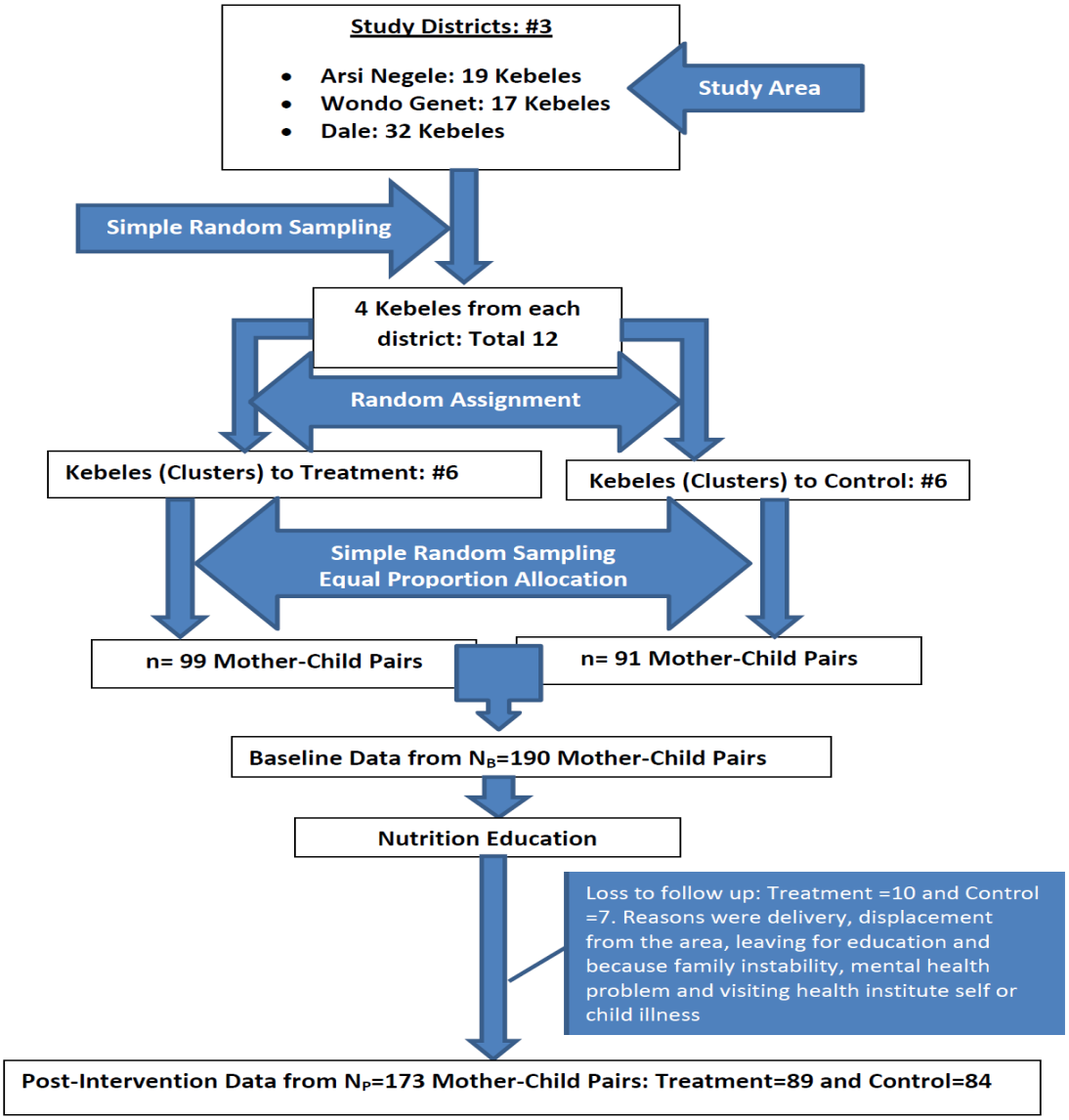

Figure 3 Diagrammatic representation of sampling process for cluster randomized controlled trial

3.6. Data Collection Tool, Anthropometric Measurement, Data Collectors and Nutrition Education

The data were collected using semi-structured questionnaire developed considering standard recommendations for household food security status (HHFS), (FANTA, 2007) and dietary diversity (DD) of women and young children (FAO, 2010) assessment. Household-level ASF consumption frequency was assessed using ASF specific food frequency screener. Animal source food consumption practice of the lactating mothers and children was assessed usind dietary diversity assessment tool for women and infant and young children. In addition, the data collection tool consistes sections for socio-demographic and economic characterstics, statements to assess constraints and facilitators to the consumption of ASF in Likert scale, water, sanitation and hygiene, illness history of mothers and children, and anthropometric measurments. The data collection tool was translated to Oromiffaa and Sidamu Afoo languages, as they were identified being common in the study districts.

Lengths of the children were measured using length board. Weights of mothers and children were measured using SECA digital weighing scale. Heights of mothers were measured using SECA stadiometer. Mid-upper arm circumference was measured using MUAC tape produced by Save the Children (the one with green, yellow and red color labling) for children and MUAC tape produced by World Food Program (fully white colored) for mothers. All anthropometric measurements (weight and height) for children and mothers were taken by the principal investigator, with an assistant for children. Standard anthropometric measurement procedures were used as it is recommended in a document developed by Food and Nutrition Technical Assistance (Bruce, 2003). Selection of measurement point/area and standardization and calibration of instruments used for measurements were considered accordingly (Bruce, 2003).

Staff from the School of Nutrition and Food Science and Technology (SNFST) of Hawassa University collected the data. The data collectors can speak Amharic (National Working Language), and they were native local languages (Oromiffa and Sidaamu Afoo) speakers. Completeness, quality and consistency of data were checked by the investigator at spot during the data collection at the field.

Nutrition education materials were developed considering relevant documents on maternal and child nutrition (Eva, 1981; Mathai *et al.*, 2000; FMoH-E, 2011; Hunter and Fanzo, 2013; WHO, 2013a,

2015; FDRE, 2018; UNICEF and WHO, 2018) and research outputs (Fabrizio, van Liere and Pelto, 2014; Negash *et al.*, 2014; Kim *et al.*, 2016; Mulualem *et al.*, 2016; Kang *et al.*, 2017; Omer *et al.*, 2018; Zongrone *et al.*, 2018). The developed nutrition education materials focused on infant and young child feeding (IYCF) (breastfeeding and complementary feeding), nutrition during lactation, dietary diversity, inclusion of ASF in diversified diets, food hygiene and water, sanitation and hygiene (WASH) practices. For each of the session, banners with pictures and key messages were prepared and posted during delivery of the respective session. The materials were originally prepared in English and then translated to the local languages (Afaan Oromo and Sidaamu Afoo).

Six nutrition professionals who can speak the local languages were recruited for the nutrition education. The research team provided five days (40 hours) intensive training to the recruited nutrition educators on the purpose of the study, purpose of the nutrition education, basics of low health literacy approach, nutrition education skills and knowledge, skills and attitude pertinent to the specific sessions to be covered by the nutrition education sessions to the mothers. During the training, teach back sessions were also conducted by the nutrition educators. This gave them to rehearse session specific knowledges and practice skills acquired before they are placed to the real community settings to deliver the nutrition education. This also provided them an opportunity to practice strategies though which they are expected to apply low health literacy approach.

Nutrition education sessions were delivered following a low health literacy approach (Murimi, 2013) in consideration of recommended strategies to improve it (Kountz, 2009). Key messages were repeatedly conveyed verbally and with posted material to mothers. Mothers were also given colored pictures of ASF to post in their house. A total of eight sessions were delivered: (1) Breastfeeding, (2) Complementary feeding, (3) Nutrition during lactation, (4) Dietary diversity (5) Inclusion of animal source foods in diversified diets, (6) WASH, (7) Review of sessions, and (8) demonstrations on IYCF. Each of the sessions on average took two hours. A group of mothers attended a session in a week. All the sessions were provided at open field under tree and at the side fences surrounding kebele administrative office or health posts or volunteers' residence compounds.

3.7. Data Quality Control Measures

Data collectors attended training for three days for the cross-section study and two days for the cluster randomized controlled trial on basics of research in community, data collection techniques, research ethics and purposes of the respective study. Pre-testes of the data collection tool was

conducted in area different from the study districts for the sake of testing and making necessary correction on the tool and familiarizing data collectors with the actual data collection scenario.

3.8. Data Management

Nutritional status indicators were generated using WHOAnthro software for children. Body mass index of the mothers were computed using excel worksheet. Nutritional status results were compared with standard cutoffs (Gibson, 2005). Other quantitative data were analyzed using Statistical Software Package for Social Sciences (SPSS). Both descriptive (frequency, mean/median scores, proportions/percentages) and inferential statistics (Statistical Tests: Chi-square tests, t-tests, Logistic Regressions) were used to generate descriptive quantitative results, identify determinants of ASF consumption practice and other nutritional outcome variables and compare statistical significance of pre- and post-intervention differences on ASF consumption status and nutritional status of mothers and children.

3.9. Ethical Considerations

Ethical clearance was obtained from Institutional Review Board at College of Medicine and Health Sciences of Hawassa University (***Ref. No: IRB/027/10***). A trial registration was made at Pan Africa Clinical Trail Registry platform (*unique identification No.:* ***PACTR201911690619601***). A letter requesting for cooperation written by the School of Nutrition and Food Science and Technology of Hawassa University was handed to the study districts' health offices (***Ref. No: S/N/F/S/T/3025/2010***). All the study subjects were informed about the purpose of the study. Their participation was on voluntary bases. Study participants were with all rounded right to refuse participation and withdraw at any time they decide. Data were kept anonymous. Participants identified with undernutrition were considered: (1) Nutrition counseling on key messages were delivered for mothers with undernutrition identified by MUAC and have moderately undernourished child; (2) As the health extension workers were involved in the data collection mainly to support child anthropometric measurements, children who are identified being severely undernourished, by the MUAC measurement, will be linked to the community based management of acute malnutrition program (FANTA, 2018) that is managed by the health extension workers themselves.

CHAPTER FOUR

Facilitators, Constraints and Predictors to Household Level Animal Source Food Consumption in Rural Communities in Ethiopia

Abstract

Animal source foods (ASF) contain quality nutrients important for growth, development, immunity and behavioral outcomes**.** Plant based foods also provide the nutrients, but with lower bioavailability than ASF. Evidence on household level ASF consumption frequency, constraints and determinants are limited for Ethiopia. Therefore, this study aimed to assess consumption frequency of ASF, and to identify predictors and constraints among rural households in Ethiopia. A cross-sectional study was conducted in 422 households. Consumption frequency of ASF was assessed using a food frequency screener over 30-days. Twelve statements with likert scale responses were used to identify constraints to ASF consumption. Ordinal logistic regression was used to identify determinants of ASF consumption. About a quarter (26%) of the households consumed milk 1-2 times/week. One out of five households consumed eggs 1-2 times/week (20%) or 1-2 times/month (19%). Poultry and meat were never consumed by 92% and 60% of the households, respectively. Unavailability, unaffordability, limited ASF consumption tradition and income generation priority from livestock rearing were constraints identified. Food insecure households were less likely to consume poultry (P =0.035), meat (P <0.001), eggs (P <0.001), milk (P= 0.035) and milk products (p. =0.005) than food secure households. Households that did not own chicken were less likely to consume eggs (P <0.001) than households that did own chicken. Households that did not own donkey were less likely to consume poultry (P =0.017) and meat (P =0.008) than households that did not own the donkey (P <0.05). Households that did not own cow were less likely to consume milk (P <0.001) and milk products (P <0.001) than households that did own cow. Households that did not produce cash crops were more likely to consume milk (p. =0.003) products than households that did produce cash crops (P <0.05). Households with more family size were less likely to consume poultry (P =0.002), meat (P =0.007) and eggs (P <0.03). Lesser household income was associated with lesser probability of meat (P <0.001), eggs (P <0.013) and milk product (P= 0.017) consumption. Hoseholds with women who never attended school are less likely to consume eggs (P =0.012) than households with women who attended school. Poor sociodemographic and economic conditions as determined by food insecurity, property ownership, income, educational achievement, family size and ASF unavailability and unaffordability contributed to lower consumption frequency of ASF by households in rural Ethiopia. Nutrition policy and programs should focus on nutrition sensitive agricultural extension, livelihood improvement and women empowerment interventions integrated with nutrition education to improve ASF consumption in rural settings.

Keywords: Animal Source Foods, Consumption Frequency, Constraints and Determinants, Households in Ethiopia

Introduction

Malnutrition is a significant public health concern. Globally, out of 676 million children underfive(Ritchie and Roser, 2020), 155 million are stunted and 52 million are wasted(UNICEF/WHO/World Bank, 2017; UNICEF, 2019). Worldwide, almost three million children die before the age of five years and 45% of those deaths are attributed to malnutrition(World Health Organization, 2019). Africa is home to about 59 million stunted and 14 million wasted children in the world. Regionally, countries located in East Africa share 4.1% of wasting and 24% of stunting (UNICEF, 2019).

Undernutrition can be manifested as either growth failure or micronutrient deficiency, and a multitude of factors contribute to undernutrition(Huybregts and Lachat, 2019). For example, low ASF consumption has been reported to increase the risks of being undernourished (Krasevec *et al.*, 2017; Headey, Hirvonen and Hoddinott, 2018; Kaimila *et al.*, 2019). Animal source foods are excellent sources of quality macro- and micro-nutrients(Schönfeldt, Pretorius and Hall, 2013) including all of the essential amino acids(Hoffman and Falvo, 2004), zinc, iron, calcium, selenium, vitamin A, vitamin B_{12}(Neumann, Harris and Rogers, 2002) and vitamin D(Schmid and Walther, 2013). Having access to such foods is vital for bone health, growth, healthy blood cell production, immunity, neurological function and behavioral outcomes (Murphy and Allen, 2003; Neumann *et al.*, 2007; Eaton *et al.*, 2019). Moreover, the addition of small quantities of ASF in a diet can improve the nutritional performance of plant based diets and consumers' nutritional status (Darapheak *et al.*, 2013; Iannotti *et al.*, 2017; Eaton *et al.*, 2019). However, there are still many communities throughout the world that have poor or minimal access to ASF (Adesogan *et al.*, 2020).

Ethiopia has a high burden of malnutrition. According to the 2016 Ethiopian Demographic and Health Survey, within half a decade small decrements in stunting (44% to 38%), wasting (12% to 10%) and underweight (29 to 24%) for children underfive were reported. In addition more than half (56%) of children underfive suffer from iron deficiency anemia (CSA, 2016b). Ethiopia is committed to ending hunger and dramatically reducing stunting by 2030 (FDRE, 2019) and emphasized the need for moderate increase in ASF consumption. A review paper illustrated that Ethiopia's per capita of meat consumption is 8 kg, which is the lowest as compared to developing countries (77 kg) and developed (25 kg) (Birhanu, 2019). In proportion it was reported that Ethiopians consume on average one-tenths as much meat as people in

developed countries (BBC Amharic, no date; FDRE, 2019). Dietary diversity and other food consumption pattern assessments also reported that limited proportion of diets in Ethiopia contain ASF. For example, according to a survey on household level dietary diversity, diets in more than 90% households were cereal dominated with little inclusion of ASF (Workicho *et al.*, 2016). Evidence from the Ethiopian National Food Consumption Survey (EPHI, 2013) and small area assessments reported that only a small proportion (11% - 16%) (Aemro *et al.*, no date; Beyene, Worku and Wassie, 2015; Dangura and Gebremedhin, 2017; Forsido *et al.*, 2019) of children met minimum dietary diversity recommendations (FANTA, 2007), and investigations documented ASF as the most limiting food group (Gatahun, 2015; Solomon, Aderaw and Tegegne, 2017).

Women and children are more vulnerable to malnutrition as compared to the general population and it is estimated that almost 30% of Ethiopian women of reproductive age had a body mass index (BMI) less than 18.5Kg/m^2 (CSA, 2016a). A study (Amare *et al.*, 2012) in Ethiopia with the majority (71%) of female participants also estimated that the intakes of nutrients available from ASF were below the recommended levels for protein (11%), calcium (90%) and vitamin-A (100%). Furthermore, almost a quarter (23%) of women enrolled in the country had iron deficiency anemia (CSA, 2016b) for which ASF have been found to be beneficial (Hall *et al.*, 2017). According to a study (Weldehaweria *et al.*, 2016) from northern Ethiopia, the proportion of lactating women who ate ASF was also low; with 17% consuming meat and fish, 18% eggs and 12% dairy products.

While ASF may protect against undernutrition, research on dietary patterns in Ethiopia has not addressed household level ASFs consumption patterns (Beyene, Worku and Wassie, 2015; Gatahun, 2015; Workicho *et al.*, 2016; Dangura and Gebremedhin, 2017; Solomon, Aderaw and Tegegne, 2017; Forsido *et al.*, 2019). Furthermore, those published studies have not investigated constraints to- and determinants of ASF consumption in the country. Hence, the purpose of this study was to determine household or family level dietary behaviors related to the consumption of ASF, and to identify facilitators, constraints and predictors of ASF consumption. The findings of the present study can be a base to strategize and realize far reaching food based nutrition interventions and to reduce the magnitude of undernutrition in rural families in Ethiopia (Government of Ethiopia, 2016; FDRE, 2018).

Materials and Methods

Study Area and Design

This cross-sectional study was conducted in rural kebeles (the lowest unit in Ethiopia's administrative structure) from the Milkshed region of Hawassa, districts of Oromia and Sidama regional states. The milkshed includes Arsi Negelle (Oromia), Dale, Wondo Genet and other districts (Sidama) (Brandsma *et al.*, 2012).

Sample size and Sampling

Sample size was calculated using a single population proportion formula (Lemeshow *et al.*, 1991) considering 50% proportion (no findings on household level ASF consumption frequency to base the estimate on), a 95% confidence level, 0.05 of alpha and 10% non-response rate. Data were collected from 422 households selected using a simple random sampling technique. Four kebeles were randomly selected from each district (12 kebeles in total). An equal proportion allocation was applied to draw sample size from each of the selected kebeles. All the respondents were women who were responsible for food preparation for the family.

Data Collection

Data were collected by individual interview using a pre-tested questionnaire. The pre-test was done in districts from Oromia and Sidama regional states, but other than districts where the actual data were collected. The tool was constituted of four parts: (1) socio-demographic and economic characteristics, (2) household food insecurity access scale (Food and Nutrition Technical Assistance Project (FANTA), 2007), (3) selected ASF consumption frequency screener, and (4) facilitators and constraints to the consumption of specific ASF questionnaire in Likert scales.

The ASF consumption frequency screener for household- (family-) level selected ASF consumption during the 30-days had closed ended response options. These were *>Once/day, Once/day, 3-6 Times/week, 1-2 Times/week, 1-2 Times/fortnight, 1-2 Times/month and Never consumed in the last month* for consumption frequency of meat, poultry, fish, egg, milk and milk products.

Data on facilitators and constraints to the consumption of ASF were collected using predefined statements with five level Likert scale response options. The statements focused on quality, availability, affordability, price of ASF as compared to plant-based food, effort involved to prepare food products from the specific ASF, ASF storage, health beliefs about specific ASF, medical concern related to consumption of ASF, ASF consumption tradition during childhood, religious

restrictions on consumption of ASF, fasting restrictions to ASF consumption and income generation priority from livestock rearing. The 12 predefined statements included items such as "*The quality of meat/fish/eggs/milk/milk products is important for me*", "*I am able to afford meat/fish/eggs/milk/milk*" "*Eating plant based foods is more affordable for us than eating meat/fish/eggs/milk/milk*" and others. All statements were provided with response options of- "strongly agree/ slightly agree/ neither agree nor disagree/ slightly disagree/ strongly disagree."

The data collectors attended three days training on basics of data collection methods, research ethics and the purpose of the study. The principal investigator supervised data collection and reviewed the questionnaires for completeness.

Data Analysis

Data were coded and entered into SPSS version 20 for Windows and cleaned. Frequencies, proportions, means or medians scores and standard deviations (SD) or inter-quartile ranges (IQR) were computed. After checking for existence of multicollinearity, predictors of specific ASF consumption frequency were identified with the application of cumulative odds ordinal logistic regression with proportional odds model at significance set at p. <0.05. The regression analysis was not done for fish because it was consumed by small proportion of households in 30-days before the survey.

Ethical Consideration

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Institutional Review Board of Hawassa University (***Ref No: IRB/027/10***). Verbal informed consent was obtained from all subjects before data collection. Verbal consent was witnessed and formally recorded.

Results

Socio-demographic and economic Characteristics

Almost all of the women were married (96%) and 81% were homemakers. Regarding education, some of the respondents (34%) had completed from grade one to five, while 43% had completed from grade six to twelve. Respondents' mean(SD) age was 25.55 ± 4.96 years. The majority of the participants identified themselves as Sidama (61%) by ethnicity and protestant (67%) (**Table 3**).

More than half (57%) of the households had four to six family members, and almost all (94%) were male headed. The median (IQR) annual household income was 6650 (3000, 15000) Ethiopian Birr [1USD≈ Birr 30.50]. This monetary income is minor in the rural family settings, where their major living expenditures are derived in-kind from their own agricultural produce, and their lifestyle is associated with low cost family labor and with natural utilities like fuel/energy, water and housing materials. Majority (80%) of the households earned less than 15,000 Ethiopian Birr or $491 annually on top of farm goods and services that make their major living. Decisions on household needs were made by the women for 58% of the households or by both husband and wife for 31% of households. Almost all (95%) households owned different amounts of agricultural land with 48% of the households owning less than one hectare. Concerning domestic animal ownership, about 43% households owned cows and 41% owned chickens. More than half (54%) of the households were food insecure (**Table 3**).

Table 3 Socio-demographic and economic characteristics of households and respondents from Hawassa Milkshed, Ethiopia (n=422)

Respondents' Characteristics		**N**	**%**
Educational Status	Never Attended School	87	20.6
	Grade 1-5	144	34.3
	Grade 6-12	179	42.6
	College and Above	12	2.8
Marital Status	Married	407	96.4
	Single	15	3.5
Age, in completed Years	≤18	25	5.9
	19 – 30	335	79.4
	≥31	62	14.6
Ethnicity	Sidama	257	60.9
	Oromo	132	31.3
	Wolayta	13	3.1
	Others	20	4.7
Religion	Protestant	283	67.0
	Muslim	117	27.7
	Orthodox	14	3.3
	Catholic	8	1.9
Occupation	Homemaker	343	81.3
	Farmer	31	7.3
	Merchant	30	7.1
	Others	18	3.7
Households' Characteristics			
Estimated Annual Income in Ethiopian Birr/US Dollar ($)	≤5000/$163	182	46.4
	5001-15000/$164-492	131	33.8
	15001 -30000/$492-983	57	14.7
	≥30001/$984	34	8.8
Head	Woman	17	4.0
	Man	396	93.9
	Grandparent/s	9	2.1
Who decides on daily household needs?	Woman	246	58.3
	Man	39	9.2
	Both Husband and Wife	130	30.8
	Others	7	1.7
Who decides how household income used?	Woman	74	17.5
	Man	90	21.3
	Both Husband and Wife	251	59.5
	Others	7	1.7
Family Size	≤3	73	17.3
	4-6	240	56.9
	≥7	109	25.8
Domestic Animal Ownership	Ox	99	23.4
	Cow	181	42.8
	Goat	50	11.7
	Sheep	39	9.2
	Chicken	175	41.4
Agriculture land ownership in Hectare	No Agriculture Land	21	5
	< 1	197	46.7
	1-2	161	38.2
	>2	43	10.2
Food Insecurity	Secure	196	46.4
	Insecure	226	53.6

Consumption Frequency of Animal Source Foods

Poultry products were not consumed in 92% of households during the month before the survey. Meat from sheep or lamb, goat, beef or cattle and other large animals was consumed 1-2 times in a month by 26% of the households. Fish products were only consumed by 3% of the households.

Milk was consumed once in a day by less than one quarter of the households (21%) and by a quarter (26%) 1-2 times in a week. Milk products like yogurt and cheese were consumed 1-2 times in a month by 15% of the households. Eggs were consumed 1-2 times in a week by 20% and 1-2 times in a month by 19% of households (**Table 4**).

Table 4 Consumption frequency of animal source foods by households from Hawassa Milkshed, Ethiopia (n=422)

Animal Source Food	Consumption Frequency	N	%
Poultry	>Once/Day to 1-2 Times/Fortnights	11	2.6
	1-2 times/Month	24	5.7
	Never Consumed	387	91.7
Meat (Sheep/Lamb, Goat, Beef/Cattle and any other Animal)	>Once/Day to 1-2 Times/Week	42	10.0
	1-2 Times/Fortnights	17	4.0
	1-2 Times/Month	110	26.1
	Never Consumed	253	60.0
Fish Products	>Once/Day to 1-2 Times/Month	11	2.6
	Never Consumed	411	97.4
Eggs	>Once or Once/Day	12	2.8
	3-6 Times/Week	32	7.6
	1-2 Times/Week	86	20.4
	1-2 Times/Fortnights	20	4.7
	1-2 Times/Month	81	19.2
	Never Consumed	191	45.3
Milk	>Once or Once/Day	90	21.3
	3-6 Times/Week	47	11.1
	1-2 Times/Week	108	25.6
	1-2 Times/Fortnight	22	5.2
	1-2 Times/Month	76	18.0
	Never Consumed	79	18.7
Milk Products (Yogurt, Cheese, Whey …)	>Once or Once/Day	18	4.3
	3-6 Times/Week	20	4.7
	1-2 Times/Week	30	7.1
	1-2 Times/Fortnight	24	5.7
	1-2 Times/Month	66	15.6
	Never Consumed	264	62.6

Facilitators to the Consumption of Animal Source Foods

Nearly all of the study participants (97%) agreed with the statement "*The quality of meat is important for me*", and 98% agreed that eating meat is good for their health. About 64% of the participants did not agree with the statement "*It takes a lot of effort to prepare and cook meat*"; and 70% did not perceive lack of proper meat storage technologies as a barrier to meat consumption. Majority of the participants reported that they did not have religious prohibition on the consumption of meat (91%), eggs (91%) and dairy products (93%). Nearly all of the respondents (92% for meat, 94% for egg, and 94% for dairy) disagreed with the statement "*I don't eat meat/egg/dairy products when I am fasting.*"

About two-thirds of the participants reported that they can afford eggs (60%) and the majority reported that eggs are available (78%) where they shop. Lack of proper egg storage did not prevent majority of the study participants (76%) from egg consumption.

The majority of participants (76%) reported that milk and milk products were regular components of their diet while growing up as children. About 82% of respondents agreed that milk and milk products are available where they usually shop, and more than two-thirds (70%) agreed that they could afford milk and milk products (**Table 5**).

Table 5 Analysis of facilitators and constraints to the consumption of meat, egg and dairy in Hawassa Milkshed, Ethiopia (n=422)

Statement of agreement or disagreement	Responses (%)														
	Meat					Egg					Dairy				
	-2	-1	0	1	2	-2	-1	0	1	2	-2	-1	0	1	2
The quality of meat/egg/dairy is important for me	1.2	0.5	1.9	10	86.5	2.2	1	6.7	8.9	81.3	0.5	0.2	1.4	7	90.9
It is difficult to find meat/egg/dairy that I like or want where I usually shop	10.9	13.8	5.7	17.7	51.9	3.4	9.6	8.1	41.6	37.2	38.7	43.1	1.4	1.3	5.5
I am able to afford for meat/egg/dairy	10.4	7.2	2.4	40.9	39.1	12.3	19.2	2.5	41.9	24.1	9.9	18.8	1.7	45.7	24
Lack of proper meat/eggs/dairy storage prevents me from eating meat/eggs/dairy as often as I would like to eat	34.2	29.5	4.5	27.8	3.6	48.5	27.3	3.4	19	1.7	41.1	34.1	3.4	20.7	0.7
It takes a lot of effort to prepare and cook meat/egg/dairy	41.1	28	5.9	22.1	2.9	51	26.8	6.9	14.3	1	46.9	32.5	5	14.9	0.7
I think eating meat/egg/dairy is good for my health	0.5	1.5	0.2	3.3	94.8	0.5	0.5	0.5	3.2	95.3	0.5	0.2	0.5	3.4	95.4
My health doesn't allow me to eat meat/egg/dairy	79.8	9.3	3.6	4.8	2.6	83.3	7.6	2.5	7.6	83.3	82.5	9.4	2.4	2.9	2.9
Meat/egg/dairy was a regular component of my diet while growing up	25.7	24.2	2.9	28.5	18.8	19.7	21.7	4.4	31.8	22.4	9.6	12.7	1.7	37.5	38.5
My religion doesn't prohibit me eating of meat/egg/dairy	1.5	2.5	4.5	9	82.4	0.9	1.1	5.9	8.4	83	0.8	0.4	5.8	8.2	84.9
I don't eat some kinds of meat because of my religion	44.4	10.9	6.2	29.9	8.6	-	-	-	-	-	-	-	-	-	-
I don't eat meat/egg/dairy when I am fasting	83.4	8.8	1.4	2.1	4.3	87.9	5.7	1.7	1.7	3	87.5	6	1	2.4	3.1
Although we rare chicken and other livestock, we use them for income	23.2	15	26.7	20.3	14.8	29.6	17.2	23.4	20.4	9.4	37.5	20.4	22.8	11.8	7.5
Eating plant-based foods is more affordable to us than eating of meat/egg/dairy	1.9	2.1	4.3	13.5	78.1	2.5	1.2	3	22.7	70.7	4.1	3.9	2.4	18.1	71.6

2: Strongly Agree; 1: Slightly Agree; 0: Neither Agree nor Disagree; -1: Slightly Disagree; -2: Strongly Disagree

Constraints to the Consumption of Animal Source Foods

Most of the participants (70%) agreed that it is difficult to get meat where they usually shop, while majority of them (80%) indicated that they cannot afford meat (**Table 5**). The majority reported that plant based food products were more affordable than meat (92%), eggs (93%), dairy (90%) and fish (91%). About half (50%-for meat and 57% for fish) of the participants disagreed with the statement "*Meat or fish was a regular component of my diet while growing up."* Almost all of the respondents (99%) indicated that fish was not available where they usually shop, while more than half of the participants (58%) reported that they could not afford fish (**Tables 5 & 6**).

Table 6 Analysis of facilitators and constraints to the consumption of fish in Hawassa Milkshed, Ethiopia (n=422)

Statement of agreement or disagreement	Response (%)				
	-2	**-1**	**0**	**1**	**2**
The quality of fish is important to me	0.4	16.2	35.3	16.2	47
The fish that I want to eat are available where I usually shop	0.4	0.8	0.3	29.7	68.8
I am able to afford fish	5.3	21.1	15.5	33.5	24.4
It takes a lot of effort to prepare and cook fish	5.3	25.9	35.7	18.8	14.3
Lack of proper fish storage prevents me from eating fish as often as I would like to eat	3	25.9	34.8	19.9	16.3
I think eating fish is good for my health	2.6	0.3	21.1	0.4	75.6
My health does not allow me to eat fish	4.9	1.9	47.8	7.1	38.3
Fish was a regular component of my diet while growing up	35.3	21.4	26.5	9.2	7.5
My religion doesn't prohibit me eating of fish	1.5	0.4	7.1	17.7	73.3
I don't eat fish when I am fasting	1.5	1.5	12.4	8.6	75.9
Although we rear fish, we sell them for income	-	-	-	-	-
Eating plant based foods is more affordable to us than eating of fish	0.8	0.3	7.9	10.2	80.8

2: Strongly Agree; 1: Slightly Agree; 0: Neither Agree nor Disagree; -1: Slightly Disagree; -2: Strongly Disagree

Predictors of Household Level Animal Source Foods Consumption Frequency

Household food insecurity was significantly associated with consumption frequencies of all ASF types. Food insecure households were less likely to consume poultry (AOR=0.35, p. =0.035), meat (AOR=0.25 p. <0.001), eggs (AOR=0.44, p. < 0.001), milk (AOR=0.66, p. =0.035) and milk products (AOR=0.52, p. =0.005) than food secure households (**Tables 6&7**).

Family size was a factor in poultry and meat consumption patterns. Households with four to six (AOR=0.34, p. =0.029) or seven or more (AOR=0.11, p. = 0.002) members were more likely to have low frequency of poultry consumption than households with three or fewer members. Family size of seven or more predicted reduced household probability of meat consumption by 62% (AOR=0.38, p. =0.007). An estimated annual income of 5000 ETB or less also reduced meat consumption probability of households by 81% (AOR=0.19, p. <0.001) compared to those earning more than 30,000 ETB annually (**Table 6**).

Households with an estimated annual income of 5000 ETB or less (AOR=0.38, p. = 0.013), four to six family size (AOR=0.57, p. = 0.031) and no chicken ownership (AOR=0.33, p. <0.001) were less likely to consume eggs. Households that did not own donkey were less likely to consume poultry (AOR=0.25, p. =0.017), meat (AOR=0.38, p. =0.008) and eggs (AOR=0.55, p. =0.06) than their counter parts (**Table 7**).

Table 7 Ordinal logistic regression analysis on predictors of poultry, meat and egg consumption frequency by households in Hawassa Milkshed, Ethiopia (n=422)

Characteristics		Poultry		Meat		Eggs	
		AOR(95%CI)	***p.***	**AOR(95%CI)**	***p.***	**AOR(95%CI)**	***p.***
Food Insecurity	Insecure	0.35 (0.13, 0.93)	0.035	0.25 (0.16, 0.40)	0.000	0.44 (0.29, 0.66)	0.000
	Secure	1		1		1	
Cash Crops Production	No	0.40 (0.11, 1.46)	0.168	0.98 (0.46, 2.09)	0.954	0.92 (0.46, 1.86)	0.822
	Yes	1		1		1	
Chicken Ownership	No	0.70 (0.28, 1.71)	0.43	0.90 (0.57, 1.43)	0.658	0.33 (0.22, 0.50)	0.000
	Yes	1		1		1	
Donkey Ownership	No	0.25 (0.08, 0.78)	0.017	0.38 (0.18, 0.77)	0.008	0.55 (0.29, 1.03)	0.06
	Yes	1		1		1	
Sheep Ownership	No	2.80 (0.62, 13.53)	0.176	0.97 (0.48, 1.96)	0.929	0.97 (0.51, 1.88)	0.938
	Yes	1		1		1	
Goat Ownership	No	1.24 (0.37, 4.18)	0.726	1.58 (0.77, 3.27)	0.216	0.86 (0.47, 1.59)	0.636
	Yes	1		1		1	
Cow Ownership	No	1.36 (0.51, 3.63)	0.544	1.24 (0.76, 2.02)	0.389	0.99 (0.63, 1.53)	0.947
	Yes	1		1		1	
Ox Ownership	No	0.61 (0.23, 1.64)	0.324	1.56 (0.88, 2.77)	0.132	0.86 (0.52, 1.41)	0.541
	Yes	1		1		1	
Women's Educational Status	No Education	0.1 (0.01, 1.06)	0.056	0.51 (0.14, 1.88)	0.311	0.20 (0.06, 0.71)	0.012
	Grade 1-5	0.22 (0.03, 1.70)	0.148	0.94 (0.27, 3.22)	0.918	0.50 (0.15, 1.63)	0.248
	Grade6-10	0.15 (0.02, 1.12)	0.064	0.79 (0.23, 2.70)	0.707	0.68 (0.21, 2.19)	0.517
	Higher Education	1		1		1	
Family Size	≥7	0.11 (0.03, 0.45)	0.002	0.38 (0.19, 0.77)	0.007	0.60 (0.32, 1.14)	0.117
	4-6	0.34 (0.13, 0.89)	0.029	0.59 (0.34, 1.03)	0.064	0.57 (0.34,0.95)	0.031
	≤3	1		1		1	
Households Estimated Annual Income in Ethiopian Birr	≤5000	0.27 (0.07, 1.08)	0.064	0.19 (0.08, 0.42)	0.000	0.38 (0.18, 0.82)	0.013
	5001-15000	0.66 (0.18, 2.38)	0.524	0.50 (0.23, 1.11)	0.088	0.92 (0.43, 1.97)	0.829
	15001-30000	0.86 (0.20, 3.77)	0.845	0.83 (0.35, 1.96)	0.672	0.99 (0.43, 2.29)	0.997
	≥30001	1		1		1	
Respondents' Religion	Orthodox/Catholic	0.77 (0.07, 9.03)	0.835	1.28 (0.50, 3.25)	0.606	2.37 (0.99, 5.68)	0.053
	Muslim	3.19 (0.86, 11.79)	0.835	0.53 (0.24, 1.16)	0.113	2.87 (1.44, 5.71)	0.003
	Protestant	1		1		1	

(1) AOR: adjusted odds ratio; (2) Maximum Variance inflation factor (VIF): Poultry=2.08; Meat=2.08; Eggs=2.08; Pseudo R-Square: For Poultry =0.32; For Meat=0.28; For Eggs=0.34

Table 8 showed that households with more than 2 hectares of agricultural land were more likely to report consuming milk on a daily basis than households with one hectare or less (AOR=0.48, p. =0.039). Households who owned cows were more likely to consume milk (AOR=0.42, p. < 0.001) and milk products (AOR=0.35, p. <0.001) frequently than that didn't own cows. Households with no cash crop production were more likely (AOR=3.01, p. = 0.003) to consume milk products more frequently than households producing cash crops. In contrast to households with an estimated annual income of more than 30,000 ETB, those with annual income of less than 5000 ETB were less likely (AOR=0.37, p. = 0.017) to consume milk products.

Table 8 Ordinal logistic regression analysis on predictors of milk and milk products consumption frequencies by households in Hawassa Milkshed, Ethiopia (n=422)

		Milk		Milk Products (Yogurt, Cheese, Whey…)	
Characteristics		**AOR(95%CI)**	***p.***	**AOR(95%CI)**	***p.***
Household Food Insecurity	Insecure	0.66 (0.45, 0.98)	0.035	0.52 (0.33, 0.83)	0.005
	Secure	1		1	
Cash Crops Production:	No	0.93 (0.49, 1.74)	0.813	3.01 (1.46, 6.20)	0.003
Coffee, khat...	Yes	1		1	
Chicken Ownership	No	0.75 (0.51, 1.11)	0.149	1.10 (0.69, 1.76)	0.684
	Yes	1		1	
Donkey Ownership	No	0.91 (0.49, 1.70)	0.768	1.01 (0.53, 1.93)	0.979
	Yes	1		1	
Sheep Ownership	No	0.63 (0.33, 1.21)	0.169	0.44 (0.22, 0.90)	0.024
	Yes	1		1	
Goat Ownership	No	1.5 (0.83, 2.72)	0.182	0.90 (0.47, 1.71)	0.742
	Yes	1		1	
Cow Ownership	No	0.42 (0.28, 0.64)	0.000	0.35 (0.21, 0.58)	0.000
	Yes	1		1	
Ox Ownership	No	0.8 (0.49, 1.31)	0.372	0.95 (0.55, 1.64)	0.856
	Yes	1		1	
Women's Educational Status	No Education	0.29 (0.08, 1.01)	0.052	0.61 (0.16, 2.36)	0.471
	Grade 1-5	0.37 (0.11, 1.24)	0.107	1.20 (0.33, 4.31)	0.784
	Grade 6-10	0.67 (0.20, 2.22)	0.517	0.87 (0.24, 3.09)	0.827
	Higher Education	1		1	
Agriculture Land Ownership	No Land	0.71 (0.22, 2.26)	0.557	0.55 (0.12, 2.49)	0.441
and Size	<1Hr	0.48 (0.23, 0.96)	0.039	1.35 (0.55, 3.33)	0.519
	1-2Hr	0.71 (0.37, 1.38)	0.309	1.52 (0.66,3.53)	0.33
	>2Hr	1		1	
Family Size	≥7	0.73 (0.41, 1.32)	0.3	0.99 (0.49, 2.02)	0.995
	4-6	0.72 (0.44, 1.18)	0.19	0.86 (0.47, 1.55)	0.608
	≤3	1		1	
Household Estimated Annual	≤5000	0.48 (0.23, 1.02)	0.055	0.37 (0.16, 0.84)	0.017
Income in ETB	5001-15000	0.61 (0.29, 1.30)	0.204	0.47 (0.21, 1.05)	0.066
	15001-30000	1.51 (0.66, 3.47)	0.331	0.43 (0.17, 1.08)	0.074
	≥30001	1		1	
Respondents' Religion	Orthodox/Catholic	1.84 (0.80, 4.24)	0.15	1.96 (0.71, 5.43)	0.196
	Muslim	1.94 (1.03, 3.64)	0.04	2.74 (1.35, 5.56)	0.005
	Protestant	1		1	

AOR, adjusted odds ratio; Hr, hectare; ETB, Ethiopian Birr

Maximum variance inflation factor (VIF): Milk=2.08; Milk Product=2.08; Pseudo R-Square: For Milk =0.27; For Milk Products =0.33

Discussion

The purpose of this study was twofold: (1) to assess household level dietary behaviors related to the consumption of animal products, and (2) to identify facilitators, constraints and predicotrs of household level ASF consumption. We found that poultry was not consumed by 92% of the participating households, and meat was not consumed by 60% of the households over a one-month period. This is in agreement with other papers (Delgado *et al.*, 1999; Abegaz, Hassen and Minten, 2018) those described limited inclusion of ASF in diets of families in low and middle income countries (India, China, Latin America). However, there are also studies in which better consumption patterns were reported. In south Ethiopia, once in a month consumption of meat was reported for 80%, 72% and 26.8% of households in Wolaita Sodo town (Amistu K, Ermias B and Asrat A, 2017), Mirab Abaya (Yibrah and Esheti, 2017) and Hawassa city (Lijalem, Beyan and Banerjee, 2013). As the studies were conducted in towns, the difference in consumption practice from the current study could be subject to the availability of retailer butcher houses and households' interest to pay and purchasing power. The habit of frequent meat consumption in the immediate local culture may also have contributed. A study from Sudan (Khalid *et al.*, 2017) also reported once per-week meat consumption frequency for more than two-thirds (68%) of the studied households. Overall, in the present study meat consumption was constrained by the reported unavailability (70%) and unaffordability (80%) of the food product.

About a quarter of the studied households consumed milk once per-day (21%) or 1-2 times per-week (26%). According to a study conducted in East Shoa Zone in Ethiopia, 67-100% of households from urban areas and 67-87% of households from peri-urban areas consumed milk 3-6 times per-week (Melesse and Beyene, 2009). The variations could be due to study setting, socioeconomic and food habit differences in urban and rural scenarios. A study conducted in China identified that urban dwellers consume more animal products than those in rural areas (Streeter, 2017). Animal product consumption also increased in response to income growth.

Eggs were consumed 1-2 times per-week (20%) or 1-2 times per-month (19%) by about one-fifth of the households during the one month period prior to the day of assessment. In the present study egg consumption was found to be better than poultry, meat, and fish. This could be because of relative availability (78%) and affordability (60%) of eggs as many of the participants reported. However, egg consumption frequency in this study was lower than a report from Hyderabad district in India, where daily egg consumption was reported for half (51%) of the households (Memon *et al.*, 2009). Egg consumption habit, higher price as compared to plant-based food items, and poultry production primarily for income generation (Hundie *et al.*, 2019; Haileselassie *et al.*, 2020) might have constrained consumption of eggs.

Meat was unavailable in the rural settings to more than two-thirds of research participants (70%), where they usually shop, while 80% could not afford the price. Plant-based food products were more affordable than meat for 92% of the respondents. The present findings are supported by reports (Pachón *et al.*, 2007; Haileselassie *et al.*, 2020) that identified poverty and high price of nutritious foods including animal products as constraints of ASF consumption. A study from Ghana (Colecraft *et al.*, 2006) identified low income and lack of market access as contributing factors for low ASF consumption.

Availability, positive attitudes to its quality, relative affordability, less effort needed to prepare and cook, storage, and favorable beliefs about health benefits were found to be facilitators for consumption of eggs. However, income generation priority from poultry rearing, and higher price of egg (93%) as comparison to plant-based food were the constraints identified. A large proportion of households (91%) in Ethiopia rear chickens for the sake of income generation and savings (Hundie *et al.*, 2019; Haileselassie *et al.*, 2020) rather than household level consumption similar to the current findings.

Unlike the findings from the Amhara (Kim *et al.*, 2019) and Tigray (Haileselassie *et al.*, 2020) regions with more Orthodox Christians, and from a review on meat consumption (Seleshe, Jo and Lee, 2014) religion and related fasting did not hinder the use of ASF in the present study. This could be because of the dominating Protestant (67%) and Muslim (28%) religion followers in the present study areas, who do not abstain from consumption of ASF during their fasting seasons.

Household food insecurity and ASF consumption pattern were associated. Food insecure households were less likely to consume poultry, meat, eggs, milk and milk products than food secure households. In Ethiopia, a 40-70% price increment was documented for nutritious food commodities like eggs, meat, dairy and other products since the year of 2005 (Minten and Fantu, 2020). Studies from Jimma in Ethiopia (Asesefa Kisi *et al.*, 2018) and Sierra Tarahumara in Mexico (Cordero-Ahiman, Santellano-Estrada and Garrido, 2018) identified households' shifting to inexpensive food items as a coping strategy for food insecurity. This could explain the inverse association between household food insecurity and ASF consumption frequencies observed in the present study districts.

The consumption of ASF is expected to increase when a household owns domestic animals as a source of food commodities and income for diversified diets. According to the results of the present study, households owning cows were likely to consume milk and milk products more frequently than households not owning cows. Households with chickens were also more likely to consume eggs than households with no chickens. Households with donkeys were more likely to consume poultry, meat and eggs than households without donkeys. Studies (Marshall and Ali, 2000; Angara, T. E. E., Ismail, A. A. and Ibrahim, 2011; Valette, 2015; Geiger *et al.*, 2020) from Ethiopia have identified that donkeys contribute to human livelihood and household food security through their role in income generation and gender empowerment. This might have contributed to the observed positive associations between donkey ownership and ASFs consumption frequency.

Lesser farmland size and cash crop production practice were inversely associated with households' dairy product consumption frequency. Land size is an important asset for farming households in the study districts. Larger land allows households to rear cows on free grazing (Duressa *et al.*, 2014) to serve as source of dairy products (Rahman, SMR., Hashan, S., Shahjahan, MD. and Islam, 2001). On the other hand cash crops may constantly take over the limited land holding and make it unfit for traditional livestock farming that would contribute to ASF availability and access.

Education is an important tool of empowering human being to positively influence livelihood (Miller *et al.*, 2017; Tran *et al.*, 2020). In the present study, households with women with better education achievement were more likely to consume eggs than households with women who never attended formal education.

Larger family size has been discussed for its negative effect on household food security (Harris-Fry *et al.*, 2017; Agidew and Singh, 2018) and that may be because it constrains households' food purchasing power and challenges intra-household food distribution. Correspondingly, in the current study more family size was negatively associated with household level poultry, meat and eggs consumption. This may call for food based interventions on improvement of diversified agricultural production, family planning, and income generation with nutrition education for the public at large.

Less eggs, meat, and milk products consumption frequencies was associated with estimated annual income of 5000ETB or less. In line with the observed negative association between low income and ASF consumption in this study, a global analysis on affordability of dietary recommendations (Hirvonen *et al.*, 2020) mentioned that diets in low and middle income countries might face limitations for nutritious foods like eggs, meat, fish, dairy, fruits and vegetables as they are high-cost food groups.

Despite comprehensively addressing evidence gaps related to ASF consumption patterns, because this study is cross-sectional it cannot identify causal relationships between the identified predictors and respective ASF consumption (Mark, 1999; Jorn *et al.*, 2010). Interpretation of the results must

also consider the unavoidable methodologic limitations (Gibson, 2005) of consumption frequency assessment like increased probability of recall bias as the period for which respondents had to remember was a full month. It is also good to consider possibility of respondents' desire to show being needy regardless of status.

Conclusions

Meat, poultry and fish were consumed less frequently than dairy and eggs. The consumption of poultry, meat and fish was nutritionally negligible. In general, ASF were not consumed often by households in the studied rural districts in Ethiopia. Unavailability, unaffordability, limited ASF consumption tradition, income generation priority from livestock rearing and higher price of ASF than plant-based foods were constraints identified.

Poverty as determined by food insecurity, income and property ownership hampered ASF consumption frequencies. Cow, chicken and donkey ownership amplified selected ASF consumption frequencies. Poultry, meat and eggs were less frequently consumed by households with lowest estimated annual income category. Women's lack of formal schooling and larger family size also contributed to the less frequent consumption of some types of ASF. Policies and programs on food-based nutrition interventions should focus on improvement of diversified agricultural production through nutrition-sensitive agricultural extension, family planning, livelihood improvement, women's empowerment and job opportunities to generate income integrated with nutrition education, and evaluate their effects on nutritional status of the public at general and on ASF consumption patterns in particular.

CHAPTER FIVE

Predictors of Animal Source Food Consumption, Minimum Dietary Diversity, Meal Frequency and Nutritional Status among Lactating Mothers in Rural Districts of Ethiopia

Abstract

The first 1000 days of life are critical for children and for the mothers who breastfeed and care for the children. In the portion of this period, from birth of a child until the second birth day, lactating mothers need special attention given that their dietary practices positively impact on their nutritional status coupled with growth and development of their babies. Thus, lactating mothers are recommended to have two additional meals in a day, eat diversified diets every day including animal source foods (ASF) and keep healthy nutritional status. Hence, this study was sought to assess meal frequency, minimum dietary diversity of women (MDDW), ASF consumption and nutritional status, and identify their predictors among lactating mothers in rural districts of Ethiopia. A community based cross-sectional study was conducted among 606 lactating mothers from three rural districts in Oromia and Sidama regions of Ethiopia. Data were collected through interviewer-administered questionnaire. Nutritional status was assessed using body mass index (BMI) and mid-upper-arm-circumference (MUAC). Predictors of number of meals in a day, MDDW, nutritional status and ASF consumption were identified using logistic regression. Almost all mothers consumed four or less meals in a day (92.1%) and from four or less food groups (90%). One out of five mothers consumed eggs (5.4%) and meat (5.1%). Slightly more than a quarter (27.6%) of the lactating mothers consumed dairy. Mothers were identified as undernourished using BMI (12.6%) and MUAC (10.7%). Cash crop production and food insecurity were associated with meal frequency ($P < 0.05$). Root crops production, maternal educational status, household annual income and chicken ownership predicted MDDW ($P < 0.05$). Hand washing practice of the mothers after cleansing child's bottom, household food insecurity and child age were associated with maternal nutritional status ($P < 0.05$). Mothers who lived in food secure households were more likely to consume meat ($P = 0.009$), eggs ($P = 0.009$) and dairy ($P = 0.014$) than mothers who lived in severely food insecure households. Meat consumption was four times ($P = 0.009$) more likely for mother from cash crop producing households than mothers from households that did not produce cash crops. Mothers lived in households that did produce root crops were more than three times ($P = 0.012$) likely to consume eggs than mothers lived in households that did not produce root crops. Mothers from households with estimated annual income of 10,001-15000 Ethiopian birr (ETB) were more than two times more likely to consume at least one of the ASF ($P = 0.014$) than mothers from households with ≤5000 ETB estimated annual income. Mothers that lived in households that owned cow ($P = 0.003$) or chicken ($P = 0.041$) were about two times more likely to consume at least one of the ASF than mothers lived in households that did not own cow or chicken. Merchant mothers were four times more likely ($P < 0.001$) to consume at least one of the ASF than mothers who were housemakers. Maternal undernutrition remains as a medium level public health problem that may attribute to limited achievements number of meals per-dayand MDDW, and to low ASF consumption. Majority of the lactating mothers did not meet the minimum recommended number of meals per-day and MDDW. Eggs, meat and nuts were least consumed food groups. Consumption of ASF was predicted by food security, maternal education and occupation, livestock ownership, crop production and household income. Nutrition programs in rural districts of Ethiopia shall focus on agricultural productivity including healthy and efficient livestock productivity and women empowerment integrated with behavioral change communication on nutrition of lactating mothers. Future researches shall focus on behavioral change communication for nutrition of lactating mothers integrated with livelihood improving activities.

Keywords: Lactating Mothers; Meal Frequency; Animal Source Foods; Dietary Diversity; Nutritional Status; Ethiopia

Introduction

Women are more vulnerable to food insecurity and malnutrition than men (Olson, 2005; Hadley *et al.*, 2008; Broussard, 2019; Negesse *et al.*, 2020). They also share the health and nutrition related burdens with their growing children expected to happen in the first 1000 days, a period from first day of pregnancy to the child's second birth day. So, their chance to be undernourished increases during pregnancy and breast feeding periods (Gewa, Oguttu and Yandell, 2012). The physiologic changes, physical and psychologic stress(Anato, Tafese and Stoecker, 2019), changes in appetite, feeding behavior and metabolism, increased nutritional needs, decrease in natural immunity, increased susceptibility to infections and cultural food taboos (Hadush *et al.*, 2017; Getnet, Aycheh and Tessema, 2018; Mohammed *et al.*, 2019) are among the contributing factors to maternal undernutrition.

Energy and nutrient requirements of lactating mothers is higher non-lactating mothers. A lactating mother needs in average 500Kcal of additional energy. Requirements for micronutrients like calcium, iron, zinc and folic acid also tends to increase during the breastfeeding period (Cervera and Ngo, 2001; Dewey, 2004). The increase in nutritional requirements demands adjustments in meal frequency and consumption of diversified diet including ASF. For instance, they are recommended to consume a diversified diet-from five or more food groups including ASF, and additional meals (may be two more meals according to Ethiopian meal culture) in Ethiopia and nutrition recommendations from ministry of health) on daily basis (FAO, 2010; FMoH-E, 2011; WHO, 2013a).

Though nutritional status of Ethiopian childbearing age women is not well studied as compared to the other developing countries (Ahmed *et al.*, 2014; Bhandari *et al.*, 2016; Mtumwa, Paul and Vuai, 2016), national report-22% (CSA, 2016b) and a regional state specific study-35% (Taddese, Larson and Hanley, 2008) documented that considerable proportion of reproductive age women in Ethiopia suffer from undernutrition. A study on adult urban dwellers with 71% female and 29% male sample found that 12.9% of the participants were undernourished. As per the result of the same study, the mean energy intake of women was less and mean energy intake of men was higher than the recommendations. In addition, nutrients found mainly in ASF for the majority of the participants were below the recommended levels: protein (11%), calcium (91%) and retinol (100%) (Amare *et al.*, 2012). In another study, it was reported that 27% of lactating women lived in food insecure households and 57% achieved low dietary diversity score (DDS). According to the study, less than one-fifths of lactating mothers ate ASF (meat and fish; 17.1%, egg; 18.2% and milk and milk

product; 12.4%) (Weldehaweria *et al.*, 2016). It was note worth that achieving higher DDS was associated with better maternal BMI and MUAC (Savy *et al.*, 2006; Dickson A Amugsi *et al.*, 2016), reduced maternal micronutrient deficiency and adverse pregnancy outcomes (Amugsi, Mittelmark and Oduro, 2015). In addition, maternal BMI was associated with weight for height (WHZ), height for age (HAZ) and BMI for age Z-score (BAZ) values of their children (Savy *et al.*, 2006; Negash *et al.*, 2015; Zerfu, Umeta and Baye, 2016; Zhang and Kang, 2016).

Making a modification to the former dietary diversity score (DDS), an assessment that fully depends on respective research data distribution in which consumption from mean score or above food groups was used as a cutoff (FAO, 2010), currently it is recommended to use dichotomous indicator with 5 or more food groups as a cutoff to assess minimum dietary diversity of women (MDDW) (Martin-prevel *et al.*, 2017). In addition of being limited in number, researches done on DDS of lactating mothers in Ethiopia (Weldehaweria *et al.*, 2016; Boke and Geremew, 2018) were: (1) not conducted with contemporary concept of MDDW (Weldehaweria *et al.*, 2016; Boke and Geremew, 2018), (2) with methodologic problem-assessed for misclassified food groups (Boke and Geremew, 2018), (3) did not addressed number of meals per-day in Ethiopian context (Haileslassie, Mulugeta and Girma, 2013), and (4) none of them reported on the interrelationship between number of meals/day, MDDW, household food security, water, hygiene and sanitation practice, livestock ownership, crop production practice and nutritional status. Also, none of them identified determinants to the consumption of ASF, the commonly missed food groups. Hence, aims of this study were to assess meal frequency, consumption of ASF, MDDW and nutritional status, and identify their predictors among lactating mothers from rural districts of Ethiopia.

Materials and Methods

Study Area and Design

A community-based cross-sectional study was conducted in Sidama and Oromia regional states of Ethiopia. Three districts within the Sidama and Oromia regions were included in the study. Arsi Negele district is from the Oromia region, and Dale and Wondo Genet are from the Sidama region.

Sampling

Sample size was calculated using single population proportion formula (Lemeshow *et al.*, 1991) at 95% confidence level, 0.05 margin of error and a design effect of 1.5. Four Kebeles (The lowest unit in the administrative structure of Ethiopia) were selected randomly from each of the study district (n=12 kebeles). A total of 606 lactating mother with their infant and young children (IYC) were selected through a systematic random sampling technique.

Data Collection

The data collection questionnaire was composed of sections for household food insecurity (FANTA, 2007), MDDW (FAO, 2010), maternal meal frequency, anthropometry, past two weeks sickness history, socio-demographic and economic characteristics and water, hygiene and sanitation characteristics. The tool was pre-tested and necessary amendments were made before its application to the actual data collection. The data collectors attended training for three days on basics of research methods, research ethics, data collection techniques and purpose of this study. Data were collected through one-on-one interview by the trained data collectors.

Weight, height and MUAC measurements were taken by the principal investigator who lead, coordinated and supervised the data collection. Standing height in centimeter and weight in kilogram were measured using a SECA stadiometer and SECA weight scale, respectively. Mid upper arm circumference was measured in centimeter using standard MUAC tape produced by world food program. The principal investigator had checked completed questionnaires on spot for completeness.

Data Analysis

Data were checked for completeness, coded, entered into statistical package for social sciences (SPSS) version 20 and cleaned. Frequencies, proportions, mean or median scores, standard deviations (SD) or interquartile ranges (IQR) were computed.

Body mass index was calculated dividing weight in kilogram by squared height in meter, and was further categorized as underweight, normal weight, and overweight. Measurements obtained for MUAC were categorized in to undernourished and not undernourished. The cutoffs used to categorize BMI and MUAC were according to recommendations in a nutritional assessment book (Gibson, 2005).

Taking in to account the national consumption recommendation for lactating mothers by Ethiopian Ministry of Health (FMoH-E) (2011), data on number of meals/day were dichotomized in-to five or more and four or less meals per-day. Dietary diversity data were dichotomized in to consumed from five or more food groups (coded with "1"), and consumed from four or less food groups (coded with "0") to fit it to logistic regression analysis. Overall ASF consumption data was generated by summing up "0"-not consumed in the last 24hours and "1"-consumed in the last 24hours response coding for meat, poultry, fish, eggs and dairy consumption status. Then, the summation for overall ASF consumption data were dichotomized in to consumed at least one of the ASF (coded "1") and consumed none of the ASF (coded "0") in the last 24hours to fit it with logistic regression analysis.

Data on water sources were dichotomized in-to safe and unsafe. Safe water source includes tap or public stand and protected well or spring. Unsafe water source includes unprotected well or spring, river and stream. Solid and liquid waste disposal practices were also dichotomized in-to proper and improper disposal practices. Proper solid waste disposal works for households that dispose in pit or burn it or use it as compost or fertilize or dispose in farm. Improper solid waste disposal works for households that dispose it in the compound or at road side or throw to river side. Proper liquid waste disposal works for household that drain in to latrine or separate pit or drain to garden. Improper liquid waste disposal works for households that flush in the compound or on road.

Bivariate logistic regression analysis was done to select variables to be included in multivariable forward stepwise logistic regression. Based on the result from the bivariate logistic regression, variables with p. <0.25 were included (Bendel and Afifi, 1977). Multivariable forward stepwise logistic regression analysis was applied to identify predictors of number of meals/day, MDDW, BMI, MUAC, and meat, eggs, dairy and overall ASF consumption at statistical significance level of 0.05 or below.

Ethical Considerations

Letter of ethical clearance (*Ref No: IRB/027/10*) was issued after the research proposal was reviewed by Institutional Review Board of Hawassa University-College of Medicine and Health Sciences. A letter of cooperation written from the School of Nutrition, Food Science and Technology-Hawassa University (*Ref No: S/N/F/S/T/3025/2010*) was also submitted to respective health service administrative departments of the study districts. Data collectors explained the study and its purpose to the participants using the local languages. Participation was on voluntary bases. Informed verbal consent was obtained from the mothers. Anonymity of information was assured throughout the data collection period and data management process. All mothers were informed of their nutritional status according to their respective MUAC result. Mother identified being undernourished were counseled on spot on key messages for nutrition of lactating mothers.

Results

Sociodemographic and economic characteristics: Maternal and Household

Nearly all of the mothers (96.9%) were married. The average age of the mothers was 25.63 (5.02) years. More than half of the mothers identified themselves as Sidama in Ethnicity (62.9%) and protestant (67.7%). Two-thirds (66%) of the mothers completed primary education: 27% achieved grades one to four and 39% achieved grades five to eight. Eight out of ten (79.8%) mothers were housemakers.

Almost all of the households (93.6%) were male headed. About 60% of the households were with five or more members. The median (IQR) for estimated household level annual income was 7700(3000) Ethiopian Birr (ETB) or $251(98). Two-thirds (61.2%) of the households both women and men decided on how to use household income, while slightly over a half (58%) of women decided on purchase of household daily needs alone. Concerning household level domestic animal ownership, 42.4% owned cows and 41.1% owned chickens. Slightly more than one-fourths (27.9%) of the households were food secure (**Table 9**).

Table 9 Maternal and household characteristics (n=606)

Maternal Characteristics		**N**	**%**
Age in Completed Years	≤26	363	59.9
	≥27	243	40.1
Marital Status	Married	587	96.9
	Single/Divorced/Widowed	19	3.1
Ethnicity	Sidama	381	62.9
	Oromo	187	30.9
	Wolayta	16	2.6
	Amhara	11	1.8
	Others (Kembata, Hadiya...)	11	1.8
Educational Status	Not Attended Formal Education	119	19.6
	Grade 1-4	160	26.4
	Grade 5-8	236	38.9
	Grade 9 and above	91	15.0
Religion	Protestant	410	67.7
	Muslim	164	27.1
	Orthodox/Catholic	32	5.3
Occupation	Housewife	482	79.5
	Merchant	50	8.3
	Farmer	47	7.8
	Others	27	4.5
Did the mother get sick in the last two weeks?	No	396	63.5
	Yes	210	34.7
Household Characteristics			
Family Size	≥5	363	59.9
	≤4	243	40.1
Who is the head of the household?	Woman	23	3.8
	Man	567	93.6
Estimated Household Annual Income in Ethiopian Birr	≤5000//$163	276	45.5
	50001 – 10000//$164-326	121	20.0
	10001 – 15000/327-490	65	10.7
	15001 -20000/$491-653	45	7.4
	>20000/>$653	99	16.3
Who decides how the household income will be used?	Both Wife and Husband	371	61.2
	Wife/Woman	102	16.8
	Husband/other	133	21.9
Who usually makes decisions about making purchase for daily household needs?	Both Wife and Husband	186	30.7
	Wife/Woman	352	58.2
	Husband/other	68	11.2
Number of Under five Children	≥2	323	53.3
	1	283	46.7
Age of Indexed Under two Years Child in months	6-8	130	21.5
	9-11	112	18.5
	12-23	364	60.1
Agricultural land ownership in hectare	<1	305	50.3
	1-2	232	38.3
	>2	69	11.4
Domestic Animal Ownership	Cow	257	42.4
	Chicken	249	41.1
	Ox	144	23.8
	Donkey	83	13.7
	Goat	69	11.4
	Sheep	62	10.2
Household Food Insecurity	Secure	169	27.9
	Mildly or Moderately Insecure	259	42.7
	Severely Insecure	178	29.4

Water, Hygiene and Sanitation Conditions and Practices

Nearly all of the households (92.4%) reported that they fetch water from safe sources. For majority of (74.9%) of the households it takes ≤30 minutes to fetch water with median (IQR) of 20 (9.75). The amount of water fetched in the day before the survey was less than fifteen liter/person/day in about 94% of households. No household level drinking water treatment was practiced in about 90% of the households. Majority of the households practiced proper solid waste (86.5%) and liquid waste (62.9%) disposal. Nearly all (98.3%) of the households owned different types of toilet facilities. Nine out of ten (90%) participants used water with soap or ash for hand washing. The majority of mothers practice hand washing after visiting toilet (84.5%), after cleaning child's bottom (76.2%), before cooking (94.6%) and before every meal (95%) (**Table 10**).

Table 10 Water, Hygiene and Sanitation Condition and Maternal Hand Washing Practice (n=606)

Variables		**N**	**%**
Water Source	Unsafe	46	7.6
	Safe	560	92.4
Time to fetch water, in minutes	≤30	454	74.9
	>30	152	25.1
	<15	571	94.2
Water fetched last 24Hours in Liters	≥15	35	5.8
Home Level Drinking Water Treatment	Yes	63	10.4
	No	543	89.6
Hand Washing Practice	After Visiting Toilet	512	84.5
	After Cleaning Child's bottom	462	76.2
	Before Cooking	573	94.6
	Before Breast Feeding	347	57.3
	Before Every Meal	576	95.0
Hand Washing Materials	Water Only	62	10.2
	Water with Soap/Ash/Other	544	89.9
Solid Waste Disposal	Improper	82	13.5
	Proper	524	86.5
Liquid Waste Disposal	Improper	225	37.1
	Proper	381	62.9
Toilet Facility	No Toilet	10	1.7
	Toilet with no Shade	372	61.4
	Toilet with Shade	215	35.5
	Ventilated Improved Toilet	9	1.5

Dietary Diversity and Meal Frequency

Almost all of the mothers (97%) consumed grain, roots and tubers based food products. Eggs were consumed by 5.4% of the participants and meat by 5.1%. About 90% of the mothers consumed from four or less food groups. Nearly all mothers (92.1%) consumed four or less meals per-day (**Table 11**).

Table 11 Dietary diversity and meal frequency of lactating mothers (n=606)

Food Groups, Dietary Diversity Score and Meal Frequency	N	%
Grains, white roots and tubers, and plantains	588	97.0
Pulses (beans, peas, and lentils)	348	57.4
Nuts and seeds	6	1.0
Dairy	167	27.6
Meat, poultry, and fish	31	5.1
Eggs	33	5.4
Dark-green leafy vegetables	385	63.5
Other vitamin A–rich fruit and vegetables	147	24.3
Other vegetables	306	50.5
Other fruit	110	18.2
Overall ASFs	201	33.2
MDDW: Consumed from five or more food groups	542	89.4
MDDW: Consumed from five or more food groups	64	10.6
MDDW: Mean Score (SD)	3.19(1.14)	
Meal Frequency: Consumed four or less meals/day	558	92.1
Meal Frequency: Consumed five or meals/day	48	7.9

ASF: Animal Source Foods; MDDW: Minimum Dietary Diversity of Women

Nutritional Status

Median scores (IQR) for height, for weight, for BMI and for MUAC were 156.5(152.5), 50.5(46.4), 20.5(18.9) and 24.5(23), respectively. Mothers were undernourished (Figure 2) as identified (About 12.6%-as identified usingby BMI (12.6%) and 10.7%- as identified by MUAC (10.7%) mothers were undernourished (Figure 2).

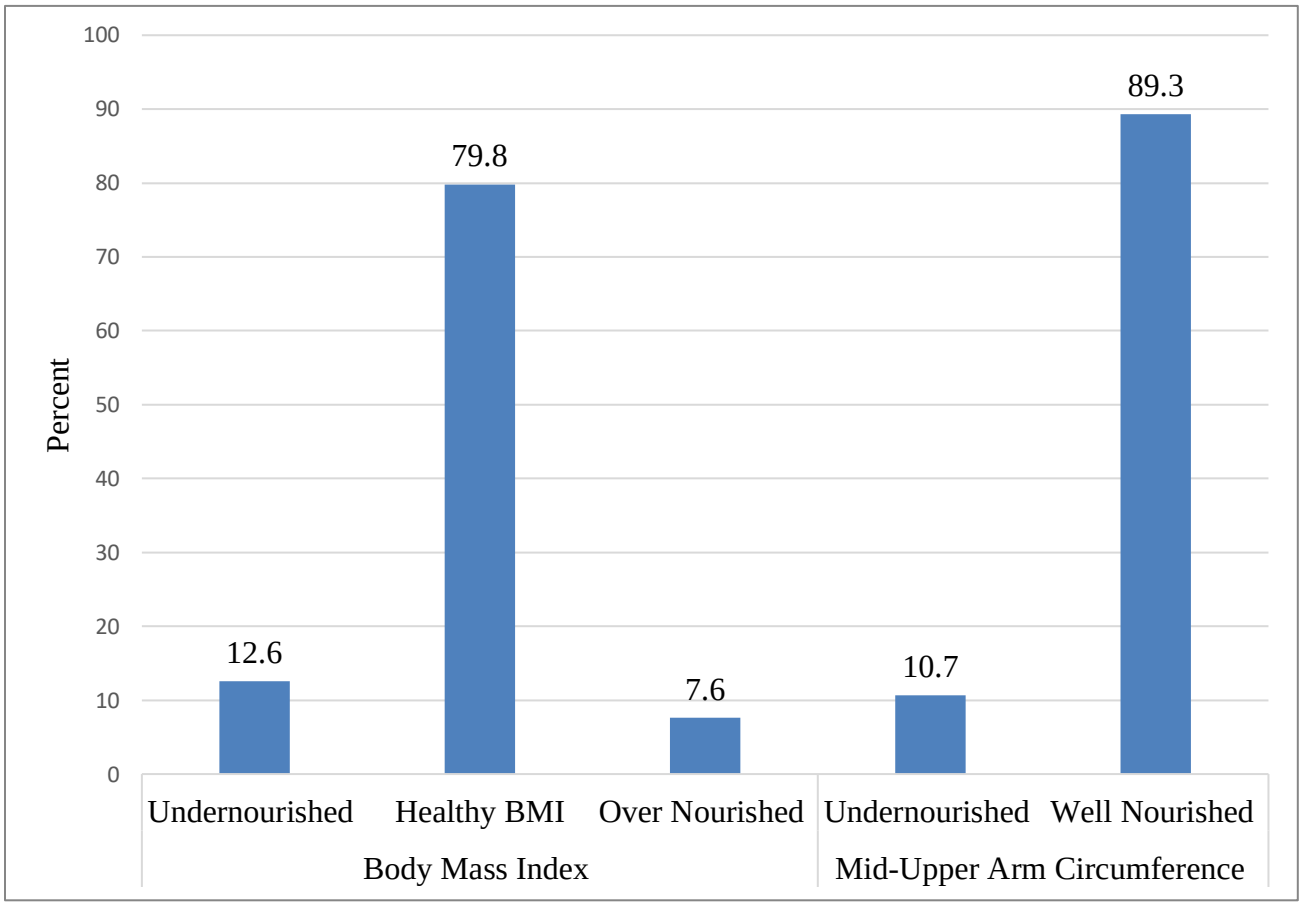

Figure 4 Percentage distribution of nutritional status of lactating mothers (n=606)

Predictors of Meal Frequency, Minimum Dietary Diversity of Women and Maternal Nutritional Status

Household food security, cash crops production and MDDW were associated increased odds of achieving recommended minimum number of meals in a day. Mothers from food secure households were about three times [AOR=2.86 (95%CI: 1.22, 6.68), p =0.015] more likely to consume five or more meals/day. Mothers from cash crop producing households [AOR=3.13(95%CI: 1.41, 6.97), p. =0.005] were also three times more likely to consume five or more meals/day than their counterparts.

Root crops production, chicken ownership, maternal educational status, household annual income and number of meals per-day were associated with MDDW. Mothers from root crops producing households were about two times [AOR=1.83 (95%CI: 1.04, 3.21), p. =0.036] more likely to consume from five or more food groups. Mothers who consumed five or more meals/day were more than two times [AOR= 2.25 (95%CI: 1.01, 4.99), p. =0.046] more likely to consume from five or more food groups than mother who consumed four or less meals/day. In reference to mothers from households with estimated annual income of 5000ETB or less, mothers who lived in households with income of 10,001-15,000 ETB [AOR=2.79 (95%CI: 1.23, 6.33), p.=0.014] and greater than 20,000ETB [AOR=2.63 (95%CI: 1.27, 5.47), p. =0.002] were about three times more likely to consume from five or more food groups. Mothers who lived in households that owned chicken were about two and half times [AOR=2.46 (95%CI: 1.38, 4.37), p. =0.002] more likely to consume from five or more food groups than mothers lived in households that did not own chicken. Indexed child age was the other variable found associated with MDDW. Mothers with 6-8 months old [AOR=2.01(95%CI: 1.02, 3.98), p. =0.045] and 9-11 months old [AOR=2.20 (95%CI: 1.11, 4.35), p. =0.024] children were two times more likely to consume from five or more food groups than mothers with 12-23 months old children. Mothers who achieved grade 9 or above educational status were three time [AOR=3.02 (95%CI: 1.09, 8.38), p. =0.034] more likely to consume from five or more food groups than mothers who never attended school.

Hand washing practice of mothers after cleaning child bottom, child age and household food insecurity were associated with maternal nutritional status. Mothers who did not practice hand washing after cleaning child's bottom were three times more likely to be undernourished as identified by MUAC [AOR=3.028 (95%CI: 1.678, 5.464), p. <0.001] and two times more likely to be undernourished as identified by BMI [AOR=2.292 (95%CI: 1.364, 3.850), p. =0.002] than

mothers who practice hand washing after cleansing child bottom. Mothers with children in the age range of 9-11 months [AOR=2.79 (95%CI: 1.14, 6.83), p. =0.025] and 12-23 months [AOR=2.57 (95%CI: 1.17, 5.62), p. =0.018] were more than two times likely to be undernourished, as identified by BMI than mother with 6-8 months old child. Mothers lived in mild to moderate food insecure households were more than two times [AOR=2.37 (95%CI; 1.15, 4.86), p. =0.019] more likely to be undernourished as identified by MUAC than mothers in food secure households (**Table 12**).

Table 12 Logistic regression analysis on meal frequency, minimum dietary diversity and anthropometric status of lactating mothers (n=606)

Characteristics	Category	AOR (95%CI)	*p.*
Meal Frequency			
Cash Crops Production	Yes	3.13(1.41, 6.97)	.005
MDDW	≥5	3.10 (1.47, 6.54)	.003
Household Food Insecurity	Secure	2.86 (1.22, 6.68)	.015
MDDW			
Roots production	Yes	1.83 (1.04, 3.21)	.036
Number of Meals/day	≥5	2.25 (1.01, 4.99)	.046
Educational Status of the mother	Grade 9 or above	3.02 (1.09, 8.38)	.034
Household Estimated annual Income in	10, 001-15, 000	2.79 (1.23, 6.33)	.014
ETB	>20000	2.63 (1.27, 5.47)	.009
Chicken Ownership	Yes	2.46 (1.38, 4.37)	.002
Child Age in Months	6-8	2.01 (1.02, 3.98)	.045
	9-11	2.20 (1.11, 4.35)	.024
Undernourished Mothers as determined by MUAC			
Hand washing after cleaning child's bottom	No	3.03 (1.68, 5.46)	.000
Household Food Insecurity	Mild/Moderate	2.37 (1.15, 4.86)	.019
Undernourished Mothers as determined by BMI			
Hand washing after cleaning child's bottom	No	2.29 (1.36, 3.85)	.002
Child Age in Months	9-11	2.79 (1.14, 6.83)	.025
	12-23	2.57 (1.17, 5.62)	.018

ETB: Ethiopian Birr; MDDW: Minimum Dietary Diversity of Women; MUAC: Mid-upper Arm Circumference; BMI: Body Mass Index

Predictors of Meat, Eggs, Dairy and Overall Animal Source Foods Consumption

Household food security was associated with the consumption of all food groups that are within the ASF category according to this study and overall ASF consumption. Mothers lived in food secure households were more likely to consume meat [AOR=16.42 (95%CI: 2.02, 133.5), p. =0.009], eggs [AOR=6.06 (95%CI: 1.57, 23.43), p. =0.009] and dairy [AOR=2.01 (1.15, 3.52), p. =0.014] than mothers lived in severely food insecure households. Consumption of at least one of the ASF is about three times [AOR=2.75 (95%CI: 1.59, 4.75), p. <0.001] more likely for mothers lived in food secure households than mothers lived in food insecure households.

Cash crops production was associated with increased odds of meat consumption. Meat consumption was four times [AOR=4.16 (95%CI: 1.42, 12.22), p. =0.009] more likely for mother from cash crop producing households than mothers from no cash crop producing households.

The consumption of eggs was predicted by root crops production. Mothers in root crops producing households were more than three times [AOR=3.31 (95%CI; 1.31, 8.40), p. =0.012] likely to consume eggs than mother lived in households that did not produce root crops. Maternal dairy consumption practice was associated with cow ownership and maternal occupation. Mothers lived in cow owned households were two times [AOR=2.17 (95%CI: 1.43, 3.29), p. <0.001] more likely to consume dairy than mothers lived in households those did not own cow. Merchant mothers were two and half times [AOR=2.55 (1.30, 4.99), p. =0.006] more likely to consume dairy than housemakers.

In addition to household food insecurity, cow and chicken ownership, household annual income, maternal education and maternal occupation were associated with overall ASFs consumption. Mothers lived in households that owned cow [AOR=1.83 (95%CI: 1.22, 2.74), p. =0.003] or chicken [AOR=1.53 (95%CI: 1.02, 2.31), p. =0.041] were about two times more likely to consume at least one of the ASF than mothers lived in households that did not own cow or chicken. The consumption of at least one of the ASFs was more than three times [AOR=3.54 (95%CI: 1.83, 6.87), p. <0.001] likely for merchant mothers than housemakers. Mothers lived in households with estimated annual income of 10,001-15,000ETB were two times [2.23 (95%CI: 1.17, 4.24), p. = 0.014] more likely to consume at least one of the ASF than mothers lived in households with 5,000ETB or less estimated household annual income. Mothers who achieved grade 5-8 [AOR=1.98 (95%CI: 1.13, 3.46), p. =0.017] or grade 9 or above [AOR=2.43 ((95%CI: 1.25, 4.73), p. =0.009]

education were about two times more likely to consume at least one of the ASF as compared with mothers who never attended school/formal education (**Table 13**).

Table 13 Logistic regression analysis on meat, eggs, dairy and overall animal source foods consumption by lactating mothers (n=606)

Characteristics	**Category**	**AOR (95%CI)**	***p.***
Meat			
Cash Crops Production	Yes	4.16 (1.42, 12.22)	.009
MDDW	≥5 Food Groups	17.65 (7.62, 40.84)	.000
Household Food Insecurity	Secure	16.42 (2.02, 133.50)	.009
Age in Completed Years	≥27	.335 (.125, .901)	.030
Eggs			
Roots Production	Yes	3.31 (1.31, 8.40)	.012
MDDW	≥5 Food Groups	22.41 (9.27, 54.19)	.000
Household Food Insecurity	Secure	6.06 (1.57, 23.43)	.009
Religion	Muslim	4.26 (1.76, 10.45)	.002
Dairy			
Number of meals/day	≥5	2.23 (1.06, 4.66)	.034
MDDW	≥5 Food Groups	13.97 (6.97, 27.99)	.000
Cow Ownership	Yes	2.17 (1.43, 3.29)	.000
Household Food Insecurity	Secure	2.01 (1.15, 3.52)	.014
Employment/Occupation	Merchant	2.55 (1.30, 4.99)	.006
	Others	2.85 (1.10, 7.36)	.031
Religion	Muslim	2.98 (1.80, 4.95)	.000
Overall ASF			
Number of meals/day	≥5	2.25 (1.15, 4.43)	.018
Educational Status	Grade 5-8	1.98 (1.13, 3.46)	.017
	Grade 9 or above	2.43 (1.25, 4.73)	.009
Household Estimated Annual Income in ETB	10001-15000	2.23 (1.17, 4.24)	.014
Cow Ownership	Yes	1.83 (1.22, 2.74)	.003
Chicken Ownership	Yes	1.53 (1.02, 2.31)	041
Household Food Insecurity	Secure	2.75 (1.59, 4.75)	.000
Employment/Occupation	Merchant	3.54 (1.83, 6.87)	.000
Religion	Muslim	3.31 (2.03, 5.41)	.000

Discussion

Nutritional requirements depend on personal conditions and characteristics. Lactation is one of the conditions that make difference in nutritional requirements. Lactating mothers are in need of special nutritional consideration to keep their nutritional status healthy; and to let them produce adequate breastmilk in a way that does not affect their nutritional status and nutrient deposit and to support the healthy growth and development of their babies. Hence, the purposes of this study were to assess MDDW, ASF consumption, meal frequency and nutritional status; and to identify their predictors among lactating mothers from rural districts of Ethiopia.

Findings of the present study showed that dairy, eggs and meat were consumed by 27.6%, 5.4% and 5.1 of the lactating mothers in the day before the survey, respectively. Proportion of mothers who consumed eggs was equivalent to finding (5.2%) from north Ethiopia (Desalegn *et al.*, 2018). With regard to the consumption of dairy, almost similar proportion (21.2%) was reported by study conducted in south Ethiopia (Bosha *et al.*, 2019). But meat consumption practice varies across the studies (Desalegn *et al.*, 2018; Bosha *et al.*, 2019). Religious norms, consumption culture, period by when the study conducted and fasting practice (Desalegn et al., 2018) of the study participants might have contributed to the differences. Overall, the less consumption of ASF by the lactating mothers in area where the present study conducted is subjected to constriants identified by **Daba** *et. al.*,(2021)

Maternal occupation and education, MDDW, number of meals per-day, household income, household food insecurity, cash and root crops production, and cow and chicken ownership were associated with ASF consumption by mothers. The chance for meat, eggs, dairy and overall ASF consumption was higher for mothers who lived in food secure households than those lived in food insecure households. A national report indicated that price for nutritious foods including ASF has increased in Ethiopia (Fantu N. and Bart, 2019), and the increased price of ASF might have strengthened the challenge exerted by food insecurity on ASF consumption practice of the studied lactating mothers. In addition of the increment on the price of ASF, findings have identified shifting to less expensive food products as a mechanism with which victims cope with food insecurity (Asesefa Kisi *et al.*, 2018; Sani and Kemaw, 2019). Finding of the current study revealed that cash crop production increased the chance of meat consumption by lactating mothers, while root crops production did the same on consumption of egg. This might be explained by the direct cash that can be earned from the sale of produced cash crop, which can be invested to the purchase of food

commodities including ASF (Immink and Alarcon, 1993; Govereh and Jayne, 2003; Goshu, Kassa and Ketema, 2012; Cockburn *et al.*, 2014; Adjimoti and Kwadzo, 2018; Mango *et al.*, 2018; Rubhara *et al.*, 2020). Cash crops like coffee, sugarcane, khat cannot be easily destroyed by chickens and can serve as a shed where to allow hens to look for feed freely. In agreement to findings on livestock's contribution to the availability, accessibility and utilization of ASF (Hetherington *et al.*, 2017; Wodajo *et al.*, 2020), the current study found that mothers from cow owning households were two times more likely to consume dairy. Overall ASF consumption was predicted by cow or chicken ownership, maternal occupation and education. Mothers who lived in cow or chicken owning households were more likely to consume at least one of the ASF. Mothers who attended school (grades five to eight or grade nine or above education) had more chance to consume at least one of the ASF than mother who never attended school. Being a merchant increased the chance of consumption of at least one of the ASF. For merchants, especially for pity traders, it is likely to have cash in hand in most days, and this might have given them the capacity to purchase ASF with their own decision.

In Ethiopia, consumption of three meals in a day is common: breakfast, lunch and dinner. According to a national document on Adolescent, Maternal and Infant and Young Child Nutrition (FMoH-E, 2011), lactating mothers in Ethiopia are recommended to consume at least two additional meals in a day, which makes the minimum recommended number of meals in a day five. In the current study, only about 8% of the mothers met the recommended number of meals in a day. About 92% of the mothers consumed four or less meals in the day before the survey, did not meet the minimum recommended number of meals in a day. The figure is higher than proportion of lactating mother reported for not taking additional meal during period of lactation from west (62.2%) (Bekele, Jima and Regesu, 2020) and north (72%) (Haileslassie, Mulugeta and Girma, 2013) Ethiopia. The observed difference could be subjected to period for which meal frequency data were collected. In the current study, data on numbers of meals were collected for the day (24 hours period) before the survey counting for number of meals consumed and it was operationalized, but for the studies cited (Haileslassie, Mulugeta and Girma, 2013; Bekele, Jima and Regesu, 2020) mothers were asked a general question whether they practiced (a question with yes or no response options) consumption of additional meal or not during the breastfeeding period.

In this study, consumption of five or more meals in a day was more likely for mothers lived in food secure households than those lived in severely food insecure households. The observed association is in line with mechanisms documented to cope with food insecurity. Findings from Jimma in

Ethiopia (Asesefa Kisi *et al.*, 2018) and Tarahumara in Mexico (Cordero-Ahiman, Santellano-Estrada and Garrido, 2018) reported that households cut number of meals to cope with food insecurity. According to the result of this study, mothers lived in cash crop producing households were more likely to consume five or more meals in a day than mothers lived in households that did not produce cash crops. The effect of cash crop production might be due to the role it plays to increase household income (Immink and Alarcon, 1993; Govereh and Jayne, 2003; Goshu, Kassa and Ketema, 2012; Cockburn *et al.*, 2014), which in return can boost household purchasing power and positively impact food security (Adjimoti and Kwadzo, 2018; Mango *et al.*, 2018; Rubhara *et al.*, 2020).

Dietary diversity is a proxy indicator of food insecurity and qualitative indicator of nutrient adequacy (Rathnayake, Madushani and Silva, 2012). In this study, only 11% of the lactating mothers consumed from five or more food groups in the day before the survey. On the other hand, about 89% of the lactating mothers consumed from four or less food groups or did not meet the MDDW. Other studies conducted in Ethiopia also reported that considerable proportion of mother fall in low DDS. It was reported that 44.4% from west Ethiopia (Bekele, Jima and Regesu, 2020) and 94% from south Ethiopia (Bosha *et al.*, 2019) achieved low DDS. According to cross-sectional studies on DD of lactating mothers, in south (Boke and Geremew, 2018) 52.2% and north Ethiopia 56.4% (Weldehaweria *et al.*, 2016) were with low DDS. Though the findings of this study and studies conducted before agree on that significant proportion of lactating mothers scored low DDS, they vary in the specific proportion they reported. The variation could be because of the different methods used to judge DD achievement of the mothers across the studies. The current study used the up-to-date MDDW cutoff (Martin-prevel *et al.*, 2017), while the cited researches applied mean scores or above cutoff (FAO, 2010) to identify mothers who achieved the recommendations. The judgment for this research is against a standard of consumption from five or more food group cutoff, while judgments for the cited (Weldehaweria *et al.*, 2016; Boke and Geremew, 2018; Bosha *et al.*, 2019; Bekele, Jima and Regesu, 2020) findings were respective study data distribution dependent that considered mean scores or above.

Results of this study revealed that number of meals in day and MDDW were positively associated with each other. Achievement of the recommended number of meal in a day increased the probability of consumption from five or more food groups and achieving minimum dietary diversity increased the probability of consuming five or meals in a day. The relationship between number of

meals in a day and MDDW might be because of their shared relationship with household food insecurity (Abebe and Mulu, 2017).

In the present study, the chance for consumption from five or more food groups almost doubles for mothers lived in root crops producing households than those who lived in households that did not produce root crops. Compared to cash crops and cereal grains, length of time required to farm most root crops is less. A research finding also documented that women have the control over production of small scale agricultural productions like root crops, vegetables and fruits (Nyikahadzoi *et al.*, 2017). The less lengthy farming period that root crops require and women's control over the value chain might have contributed to the positive association directly through its contribution for household consumption and indirectly through income generation possibly to be used for purchase of food commodities to be counted to other food groups (Nguyen *et al.*, 2013; Emana *et al.*, 2015). This study has found an association between maternal educational status and MDDW. Mother with grade nine or above educational achievement were more likely to consume from five or more food groups than mothers who never attended school. Consistent to the result of this investigation, evidence from Ethiopia, Ghana, Vietnam and Bangladesh reported a similar relationship (Mirmiran *et al.*, 2002; Murakami *et al.*, 2009; Legesse *et al.*, 2010). According to the study in Ethiopia, mothers who cannot read and write were 2.5 times more likely to have low DDS than those who had attended school. Similarly, the study conducted in Ghana found that women who had achieved primary education were about two times more likely to meet higher DDS as compared to women who never attended school. According to the results of this study, an association was also observed between estimated household annual income and MDDW. Consumption from five or more food groups was more likely for mothers from households with estimated annual income of 10,001-15,000 ETB or >20,000ETB, as compared to mothers from households with less than 5000ETB. This could be because of better purchasing power that households in higher income category have. Similarly, a study conducted in northern part of Ethiopia pointed that lactating mothers who had monthly income of less than 501 ETB or 501 to 1500 ETB were more likely to have low DD as compared to those who had a monthly income of above 1500 ETB (Weldehaweria *et al.*, 2016). Small animals like chickens can be reared in an easy way and with a limited resource and time to contribute to income, human livelihood and nutrition (Mammo, Berhan and Dessie, 2008; Reta, 2009; Dinka *et al.*, 2010; Wodajo *et al.*, 2020). In a similar way that rearing small animals is expected to contribute to nutrition, mothers lived in households that owned chickens were more

likely to consume from five or more food groups than mothers lived in households that did not own chicken.

The finding of this study revealed that 12.6% as identified by by-BMI and 10.7% as identified by-MUAC of the lactating mothers were undernourished. The prevalence is in agreement with results of different studies. A 17.4% prevalence was documented in Arbaminch (Tikuye *et al.*, 2019), 17.7% in Moyale (Bekele, Jima and Regesu, 2020), 13% in Samare (Haileslassie, Mulugeta and Girma, 2013) and 14.2% in Hula (Negash *et al.*, 2015) districts of Ethiopia. But it is far lower than prevalence (50.6%) reported for fasting lactating mothers in rural Tigray (Desalegn *et al.*, 2018). The fasting practice might have contributed to the difference. World health organization also classifies prevalence of underweight (by BMI) as low (5-9%), medium (10-19%), high (20-39%) and very high (≥40%) public health problem (WHO, 2012).

This study discovered an association between maternal WASH practice and their nutritional status. Maternal hand washing practice after cleansing child's bottom was associated with BMI and MUAC. Mothers who did not practice hand washing after cleansing child's bottom were more likely to be undernourished as identified by MUAC and BMI. Water, hygiene and sanitation are key components of human life and were documented to associate with nutrition status (Rah *et al.*, 2015; Assefa *et al.*, 2017; Hossain *et al.*, 2018; Kwami *et al.*, 2019). Accordingly, the finding of this research revealed the need to consider child caring practice not only for the benefit of the growing children, but also in view of maternal safety, health and nutrition status. Despite achieving it for a while, sustainability of healthy nutritional status and practices are challenges all concerned bodies including individuals have to focus on to let healthy outcomes continue. In the present study age of indexed child was associated with MDDW and BMI. The chance to meet MDDW doubles for mothers with children in the age range of six to eight months or nine to eleven months than mothers with children in the age range of twelve to twenty three months. This could be because of non-sustainability of cares lactating mothers receive throughout their breastfeeding period. In addition, this study found that mothers with children in the age range of nine to eleven or twelve to twenty three months had increased probabilities for being undernourished as measured by BMI. The high chance of undernourishment for mothers with children in the upper age category might be subjected to depletion of their nutrition reserves, non-sustainability of cares rendered to lactating mothers throughout the breastfeeding period, and the increased need for care and nutrition by the growing children (Dewey, 2004).

This research shares the common attributes of any research. Among those, assessing nutrition of lactating mothers from rural areas from different perspectives like meal frequency in contextual way, consumption of ASF, minimum dietary diversity of women against a standard, nutritional status through more than one indicator and considering other livelihood issues like women empowerment, agriculture practices, livestock ownership and WASH were the strengths. However, cross-sectional nature of the study and usage of a single 24hours (one day before the survey day) consumption recall for data on meal frequency, MDDW, ASF consumption and amount of water fetched can be considered as its limitations.

Nutrition of women is one of the critical area through which intergenerational cycle of malnutrition can be cracked to positively impact nutritional outcomes of the future generation. Accordingly, even though nutrition of women has been considered in nutrition policy (FDRE, 2018) and program (FDRE, 2016) of Ethiopia, this study revealed that lactating mothers in rural districts of Ethiopia were challenged to achieve the recommendations for meal frequency and MDDW in a day , include ASF in their diet, and they have suffered from undernutrition. Thus, stakeholders shall work to identify strategies to let mothers practice the recommendations and the situation got improved.

Conclusions

In the study area, underweight was a medium level public health problem of lactating mothers. Eggs, meat, and nuts were consumed by lesser proportion of the lactating mothers than other food groups. Low proportion of the lactating mother consumed the recommended number of meals in a day and achieved MDDW.

Mothers who met minimum recommended number of meals per-day were likely to meet MDDW, and the vice versa. Cash crops production and household food security were positively associated with consumption of recommended number of meals in a day. Chicken ownership, root crops production, higher category estimated household annual income and being a mother of child in the age range of six to eight or nine to eleven months positively contributed to MDDW.

Mild or moderate household food insecurity negatively affected maternal MUAC. Not practicing hand washing after cleansing child’s bottom increased mother’s chance of undernourishment. Mothers who have older children were more prone for undernutrition.

Mothers from food secure households consumed all types of ASF than mothers in severely food insecure households. Regarding farming practices, cash crop production was positively associated with meat consumption and so did root crops production for eggs. Dairy consumption was

positively associated with meeting minimum recommended number of meals in a day and cow ownership. Probability of dairy consumption was higher for merchant mothers than housemakers. Consumption of five or more meals in a day, being educated, being a merchant, cow or chicken ownership and household food security increased the chance of overall ASF consumption. In summary, poverty as it shown-up through household food insecurity, livestock ownership, crop production and household income, women empowerment that appeared through maternal education and occupation, and WASH through hand washing practice contributed to maternal nutrition. Future researches shall focus on behavioral change communication for nutrition of lactating mothers integrated with livelihood improving activities and women empowerment.

CHAPTER SIX

Predictors of Growth Failures, Dietary Diversity and Animal Source Foods Consumption among 6-23 Months Children from Rural Ethiopia

Abstract

The first two years of life are important for growth and development of children. Missed developmental and growth milestones during this period as a result of inadequate nutrition may not be reversible later in life. In view of that, the purpose of this study was to assess and identify predictors of animal source foods (ASF) consumption, minimum dietary diversity (MDD) and nutritional status of 6-23 months children from rural districts of Ethiopia. A cross-sectional study was conducted among 605 mother-child pairs. Data were collected using interviewer-administered questionnaire. WHOAnthro was used to generate Z-scores for nutritional status. Logistic regression analysis was applied to identify determinants of growth failures, MDD, and ASF consumption. Stunting, underweight and wasting were 25.8%, 13.6% and 5.6%, respectively. Less than a quarter of the children (16%) achieved MDD. Dairy, eggs and meat were consumed by 41.2%, 16.4% and 1.8% of the children, respectively. Children lived in food secure households were two times more likely to consume dairy (P =0.006) or eggs (P =0.002) and five times more likely to consume meat (p. =0.039) than children lived in food insecure households. Children from households that owned cow (P =0.001) or donkey (P =0.024) or chicken (P =0.027) were about two times more likely to consume dairy than children from households that did not own the respective animals. Children with mothers who achieved grades five upto eight (P =0.028) or grades 9 or above (P <0.001) education were two and three times more likely to consume dairy than children with mother who never attended school. Children lived in households with estimated annual income of twenty to thirty thousands were about two times more likely to consume dairy than children lived in households with ten thousands or less estimated annual income. Children from households that owned chicken were three times more likely (P <0.001) and children from households that produced root crops were two times more likely (P =0.031) to consume eggs than their counters. Children lived in households that owned cow (P =0.001) or chicken (P =0.001) were more likely to consume at least one of the ASF than children lived in households that did not own cow or chicken. Children from households with estimated annual income in Ethiopian birr (ETB) in the range of 10,001-20,000 (P= 0.028), 20,001-30,000 (P =0.047) or >30,000 (P =0.005) were more likely to consume at least one of the ASF as compared to children from households with ≤10000ETB income. Children from households that did not produce vegetable were had lower odds of stunting (P =0.024) and underweight (P =0.01). Children with mothers who achieved grade five upto eight education (P =0.004) were more likely to consume al least one of the ASF than children with mothers who never

attended school. Stunting and underweight were medium level public health problems. Low proportion of children met MDD and consumed ASF. Household food security, livestock ownership, household income, maternal education and root crop production contributed to ASF consumption. Nutrition sensitive agricultural extension activities focused on livestock and root crops productivity aided by nutrition education should be considered and evaluated for their effect on diets and growth of children. Women empowerment especially though education and income generation may positively impact nutrition of growing children. More researchs are warranted to understand the inverse association between stunting and underweight.

Keywords: Children, Animal Source Foods, MDD, Growth Failure, Ethiopia

Introduction

The first two years of life are critical period during which organs, body systems and immunity grow, develop, change, and children start to learn the environment (Barker, 2012). During this period, good nutrition-supported by appropriate behavioral interventions plays an important role in helping children to grow and develop to their full potential and have healthier foundation for the rest of their lives (Benton, 2008). The period is long portion of the first 1000 days, which is considered as a window of opportunity during which good nutrition practice has to continue and corrective nutrition interventions has to be practiced to rectify nutritional derangements those happened during pregnancy (Martorell, 2017). If not, the wrong face of the period takeover to change the period to a window of vulnerability. As a result, for children who are did not meet the quantity and quality of nutrients their body require, the period was found being a season in which they lose much of their growth and developmental potential (Victora *et al.*, 2010).

According to Ethiopian national demographic and health survey (EDHS) report, yearly less than one percent decrement on the magnitude of growth failures among children underfive was documented since 2005. Over the period, the prevalence of wasting decreased by 5% (from 12%-7%), stunting by 14% (from 51%-37%) and underweight by 12% (from 33-21%) and child growth failure remains to be a focus of nutrition and public health analysis (EPHI, 2019). The growth failures are also prevalent among Ethiopian under-two years of age children. Studies conducted at different parts of the country reported 18.7-56.1% prevalence of stunting, 10-19.5% prevalence of underweight and 3.5-17.5% prevalence of wasting (Agedew and Chane, 2015; Fekadu *et al.*, 2015; Agedew and Shimeles, 2016; Mekonnen, 2017; Kahsay *et al.*, 2018; Desalegn *et al.*, 2019) for children under-two years. In addition of the considerable magnitude of child growth failure, more than half (56%) of children in the country are anemic (CSA, 2016a). Co-morbidity of anemia and stunting is also common among children (18-24%). Iron deficiency and anemia might have also worsen the growth failure (Malako *et al.*, 2019; Mejia *et al.*, 2019; Mohammed, Larijani and Esmaillzadeh, 2019; Tran *et al.*, 2019; Orsango *et al.*, 2021).

Nutritional requirements of growing children is higher for that they go through rapid growth and development spurts (Bier, 2008) as compared to adults. They are also fully dependent on mature individuals around them for general care, nutrition and social interaction. To support nutrition literacy of care providers and to allow children meet the increased nutritional requirement, and grow

and develop to their full potential, organization have developed guides on recommended infant and young child feeding (IYCF) practices (WHO, 2003, 2013b; WHO, 2007; FDRE, 2010). In addition of trying to meet nutritional requirements of growing children, issues related to the cultural acceptability and suitability of IYCF recommendations has been discussed in the documents for consideration.

Dietary diversity score (DDS) is a useful indicator of nutritional quality of food groups consumed and the adequacy of nutrients that complementary foods consumed by infants and young children provide (Moursi *et al.*, 2008). To satisfy the minimum dietary diversity (MDD) recommendations 6-23 months of old children are expected to consume at least four of the seven food groups (cereals and roots, legumes, vitamin A rich fruits and vegetables, other fruits and vegetables, dairy products, eggs and flesh) in a day. Further, consumption of diversified diet was found associated with growth of children. Evidence from a comprehensive analysis of merged data from multiple countries (Arimond and Ruel, 2004; Marriott *et al.*, 2012) and country specific surveys (Rah *et al.*, 2010; Hooshmand, 2013; Busert *et al.*, 2016; Getachew and Argaw, 2017) showed a positive linear association between MDD and child growth, especially height-the most prevalent form of growth failure in Ethiopia. However, only less than a quarter (maximum of 16%) of IYC in Ethiopia met MDD (Aemro *et al.*, 2013; Beyene, Worku and Wassie, 2015; Dangura and Gebremedhin, 2017; Forsido *et al.*, 2019). Fruits, vegetables and ASF were consistently reported as missed food groups. Most of the research outputs were specific either to growth failure or MDD of children eventhough it is important to investigate gaps comprehensively. They did not also investigate determinants of commonly missed food groups like ASF. Accordingly, the purpose of this study was to assess prevalence of growth failures, MDD and consumption of ASF, and identify predictors of growth failure, MDD and consumption of ASF among 6-23 months old children from rural districts of Ethiopia.

Methods and Materials

Study Area and Design

The study was conducted in Sidama and Oromia regional states of Ethiopia. Three districts (Arsinegelle, Wondo Gent and Dale) were selected from the two regional states. Arsinegelle district is from Oromia. Dale and Wondo Genet are from Sidama. A community based cross-sectional study was applied.

Sampling

Sample size was calculated using single population proportion formula (Lemeshow *et al.*, 1991) at 95% confidence level, 0.05 margin of error and design effect of 1.5. Four Kebeles (the lowest unit in the administrative structure of Ethiopia) were selected from each of the study district (n=12 kebeles). A total of 606 mother-child pairs selected through systematic random sampling techniques were included.

Data Collection

The data collection questionnaire consisted five sections; (1) Household food insecurity (FANTA, 2007), (2) child dietary diversity (FAO, 2010), (3) child anthropometry, (4) child and maternal past two weeks sickness history and common symptoms in the last two weeks and (5) socio-demographic and economic characteristics. The tool was tested and necessary amendments were made before its application to the actual data collection. Data collectors attended three days training on basics of research methods, data collection techniques, research ethics and purpose of this study.

Anthropometric measurements were done by the principal investigator with the assistance of health extension workers/community volunteers. Length was measured at a recumbent position using a SECA length board and registered to the nearest 0.5cm. Weight was taken using SECA flat weight scale and registered to the nearest 0.1 Kg. Mid upper arm circumference (MUAC) was measured using green, yellow and red color calibrated MUAC tape meter.

Data Analysis

Collected data were checked for completeness, coded, entered into SPSS version 20 for windows and cleaned. A data case was removed from the analysis due to flagging in growth indicator z-scores output from WHO Anthro. Children's ID, age in months, sex, weight in Kg and height in centimeter data were exported to WHOAnthro software. Then, weight for height (WHZ), height for age (HAZ) and weight for age (WAZ) Z-scores (standard deviations) were generated. The generated growth status indicator Z-scores were exported to spread sheet and then imported from spreadsheet to SPSS. Coexistences of growth failures were computed by summing-up zero "0"-for not undernourished and one "1"-for undernourished coding given to wasting, stunting and underweight statuses.

Dietary diversity score was dichotomized in to consumed from four or more food groups (coded with "1"), and consumed from three or less food groups (coded with "0"). Overall ASF consumption data were generated summing up "0"-not consumed in the last 24Hours and "1"-consumed in the last 24Hours coding for flesh, eggs and dairy consumption statuses. Then, the result of the summation for overall ASF consumption data were dichotomized in-to consumed at least one of the ASF ("1") and consumed none of the ASF ("0") in the 24 hours before the survey.

Data for crop production diversity was generated by computing a summation of zero-"0"-for no production and one-"1"-for production coding given to cereal, legume, oil seeds, roots, vegetable, and fruit production practices. Then, the summation results were dichotomized in-to two: practiced crop production diversity (for 2 and more results and does not practice crop production diversity (for results below 2). Data on water sources were dichotomized in-to safe and unsafe. Safe water source includes tap or public stand and protected well or spring. Unsafe water source includes unprotected well or spring, river and stream.

Bivariate logistic regression analysis was done to select variables to be included in multivariable logistic regression. Based on the results of bivariate logistic regression, variable with p. <0.25 (Bendel and Afifi, 1977) were included in multivariable logistic regression. Multivariable forward stepwise logistic regression analysis was applied to identify determinants of wasting, stunting, underweight, MDD, and flesh/meat, eggs, dairy and overall ASF consumption practice at statistical significance level of 0.05 and below.

Research Ethics

Letter of ethical clearance (***Ref No: IRB/027/10***) was issued after the research proposal was reviewed by Institutional Review Board of Hawassa University-College of Medicine and Health Sciences. A letter of cooperation written from School of Nutrition, Food Science and Technology-Hawassa University (***Ref No: S/N/F/S/T/3025/2010***) was also submitted to the respective health service administrative departments of the study districts. Participation was on voluntary basis. Informed assent was obtained from mothers of the children. Anonymity of information was assured throughout the research process. Children (n=4) identified being severely acutely malnourished, as measured by MUAC, were linked to the integrated management of acute malnutrition program (FANTA, 2018) of respective kebele/cluster for nutritional and medical therapy and progress follow-ups.

Results

Maternal, Child and Household Characteristics

About 26% and 38% of the mothers attended school from grades one upto four and and from grades five upto eight, respectively. Majority of them identified themselves as Sidama (63%) by ethnicity and protestant (67.6%). Near to one-thirds (60%) of the mothers were ≤26 years old with a mean score (SD) of 25.6(5). Four out of five (79.5%) mothers described themselves as housemakers. Slightly more than one–thirds (34.5%) of the mothers reported that they were sick in the two weeks period before the survey.

Half (50.2%) of the children were male. Majority (60.2%) of the children were between twelve to twenty three months old with a mean score (SD) of 13.9 (5.4). About half (47%) of the children were sick in two weeks period before the day of data collection. Cough (30%), fever (21%), diarrhea (10%) and skin problems (9%) were symptoms reported (**Table 14**).

Table 14 Frequency distribution of maternal and children characteristics (n=605)

Variable		N	%
Maternal Characteristics			
Mothers Education	No Education	119	19.7
	Grades 1-4	159	26.3
	Grades 5-8	231	38.2
	Grade 9 and Above	96	15.9
Ethnicity	Sidama	381	63.0
	Oromo	187	30.9
	Wolayta	15	2.5
	Others	22	3.6
Religion	Protestant	409	67.6
	Muslim	164	27.1
	Orthodox	23	3.8
	Catholic	9	1.5
Age in Completed Years	≤26	363	60.0
	≥27	242	40.0
Occupation	House Wife	481	79.5
	Merchant	50	8.3
	Farmer	47	7.8
	Others	27	4.5
Sickness in the Last Two Weeks	No	396	65.5
	Yes	209	34.5
Characteristics of the Children			
Sex	Female	301	49.8
	Male	304	50.2
Age in months	6-11	241	39.8
	12-23	364	60.2
Sickness in the Last Two Weeks	No	323	53.4
	Yes	282	46.6
Reported Symptoms	Diarrhea	60	9.9
	Cough	182	30.1
	Fever	125	20.7
	Skin Problems	53	8.8
	Vomiting	19	3.1
	Others*	13	2.1%

*Appetite loss, Abdominal cramp/pain, Eye infection, Ear infection, Burn

Nearly all (93.6%) of the households were male headed. Women were reported to decide on purchase of household daily need for more than half (58.2%) of the families. More than half of the households were with five or less family sizes with a median score of 5 (IQR: 4, 7). Half of the households (53.4%) had two or more under-five children. The estimated annual income for 65.5% of the households was ≤10,000ETB/$312 (at $32 exchange rate). Local market was reported as

usual source of milk for the majority (63%) of the households. Almost all (92.4%) of the households fetch water from safe sources. Half (52.4%) of the households were food insecure. More than half (56.2%) of the households owned more than half hectare of agricultural land. About two-thirds (70.9%) of the households produced diverse crops. Cereal (71.6%), cash crops (66%), vegetables (56.7%), legumes (47.4%) and roots (40.3%) were majorly produced crops. Cows (42.5%), chicken (41.2%), oxen (23.8%) and donkeys (13.7%) were livestock owned by the households (**Table 15**).

Table 15 Frequency distribution of household characteristics (n=605)

Variables	**Categories**	**N**	**%**
Head of the Household	Husband	566	93.6
	Wife	23	3.8
	Other	16	2.6
Decision on Daily Household Needs	Both Husband and Wife	186	30.7
	Wife	352	58.2
	Husband/Other	67	11.1
Family Size	≤5	360	59.5
	≤6	245	40.5
Number of Underfive Children	One	282	46.6
	Two and More	323	53.4
Estimated Annual income in ETB	≤10000/$312	396	65.5
	10001 – 20000/$312-624	110	18.2
	20001 – 30000/$624-937	49	8.1
	>30000/$937	50	8.3
Usual milk Source	Family Milk Cow and/or Goat	196	32.4
	Local Market	381	63.0
	Others (Grand Parents/Other-Relatives/Neighbors)	28	4.6
Food Security	Food Insecure	317	52.4
	Food Secure	288	47.6
Water Source	Safe Sources	559	92.4
	Unsafe Sources	46	7.6
Agriculture Land Ownership	≤0.5 Hectare	265	43.8
	>0.5 Hectare	340	56.2
Crop Production: Produce-	Cereal	433	71.6
	Roots	244	40.3
	Legumes	287	47.4
	Vegetables	343	56.7
	Cash Crops	399	66
	Produce diversity of crops	429	70.9
Livestock Ownership	Oxen	144	23.8
	Cows	257	42.5
	Goats	69	11.4
	Sheep	62	10.2
	Donkey	83	13.7
	Chicken	249	41.2

Nutritional Status

The mean scores (SD) for weight of the children was 8.95 (1.7) and mean score for length was 73.5 (6.7). The mean (SD) Z-scores for weight for length (WLZ), for length for age (LAZ) and for weight for age (WAZ) were -0.13(1.2), -1.17(1.39) and -0.72(1.17), respectively.

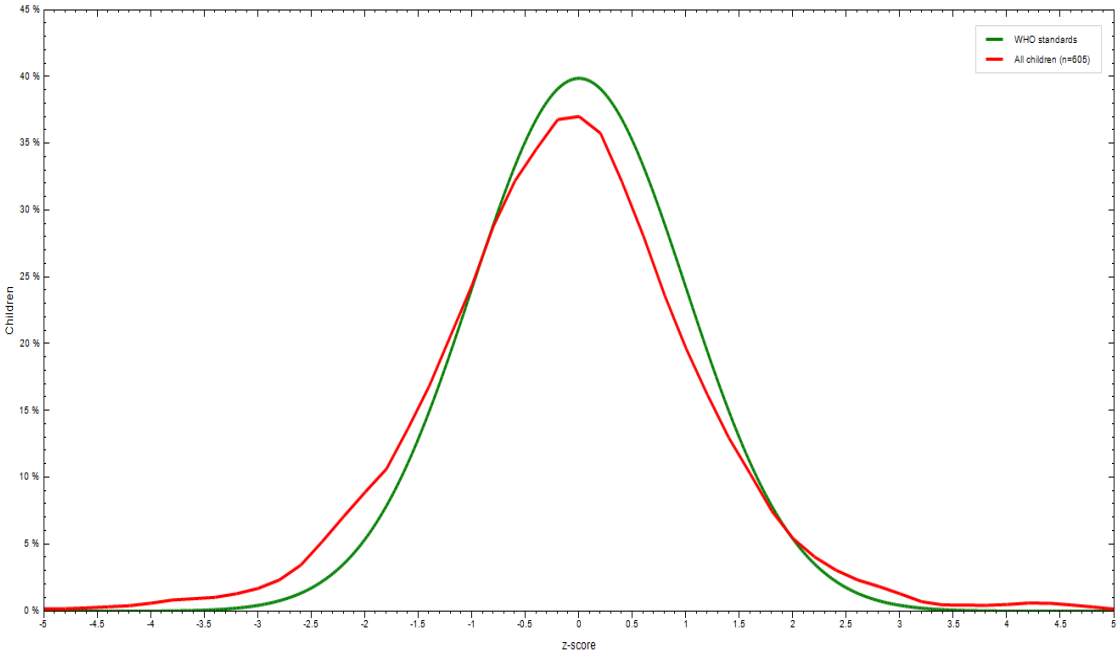

Figure 5 Distribution of weight for length Z-scores against WHO's standard curve

The prevalence of wasting, underweight and stunting were 5.6% (95%CI: 3.7, 7.5), 13.6% (95%CI: 10.7, 16.4) and 25.8% (95%CI: 22.2, 29.3), respectively (**Figures 3, 4 and 5**).

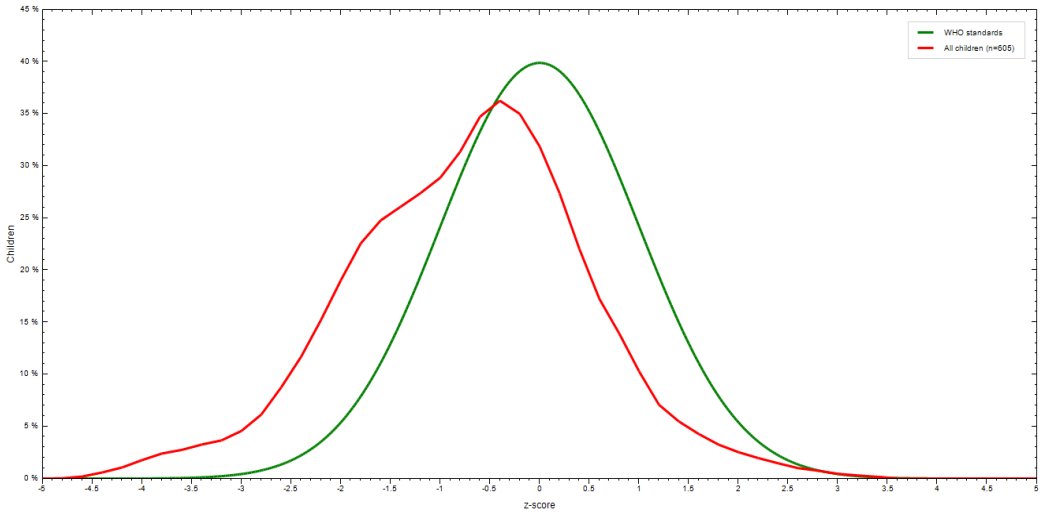

Figure 6 Distribution of Weight for Age Z-scores against WHO's standard curve

Stunting and underweight co-existed in 9.8% (95%CI: 7.4, 12.1), wasting and underweight in 4.6% (95%CI: 3, 6.3), wasting and stunting in 2.1% (95%CI: 1, 3.3) and wasting, stunting and underweight in 2.1% (95%CI: 1, 3.3.) of the children.

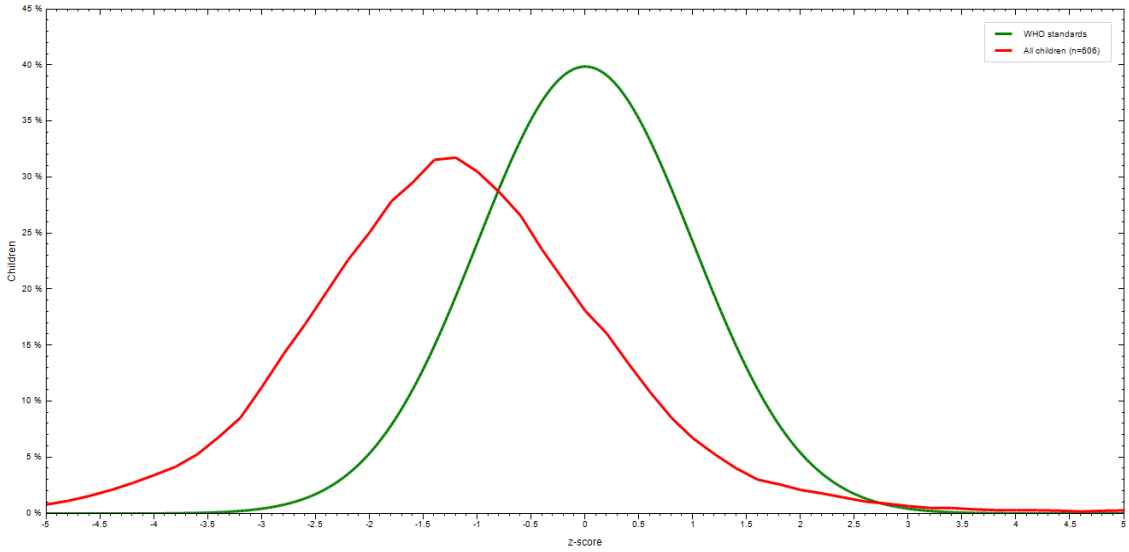

Figure 7 Distribution of length for Age Z-scores against WHO's standard curve

As measured by MUAC, 6.3% (95%CI: 4.3, 8.3) of the children were acutely malnourished, with Z-score less than -2SD.

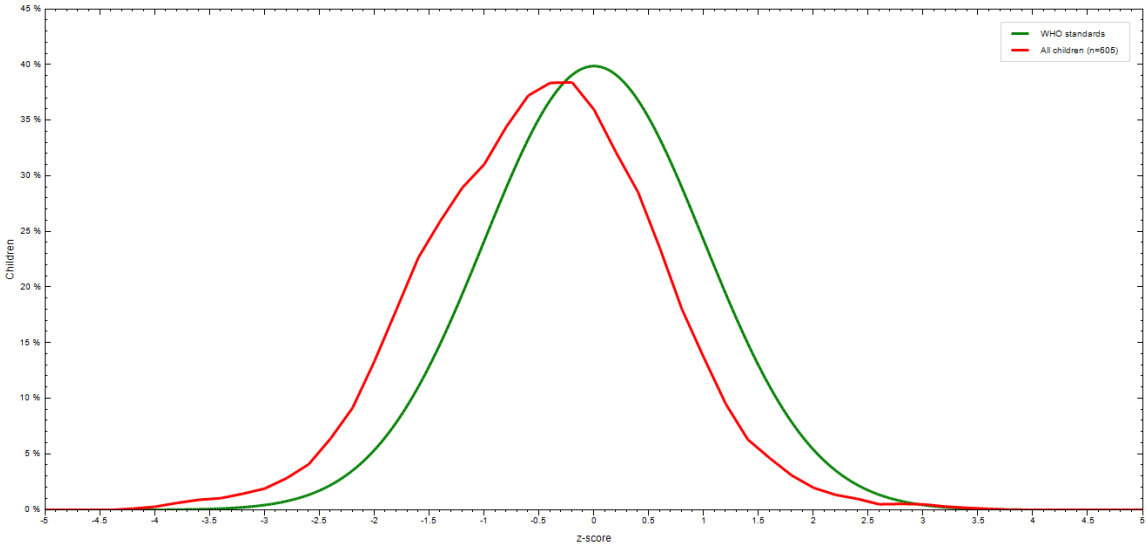

Figure 8 Distribution of Mid Upper Arm Circumference for Age Z-score against WHO's standard curve

Cereal and roots were consumed by 92.4% of the IYC; dairy was consumed by 41.2%; eggs were consumed by 16.4%; and flesh consumed by 1.8%. Mean (SD) of the dietary diversity score was 2.2 (1.2). Minimum dietary diversity was met by 15.5% (95%CI: 12.9, 18.7) of the IYC.

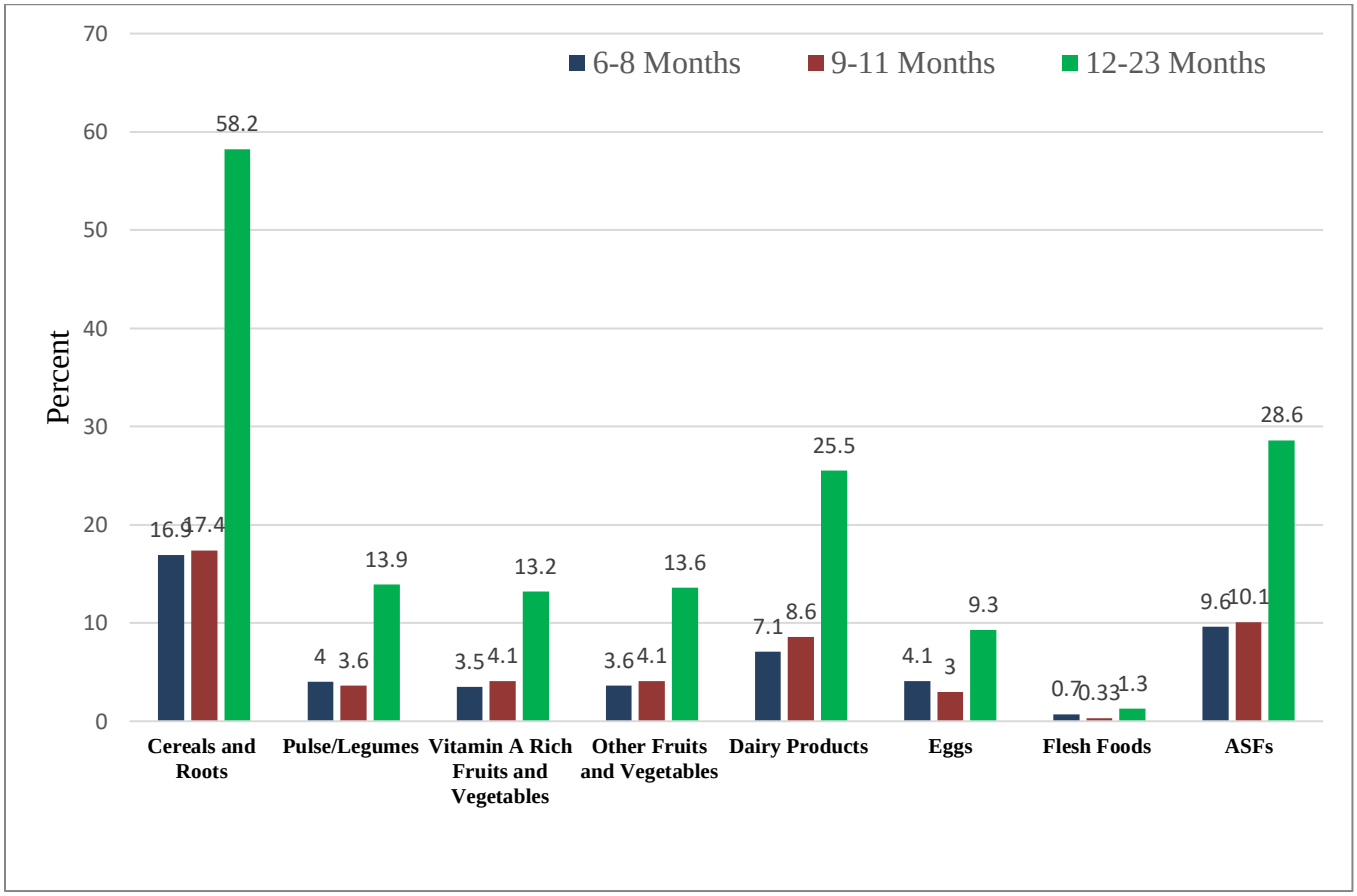

Figure 9 Percentage distributions of food groups consumed by infant and young children according to WHO recommended age category

Factors Associated with Nutritional Status and Minimum Dietary Diversity of the Children

Children with mothers who were sick in the two weeks period before the date of survey were four times [AOR=4.31 (95%CI: 1.45, 12.83), p. =0.009] more likely to be wasted than children who were with mothers who were healthy in the period. Wasting was five times [AOR=5.80 (95%CI; 2.21, 15.22), p. <0.001] more likely for children with mothers who were farmers than children with mothers who were housemakers. Children with mothers who achieved grades six up to eight education were about seven times [AOR=6.74 (95%CI: 1.41, 32.30), p. =0.017] more likely to be wasted as compared to children with mothers who achieved grade nine or above education. Children those who did not consume legume/pulse products in the day before the date of survey were three

times more likely to be wasted. The probability of wasting for children with mothers who were ≥27 years old was less by 67% [AOR=0.33 (95%CI: 0.14, 0.78), p. =0.011] than the probability of wasting for children with mothers who were ≤26 years old. The probability of wasting for children with in the age range of rwelve to twenty three months old was lesser by 58% than the probability of wasting for children in the age range of six to eleven months old.

Female [AOR=0.57 (95%CI: 0.39, 0.83), p. = 0.004] children and children from households that did not produce vegetable [AOR=0.64 (95%CI: 0.43, 0.94), p. =0.024] were 43% and 36% less likely of being stunted than their counters, respectively. Children with mothers who never attended school were two and half times [AOR=2.59 (95%CI: 1.33, 5.04), p. =0.005)] more likely to be stunted than children with mothers who achieved grade nine or above education.

Children who did not consume other fruits and vegetables in the day before the survey were two times [AOR=2.04 (95%CI: 1.01, 4.11), p. =0.047] more likely to become underweight than their counters. Occurrence of diarrhea [AOR=2.24 (95%CI; 1.1, 4.56), p. =0.027] in the two weeks period before the survey, and family size of six or more [AOR=1.74 (95%CI; 1.07, 2.83), p. 0.026]- as compared with five or less family size also increased children's underweight probability by about two times. The probability of underweight for children from no vegetable producing households was lower by half (49%) [AOR=0.51 (95%CI; 0.30, 0.85), p. =0.01] than children who were from vegetable producing households.

Family size and milk source were associated with MUAC of the children. Children from households with six or more family size were about three times [AOR=2.66 (95%CI: 1.32, 5.36), p. =0.006] more likely to be acutely malnourished than children from households with five or less family size. Children from households with market milk source were more than three times [AOR=3.23 (95%CI: 1.21, 8.62), p. =0.019] likely to be acutely malnourished, as compared to children from households with family cow or goat as a milk source. Children reported of being febrile in the two weeks period prior to the survey were also about three times [AOR=2.77 (95%CI: 1.35, 5.67), p. =0.005] more likely to be acutely malnourished than children who were free of fever in the same period. Consumption of other fruits and vegetables and production of fruits were also found to decrease the chance of acute malnutrition in children. Children from households that did not produced fruits were more than two times [AOR=2.23 (1.09, 4.56), p. =0.027] and children who did

not consumed other fruits and vegetables were about five times [AOR=4.94 (95%CI: 1.15, 21.22), p. =0.032] more likely to be acutely malnourished than their counter parts (**Table 16**).

Table 16 Logistic regression analysis on predictors of growth failure and minimum dietary diversity (n=605)

Variable	Category	AOR(95%CI)	*p.*
Wasting			
Educational Status of the Mother	Grade 5-8	6.74 (1.41, 32.30)	.017
Occupation of the Mother	Farmer	5.80 (2.21, 15.22)	.000
Mothers Age in Completed Years	≥27	0.33 (0.14, 0.78)	.011
Did the mother get sick in the last two weeks	Yes	4.31 (1.45, 12.83)	.009
Child Age in Months	12-23	0.42 (0.20, 0.89)	.024
Pulses/Legumes Consumption-last 24hours	No	3.10 (1.40, 6.82)	.005
Stunting			
Mothers Educational Status	No Education	2.59 (1.33, 5.04)	.005
Sex of the Child	Female	0.57 (0.39, 0.83)	.004
Vegetable Production	No	0.64 (0.43, 0.94)	.024
Underweight			
Other Fruits and Vegetables Consumption	No	2.04 (1.01, 4.11)	.047
Diarrhea in the Last Two Weeks	Yes	2.24 (1.10, 4.56)	.027
Vegetable Production	No	0.51 (0.30, 0.85)	.010
Family Size	≥6	1.74 (1.07, 2.83)	.026
MUAC			
Consumption of other fruits and vegetables	No	4.94 (1.15, 21.22)	.032
Fruit production	No	2.23 (1.09, 4.56)	.027
Fever	Yes	2.77 (1.35, 5.67)	.005
Milk Source	Market	3.23 (1.21, 8.62)	.019
Family size	≥6	2.66 (1.32, 5.36)	.006
MDD			
Household food security	Secured	3.33 (1.93, 5.74)	.000
Agriculture Land Size, in hectare	≥0.5	2.14 (1.22, 3.73)	.008
Root crops production	Yes	1.66 (1.01, 2.75)	.047
Chicken Ownership	Yes	2.01 (1.20, 3.39)	.008
Decision on daily household needs	Both husband and wife	2.78 (1.18, 6.57)	.020
Cash Crops Production	Yes	0.22 (0.12, 0.39)	.000

Household food insecurity status, agriculture land size, crop production and chicken ownership were associated with MDD. Children from food secure households were more than three times [AOR=3.33 (95%CI: 1.927, 5.744), p. <0.001] likely to meet MDD than children who were from food insecure households. Children resided in households with half hectare or more agriculture land ownership were two times [AOR=2.14 (95%CI: 1.223, 3.728), p. =0.008] more likely to meet MDD than children who were from households that owned less than half hectare of agricultural

land. Root crops production increased children's chance of meeting MDD by about one and half times [AOR=1.66 (95%CI: 1.007, 2.745), p. =0.047], and chicken ownership did the same by two times [AOR=2.01 (95%CI: 1.20, 3.39), p. =0.008]. Children lived in households in which both husband and wife together decides on household daily needs were about three times [AOR=2.78 (95%CI: 1.178, 6.574), p. =0.02] more likely to meet MDD than children who lived in households in which husbands/others alone decides on daily need of the households. Cash crops production practice decreased children's chance of meeting MDD by 78% [AOR= 0.22 (95%CI: 0.12, 0.39), p. <0.001] (**Table 16**).

Factors Associated with Animal Source Foods Consumption by Children

Household food security was associated with all types of ASF and overall ASF consumption. Children lived in food secure households were more likely to consume dairy [AOR=1.66(95%CI: 1.16 2.38), p. =0.006], flesh/meat [AOR=5.08 (95%CI: 1.09, 23.71), p. =0.039], eggs [AOR=2.15 (95%CI: 1.33, 3.49), p. =0.002] and at least one of the ASF [AOR=1.94 (95%CI: 1.36, 2.78), p. <0.001] than children lived in food insecure households.

Educational status the mothers and household level livestock ownership determined consumption of dairy. Children lived in households that owned cow [AOR=1.86(95%CI: 1.28, 2.70), p. =0.001] or chicken [AOR=1.53(95%CI: 1.05, 2.22), p. =0.027] or donkey [AOR=1.83(95%CI: 1.08, 3.11), p. =0.024] were about two times more likely to consume dairy. Children with mothers who achieved grades five upto eight education were two times [AOR=1.74 (95%CI: 1.06, 2.86), p. =0.028] and children with mothers who achieved grade nine or above education were three times [AOR=2.96 (95%ci: 1.62, 5.42), P. <0.001] more likely to consume dairy than children with mothers who never attended school.

Root crops production and chicken ownership were associated with eggs consumption. Children from households that owned chicken were three times [AOR=3.20 (95%CI: 1.97, 5.19), p. <0.001] more likely to consume eggs than children from households that did not own chicken. Children who resided in households that produced root crops were also about two times [AOR=1.67 (1.05, 2.66), p. 0.031] more likely to consume eggs than children in households that did not produce root crops.

Consumption of at least one of the ASF was determined by livestock ownership, income and educational status of the mothers. Children from households that owned cow [AOR=1.89 (95%CI:

1.31, 2.74), p. =0.001] or chicken [AOR=1.93 (95%CI: 1.33, 2.81), p. =0.001] were two times more likely to consume at least one of the ASF than children from households that did not own the respective livestock. Children from households with an income of 10,001-20,000 [AOR=1.70 (95%CI: 1.06, 2.73), p. =0.028], 20,001-30,000 [AOR=1.96 (95%CI: 1.01, 3.79), p. =0.047] and more than 30,000 [AOR=2.71 (95%CI: 1.36, 5.39), p. =0.005] were two to three times more likely to consume at least one of the ASF than children from households with an estimated annual household income of 10,000ETB or less. Children with mothers who achieved grades five upto eight education were two times [AOR=2.03 (95%CI: 1.25, 3.31), p. =0.004] more likely to consume at least one of the ASFs than children with mothers who never attended school (**Table 17**).

Table 17 Logistic regression analysis on predictors of dairy products, flesh/meat, eggs and overall animal source foods consumption (n=605)

Variable	**Category**	**AOR(95%CI)**	***p.***
Dairy Products			
Household Food Insecurity	Secure	1.66(1.16 2.38)	.006
Cow Ownership	Yes	1.86(1.28, 2.70)	.001
Donkey Ownership	Yes	1.83(1.08, 3.11)	.024
Chicken Ownership	Yes	1.53(1.05, 2.22)	.027
Educational Status of the Mothers	Grades 5-8	1.74 (1.06, 2.86)	.028
	Grades 9 or above	2.96 (1.62, 5.42)	.000
Household Estimated Annual Income in Ethiopian Birr	20001-30000	2.22 (1.16, 4.26)	.017
Flesh/meat Foods			
Household Food Insecurity	Secure	5.08 (1.09, 23.71)	.039
Eggs			
Household food insecurity	Secure	2.15 (1.33, 3.49)	.002
Root Crops Production	Yes	1.67 (1.05, 2.66)	.031
Chicken Ownership	Yes	3.20 (1.97, 5.19)	.000
Overall ASFs			
Household Food Insecurity	Secure	1.94 (1.36, 2.78)	.000
Cow Ownership	Yes	1.89 (1.31, 2.74)	.001
Chicken Ownership	Yes	1.93 (1.33, 2.81)	.001
Estimated Household Annual Income in	10001 – 20000	1.70 (1.06, 2.73)	.028
Ethiopian Birr	20001 – 30000	1.96 (1.01, 3.79)	.047
	>30000	2.71 (1.36, 5.39)	.005
Educational Status of the Mothers	Grades 5-8	2.03 (1.25, 3.31)	.004

Discussion

All children are in need of care including nutrition that has positively to impact their healthy growth and development. This study was sought to assess child growth failures, MDD, consumption of ASF, and identify their predictors among 6-23 months old infant and young children from rural districts of Ethiopia. Accordingly, the prevalence of wasting was 5.6%, underweight was 13.6% and stunting was 25.8%. The observed proportions for wasting is lower than figures from Somali (Fekadu *et al.*, 2015; Kahsay *et al.*, 2018) and Kamba (Agedew and Shimeles, 2016), and slightly higher than Demba-Gofa (Mekonnen, 2017) and Tigray (Desalegn *et al.*, 2019) districts in Ethiopia. The prevalence of stunting is lower than figures reported for districts in Awbare (Kahsay *et al.*, 2018), Tigray (Desalegn *et al.*, 2019) and southern nations, nationalities and people regional states (SNNPRS) (Mekonnen, 2017) of Ethiopia. But it is relatively comparable to the prevalence reported for Filtu town (Fekadu *et al.*, 2015) in Ethiopia. The prevalence of stunting reported for Kemba district (Agedew and Chane, 2015) is below the lower bound of the 95% confidence interval (95%CI) of this study. Studies conducted in Tigray (Desalegn *et al.*, 2019) and SNNPRS (Mekonnen, 2017) reported underweight prevalence that fall with in the 95%CI of finding of this study, while a study from Somali (Kahsay *et al.*, 2018) is below this study's lower bound of 95%CI for prevalence of underweight. According to WHO's growth failure prevalence public health significance level cut offs, stunting and underweight are classified as low, medium, high and very high public health problems, and wasting is classified as acceptable, poor, serious and critical public health problem (WHO, 2012). According to the results of this study the prevalence of acute malnutrition measured by MUAC was 6.3% and it is lesser than the figure reported (16.5%) for children from Mali (Makamto Sobgui *et al.*, 2018).

In the current study, stunting and underweight coexisted in 9.8%, wasting and underweight in 4.6% and wasting, stunting and underweight in 2.1% of the children. A study conducted in Tanzannia (Mgongo *et al.*, 2017), which included 0-36 months old children, reported that underweight and stunting coexisted in 33% of the children, and 12% of the studied population had all the three forms of growth failures. Prevalence of growth failure coexistence identified by the current study is lower than figures reported by the study from Tanzania. As the odds of failure to thrive increases with age (Correia *et al.*, 2014; Akombi *et al.*, 2017), the difference could be because of studied children's age range difference. The current study was done among 6-23 months old children, while the Tanzanian study was on 0-36 months old children. Similarly, a study in Bangladesh (Islam and Biswas, 2020),

in which under-five years of age children participated, also report prevalence of 18.2% for stunting and underweight, 5.5% for wasting and underweight and 5.7% for wasting, underweight, and stunting co-existences.

Minimum dietary diversity was also assessed to evaluate part of IYCF practice. According to the findings of this study, only 15.5% met the MDD. According to a study conducted in Adea district-Ethiopia (Agize, Jara and Dejenu, 2017), only half (51%) of the mothers were knowledgeable on DD of IYC and only 16% of them let let IYC to achieve MDD. On top of the agreement between the proportions for MDD, the low level of maternal knowledge towards IYC dietary diversity might have contributed to the low proportion of children who met MDD. The result is also almost comparable to findings from Aleta Wondo-12% (Dafursa and Gebremedhin, 2019), Dabat-17% (Belew *et al.*, 2017), Dangila-12.6% (Beyene, Worku and Wassie, 2015), Dejen-13.6% (Kumera, Tsedal and Ayana, 2018), Jimma-16.1% (Forsido *et al.*, 2019) and Sinan-13% (Temesgen, Yeneabat and Teshome, 2018) districts in Ethiopia. Lower proportion of children than this study met MDD in studies from Gorche-10.6% (Dangura and Gebremedhin, 2017), Halaba and Ziway-8.1 to 8.6% (Ersino, Henry and Zello, 2016) and Wollo-7% (Gebremedhin *et al.*, 2017) areas in Ethiopia. But higher proportion of children than the current finding met MDD in Addis Abab-59.9% (Solomon, Aderaw and Tegegne, 2017), Afar-21.8% (Wuneh *et al.*, 2019), Bale Zone-28.5% (Tegegne *et al.*, 2017) and Wolaita Sodo-27.3% (Mekonnen *et al.*, 2017).

To the result of this research, less than half (48.3%) of the children consumed at least one of the ASF (dairy or eggs or flesh/meat). Dairy (41.2%) was better consumed than eggs (16.4%) and flesh (1.8%). The proportion of children who consumed flesh is comparable with reports from Aleta Wondo (Dafursa and Gebremedhin, 2019), Gorche (Dangura and Gebremedhin, 2017), Dangila (Beyene, Worku and Wassie, 2015), Wollo (Gebremedhin *et al.*, 2017) districts in Ethioia, but lower than proportions from Addis Ababa city (Solomon, Aderaw and Tegegne, 2017), Afar (Wuneh *et al.*, 2019), Bale (Tegegne *et al.*, 2017) and Wolaita Sodo (Mekonnen *et al.*, 2017) towns in Ethiopia. The observed difference might be subjected to study setting differences as studies with higher proportion are conducted in city/towns where ASF consumption enabling factors are better (Streeter, 2017). Eggs are consumed by lower proportion of children than study done in Wollo (Gebremedhin *et al.*, 2017), Dejen (Kumera, Tsedal and Ayana, 2018) and Afar (Wuneh *et al.*, 2019). It was also consumed by a lesser proportion of children than children studied by studies from Woliata Sodo (Mekonnen *et al.*, 2017), Aleta Wondo (Dafursa and Gebremedhin, 2019), Addis Ababa (Solomon, Aderaw and Tegegne, 2017) and Bale (Tegegne *et al.*, 2017). Research conducted

in Gorche (Dangura and Gebremedhin, 2017), Sinan (Temesgen, Yeneabat and Teshome, 2018) and Dangila (Beyene, Worku and Wassie, 2015) districts in Ethiopia reported almost equal proportion of children who consumed eggs compared with proportion found by this study.

The third focus of this study was determinants of child growth failures. Accordingly, educational status of the mothers, occupation of the mothers, sickness status of the mothers, childhood diarrhea, family size, child sex and child age were associated with child growth failures. Being with mothers who achieved grades five up to eight education increased the chance of wasting by about seven times and being with mothers who never attended school increased the chance of stunting by more than two times as compared to being with mother who achieved grade nine or above education. Regarding mothers' occupation, being a farmer increased the odds of a child to be wasted. Mothers' sickness history in two weeks period before the date of the survey increased the probability of wasting by more than four times, while childhood diarrhea did the same by more than two times for underweight. The odds of being underweight for children from households with six or above family size was two times higher than children from households with five or less family size. Being female and being in the age range of 12-23 months were also associated with stunting and wasting, respectively. The associations are in agreement with findings of studies conducted in Ethiopia (Agedew and Chane, 2015; Fekadu *et al.*, 2015; Mekonnen, 2017; Desalegn *et al.*, 2019) and Mali (Makamto Sobgui *et al.*, 2018).

No consumption of pulses/legumes predicted wasting, and other fruits and vegetables predicted underweight. No vegetable production practice was found being protective of stunting and underweight. Women are highly engaged in child care and feeding than men (S. Bilal *et al.*, 2016; S. M. Bilal *et al.*, 2016; Abate and Belachew, 2017; Kansiime *et al.*, 2017), and they are also mandated to play the roles for vegetable farming in the study area (Abebe and Mulu, 2017). Women's engagement in the strict day-to-day vegetable farming activity might have competed for time to be invested for child care and feeding, which might have increased probability of stunting.

Pertaining to the results of this study, children from food secure households were likely to meet MDD, and the finding is in line with observations in Aleta Wondo-Ethiopia (Dafursa and Gebremedhin, 2019) and Maharashtra-India (Chandrasekhar and Krishna, 2017). Small livestock like chickens play an important role to improve dietary diversity. They used to serve as frequent source of ASF. In line to finding from Gorche-Ethiopia (Dangura and Gebremedhin, 2017) on the role of livestock ownership, in the current study chicken ownership [AOR=2.01, p. =0.008]

increased the odds of meeting MDD. As agriculture land ownership and size are also important assets to farming community, agricultural land size (≥0.5 hectare) was found associated with increased probability of meeting MDD. The chance to meet MDD was more likely for children from root crop producing households than children from households that did not produce root crops. Women's control over the production and marketing value chain of the crop might have contributed to the positive association between child MDD and root crops production practice (Abebe and Mulu, 2017). In contrary, cash crop production practice of households reduced likelihood to meet MDD. The gender disparity over the control of cash crop value chain (Mulema and Damtew, 2016; Zakaria, 2017) and its nature of taking land constantly/for long period of time could have contributed to the inverse association between cash crop production and MDD. Children from households in which both wife and husband together decides for daily household needs were more likely to meet MDD than children from households in which husband/other decides for daily household needs. The positive association is in line with results of another study from Ethiopia (Kuche *et al.*, 2020). Also, in agreement with the result of the current study, a finding from Ghana also reported a positive association between women's say for deciding on household purchases and achieving a higher DD (Dickson A. Amugsi *et al.*, 2016).

Household food security constantly increased probability of dairy, flesh and eggs consumption. The association could be explained by the incompatibility of food insecure households' purchasing power with the increasing cost of ASF (Minten and Fantu, 2020), and the fact that food insecure households prefer to consume less expensive food products to cope with it (Asesefa Kisi *et al.*, 2018). The odds of dairy consumption practice were increased by cow, donkey and chicken ownership. Similarly, odds for eggs consumption was more for children from households that owned chicken. As local market is the usual source of dairy products for majority of the children (63%), donkey's role in income generation might contributed to the positive association (Angara, T. E. E., Ismail, A. A. and Ibrahim, 2011; Valette, 2015). Mothers' educational achievements were also associated with more likelihood of dairy consumption. The overall ASF consumption analysis also showed a positive effect of mothers' higher educational achievement, cow or chicken ownership, income and household food security. The finding of a study done in Amhara-Ethiopia is in line with the observed association between cow or chicken ownership and overall ASF consumption in the present study (Kim *et al.*, 2019).

Conclusions

Growth failures were prevalent in the study area. Stunting and underweight were medium level public health problems, while wasting ranked for a level of poor situation. Lower proportion of IYC met MDD. A very small proportion of children consumed eggs and flesh foods.

Lower maternal educational achievement, farmer occupation of the mothers, mothers' sickness history, childhood diarrhea and extended family size increased the probability of different forms of child growth failures. Children from no vegetable producing households were protected of stunting and underweight.

Household food security, ownership of ≥0.5 hectare agricultural land, root crops production, chicken ownership and communal decision on household daily needs were positively associated with MDD. But cash crop production was negatively associated with MDD.

Generally low household level socio-economic status and maternal education affected ASF consumption. Household food security was positively associated with consumption of all forms of ASF and overall ASF consumption. Livestock (cow, chicken and donkey) ownership, mothers' grades five upto eight and grade nine or above educational achievement and household income in the category of 20001-30000 increased children's dairy consumption chance. Root crops production and chicken ownership were positively related to eggs consumption. Overall ASF consumption was determined by livestock ownership, household annual income and maternal education. In summary, consumption of ASF was dependent on household food security, livestock ownership, household income and maternal empowerment. Extension activities to increase healthy productivity of agriculture aided by nutrition education should be considered and evaluated for their effect on diets and growth of children. Women empowerment especially though education and income generation may positively impact nutrition and growing children. More researches are warranted to further understand the observed protective relationship between no vegetable production practice with stunting and underweight.

CHAPTER SEVEN

Nutrition Education Intervention with Low Health Literacy Approach Improved Consumption of Animal Source Foods by Mother-Child Pairs: A Cluster Randomized Controlled Trial

Abstract

Findings from Ethiopia documented that women and children did not consume diversified diets with most limited food groups being animal source foods and they have consistently recommended for feasible interventions. Therefore, this study aimed to evaluate the effect of a low health literacy approach nutrition education (LHLANE) intervention on consumption of ASF, dietary diversity and nutritional status of mother-child pairs in rural districts of Ethiopia. A cluster randomized controlled trial was conducted on 190 randomly selected mother-child pairs. Nutrition education sessions were delivered with LHLANE approach. Data were collected on nutrition of mothers and children before and after the intervention. Between group differences were tested with Chi-square and independent samples t-test at p. <0.05. After the nutrition education intervention, proportion of mothers who consumed eggs (P =0.016) and dairy (P =0.042) was higher for treatment the control group. Proportion of children who consumed dairy (P =0.001) and eggs (P =0.015) was also higher for the treatment than control group. Mean scores for dietary diversity of mothers (P <0.001) and children (P <0.001) were significantly higher for lactating mothers and infant and young children in the treatment group than in the control group. Mean scores of Weight for height (P =0.003) and Weight for age (P =0.022) were significantly higher for children in the treatment group than children on the control group. A LHLANE improved consumption of ASF by mothers and children pairs and mean scores for dietary diversity of mothers and children. It also improved weight for height and weight for age of the children. Nutrition programs should integrate nutrition education and consider strategies recommended to improve health literacy in behavioral change communication activities to improve nutrition of mothers and children.

Keywords*:* Nutrition Education; Low Health Literacy; Women; Children; Nutrition; Animal Source Foods; Ethiopia

Introduction

Undernutrition and related problems are global concerns (IFPRI., 2016) that need collaborative efforts in which multiple stakeholders should involve (USAID, 2014; Unicef, 2015). Women and children who live especially in developing countries are vulnerable to undernutrition (Haddad, 1999; Negesse *et al.*, 2020). Likewise, undernutrition is prevalent among women and children in Ethiopia. Nationally, 38% of under-five children are stunted, 10% wasted and 24% underweight (CSA, 2016b), while one out of three (27%) reproductive age women is undernourished as measured by body mass index (BMI) (CSA, 2016a). Similarly, cross-sectional studies conducted on children and women at different districts of Ethiopia equivocally documented public health significance (WHO, 2012) of undernutrition. Accordingly, significant proportion of mothers in Ethiopia are undernourished: a 17.4% in Arbaminch (Tikuye *et al.*, 2019), 17.7% in Moyale (Bekele, Jima and Regesu, 2020), 13% in Samare (Haileslassie, Mulugeta and Girma, 2013), 14.2% in Hula (Negash *et al.*, 2015) and 50.6% in Tigray (Desalegn *et al.*, 2018). Also, studies done on children in different districts of Ethiopia consistently reported that wasting, underweight and stunting are prevalent (Agedew and Chane, 2015; Fekadu *et al.*, 2015; Agedew and Shimeles, 2016; Mekonnen, 2017; Kahsay *et al.*, 2018; Desalegn *et al.*, 2019). At the same time, more than half (56%) of under-five children and about a quarter (23%) of women in the country suffer from iron deficiency anemia, for which consumption of ASF is beneficial to improve the situation (Hall *et al.*, 2017). ASF also provide various benefits. They are good sources of quality nutrients important for growth, immunity, neurological function and healthy behavioral outcomes (Murphy and Allen, 2003; Neumann *et al.*, 2007; Eaton *et al.*, 2019). Moreover, adding small quantities of ASF improves the nutritional quality and performance of plant-based diets and significantly impact consumers' nutritional status (Darapheak *et al.*, 2013; Iannotti *et al.*, 2017; Eaton *et al.*, 2019). But studies conducted in Ethiopia consistently reported that low proportion (<15%) (Aemro *et al.*, no date; Beyene, Worku and Wassie, 2015; Dangura and Gebremedhin, 2017) of children in Ethiopia achieved minimum dietary diversity and mostly lacking food groups were ASF (fish, meat, eggs and dairy) and fruits and vegetables (Gatahun, 2015; Solomon, Aderaw and Tegegne, 2017). A significant proportion (55-92%) of women in Ethiopia also scored low dietary diversity and less proportion (<20%) of lactating mothers consumed ASF (Amare *et al.*, 2012; Weldehaweria *et al.*, 2016; Boke and Geremew, 2018). In addition of discussing the concordance of maternal and

child dietary gaps, behavioral change communication (BCC) interventions has been suggested to narrow the dietary gaps and correct the situation targeting women and children together (Rahman *et al.*, 1993; Tigga and Sen, 2016). Inline to the recommendation, nutrition education interventional researches conducted in Ethiopia mainly focused on child feeding practices, assessed knowledge, attitude and practice of mothers and evaluated its effect on dietary diversity, pulse inclusion in complementary foods and nutritional status alone on children (Negash *et al.*, 2014; Tariku *et al.*, 2015; Mulualem *et al.*, 2016; Rashid *et al.*, 2018; Muluye, Lemma and Diddana, 2020; Teshome *et al.*, 2020). However, as the most limited food group, ASF are not well addressed and mothers and children are not considered collectively in the interventions. Therefore, the purpose of this study was to evaluate the effect of nutrition education intervention on ASF consumption practice, dietary diversity and nutritional status of lactating mothers and 6-23 months old infant and young children in rural districts of Ethiopia.

Materials and Methods

Study Area and Design

The study was conducted in districts in Sidama and Oromia regional states of Ethiopia. Three districts (Arsi Negelle, Wondo Gent and Dale) were included from the two regional states. Arsi Negelle district is from Oromia. Dale and Wondo Genet are from Sidama. A community based cluster randomized controlled trial epidemiologic study design was applied. The districts were areas where a project titled "***Linking Cattle Nutrition to Human Nutrition***" had been implemented.

Sampling

Sample size was calculated using two populations proportion formula (Rutterford, Copas and Eldridge, 2015) at 95% confidence level, 0.05 margin of error and a design effect of two. Four kebeles (the lowest unit in administrative structure of Ethiopia) from each of the study district (n=12 kebeles) were randomly selected. The kebeles were considered as clusters and randomly assigned to the treatment (n=6) and control (n=6) groups. After census was done to identify eligible mothers with 6-17 months old children, 190 mother-child pairs (99 in treatment and 91 in control) were randomly selected through simple random sampling technique and included in the study. Pregnant and non-breastfeeding mothers were excluded. Pregnant, but breastfeeding mothers were also excluded to lower rate of loss to follow-up because of related challenges. Non-breastfeeding mothers were also excluded not to affect practice of breast feeding specific session of the nutrition education intervention and as they will have higher chance of getting pregnant.

Nutrition Education

Nutrition education materials were developed after reviewing and considering relevant literatures on maternal and child nutrition (Eva, 1981; Mathai *et al.*, 2000; FMoH-E, 2011; Hunter and Fanzo, 2013; WHO, 2013a, 2015; FDRE, 2018; UNICEF and WHO, 2018) and research outputs (Fabrizio, van Liere and Pelto, 2014; Negash *et al.*, 2014; Kim *et al.*, 2016; Mulualem *et al.*, 2016; Kang *et al.*, 2017; Omer *et al.*, 2018; Zongrone *et al.*, 2018). The developed nutrition education materials focused on infant and young child feeding (IYCF) (breastfeeding and complementary feeding), nutrition during lactation, dietary diversity, inclusion of ASF in a diversified diet, food hygiene and water, sanitation and hygiene (WASH) practices. The need for family planning was also considered as a key message. Importance of men (male sexual partner/husband) involvement in maternal and child nutrition and ways to encourage for their involvement were also tips to the IYCF and nutrition

during lactation sessions. For each of the session, banners with pictures and key messages were prepared and posted during delivery of the respective session. The materials were originally prepared in English and then translated to the local languages (Afaan Oromo and Sidaamu Afoo).

Six nutrition (Two for Arsinegelle and Four for Dale and Wondo Genet districts) professionals who can speak the local languages were recruited for the nutrition education. The research team provided five days (40 hours) intensive training to the recruited nutrition educators on the purpose of the study, purpose of the nutrition education, basics of low health literacy approach, nutrition education skills and knowledge, skills and attitude pertinent to the specific sessions to be covered by the nutrition education sessions to the mothers. During the training, teach back sessions were also conducted by the nutrition educators. The teachback sessions gave them opportunities to rehearse session specific knowledge and practical skills acquired before they are placed to the real community settings to deliver the nutrition education. This also provided them an opportunity to practice strategies though which they are expected to apply low health literacy approach.

Nutrition education sessions were delivered following a low health literacy approach (Murimi, 2013) in consideration of recommended strategies to improve it (Kountz, 2009). Key messages were repeatedly conveyed verbally and with posted material to mothers. Mothers were also given colored pictures of ASF to post in their house. A total of eight sessions were delivered: (1) Breastfeeding, (2) Complementary feeding, (3) Nutrition during lactation, (4) Dietary diversity (5) Inclusion of animal source foods in diversified diets, (6) WASH, (7) Review of sessions, and (8) demonstrations on IYCF. Each of the sessions on average took two hours. A group of mothers attended a session in a week. The mothers were encouraged to repeat the key messages to themselves and to the group for rehearsal between each of the sessions, at the end of the sessions and before the beginning of a new session in the next week as a recap. Before the beginning a new session the recap was strengthened by asking them whether they practiced key messages rom the previouse session/s and hearing challnges they faced during the application and discussed on ways to tackle them. All the sessions were provided at open field under tree or at the side fencessurrounding kebele administrative office or in health posts or volunteers' residence compounds.

Data Collection

The data collection questionnaire consists sections for household food insecurity (FANTA, 2007), dietary diversity of women and children (FAO, 2010), maternal meal frequency, anthropometry of mothers and children, past two weeks sickness history of mothers and children, sociodemographic

and economic characteristics of the mothers, the children and the households and WASH. The tool was pre-tested and necessary amendments were made before its application for the actual data collection. Data were collected before and after the nutrition education intervention through interviewer-administered questionnaire. Maternal and child dietary diversity and maternal meal frequency were assessed through a 24hours dietary recalls. Data collectors attended three days training on basics of research methods, research ethics, data collection techniques and purpose of this study.

Weight and height/length measurements for mothers and children were taken by the principal investigator who lead, coordinated and supervised the whole field work including data collection. Maternal heights were measured using a SECA stadiometer. Lengths of the children measured at a recumbent position using a SECA length board. Weights of the children were taken using a SECA weight scale. All the anthropometric measurements were conducted by the principal investigator with the help of data collectors, health extension works, volunteers and sometimes mothers. Field supervisor, the principal investigator, had checked completed questionnaires on spot for completeness and random consistencies.

Data Analysis

Data were checked for completeness, coded, entered into statistical package for social sciences (SPSS) version 20 and cleaned. Considering national consumption recommendation for lactating mothers by Ethiopian Ministry of Health of Ethiopia (FMoH-E) (2011), data on number of meals in a day were dichotomized in to two: consumed five or more and four or less meals in a day. Maternal dietary diversity data were dichotomized in to two: consumed from five or more and from four or less food groups. Dietary diversity of children was also dichotomized in to two: consumed from four or more and three or less food groups. Both for mothers and children overall ASF consumption data were computed summing up “0”-not consumed and “1”-consumed coding for meat, poultry, fish, eggs and dairy consumption status. Then, the summation for overall ASF consumption data ranging from 0 to 5 scale were further dichotomized in to consumed at least one of the ASF (coded “1”) and consumed none of the ASF (coded “0”).

Body mass index was calculated dividing weight in kilogram by squared height in meter using excel worksheet, and was further categorized as underweight, normal weight, and overnourished. The cutoff used to categorize BMI was according to recommendation in a nutritional assessment book

(Gibson, 2005). For children, Z-scores of Weight for Height (WHZ), Height for Age (HAZ) and Weight for Age (WAZ) were generated using WHOAnthro software.

Frequencies, proportions, mean/median scores, standard deviations (SD) and interquartile ranges (IQR) were computed. Treatment and control groups were compared for baseline characteristics using chi-square and independent samples t-test. Maternal and child nutrition differences between treatment and control groups were evaluated using chi-square test and independent samples t-test.

Research Ethics

Letter of ethical clearance (***Ref No: IRB/027/10***) was obtained after the research proposal was reviewed by Institutional Review Board of Hawassa University-College of Medicine and Health Sciences. A letter of cooperation written from the School of Nutrition, Food Science and Technology-Hawassa University (***Ref No: S/N/F/S/T/3025/2010***) was also submitted to respective health service administrative departments of the study districts. Participation was on voluntary bases. The trial was also registered (*unique identification No.:* ***PACTR201911690619601***) at Pan African Clinical Trial Registry (PACTR). Informed consent was obtained from the mothers. Anonymity of information was assured throughout the data collection period and data management process. At baseline, all mothers were informed with their nutritional status according to their respective mid upper arm circumference (MUAC) result. Mother identified being undernourished were counseled on spot on key messages for nutrition of lactating mothers. Also, children (n=4) identified being severely acutely malnourished, as measured by MUAC, were linked with integrated management of acute malnutrition program (IMAM) of respective kebele that function at health posts for nutritional and medical therapy and progress follow-ups.

Results

Sociodemographic and economic Characteristics

The mean(SD) age of mothers in treatment and control groups were 25.3(4.5) and 26.2(4.5), respectively. Nearly all of the mothers (98.4%) were married. Majority of the mothers (80.5%) were housemakers. Ethnically, 38.4% of the mothers reported that they were from Oromo and 57.9% were from Sidama backgrounds. About 33.7% and 47.4% of the mothers achieved grades one to five and grades six to ten educations, respectively. Slightly more than two-thirds (67.4%) of the mothers reported that they were protestant and slightly more than a quarter (28.4%) reported that they were Islam religion followers. At baseline, mothers in the treatment and control group were similar for educational status (P =0.343), marital status (P =0.376), ethnic background (P =0.234), occupation (P =0.114), religion (P =0.66) and age (P =0.2).

The mean(SD) age of IYC in the treatment and control groups were 10.94(3.3) and 11.55(3.5) months, respectively. Slightly more than half of the IYC were male (52.6%) and in six to eleven months (56.3%) age range. At baseline, IYC were similar for sex (P =0.257), age in months (0.067) and mean(SD) of age (P =0.217) (**Table 18**).

Table 18 Comparison of baseline sociodemographic characteristics of the mothers and infant and young children in the treatment and control group (n=190)

Characteristics		Group		*p.*
		Intervention (n=99)	Control (n=91)	
Maternal				
Education	Never attended school	17	17	0.343
	Grades 1-5	31	33	
	Grades 6-10	51	39	
	Grade 11 or above	-	2	
Marital Status	Married	98	89	0.376
	Separated	-	1	
	Divorced	-	1	
	Widowed	1	-	
Ethnicity	Oromo	41	32	0.243
	Sidama	53	57	
	Hadiya	2	-	
	Other	1	-	
	Amhara	-	2	
	Kembata	1	-	
	Wolayta	1	-	
Religion	Protestant	64	64	0.660
	Muslim	30	24	
	Orthodox	5	3	
Occupation	Employed for Wages	1	1	0.114
	Self-Employed	1	3	
	House Wife	75	76	
	Merchant	14	3	
	Farmer	8	7	
	Other	-	1	
Age, in completed years	Mean ± SD	25.3±4.5	26.2±4.5	0.2
Did the mother got sick in the last two weeks	No	68	55	0.235
	Yes	31	36	
Children				
Sex	Female	43	47	0.257
	Male	56	44	
Age	6 to 11 months	62	45	0.067
	12 to 23 months	37	46	
Age, in Completed Months	Mean ± SD	10.94±3.3	11.55±3.5	0.217

The mean (SD) for number of under-two years of age children in the treatment and control groups were 1.08(0.31) and 1.1(0.34), respectively. Nearly all (95.3%) of the households were male headed. More than half of the husbands were farmer (55.3%) in occupation and achieved grades six to ten (56.8%) education. Slightly more than two-thirds (66.3%) of the households earn 10,000ETB or below estimated annual income. Majority (80%) of the households were food insecure. The mean (SD) for family size of the studied households in the treatment and control groups were 4.8(2.2) and 4.7(2.6), respectively. At baseline, households in the treatment and control groups were similar for mean of number of under-two (p. =0.699) and under-five children (0.361), food insecurity status (p. =0.245), household head (p. =0.521), family size (p. =.744), estimated annual household income (p. =0.668), husband educational status (p. =0.875) and mean (SD) age of husband (p. =.164). But they were different for occupation (p. <0.001) of the husbands (**Table 19**).

Table 19 Comparison of baseline sociodemographic & economic and related characteristics of the households in the treatment and control group (n=190)

Characteristics		**Group**		***p.***
		Treatment (n=99)	**Control (n=91)**	
Number of under-two children	Mean(SD)	1.08(0.31)	1.1(0.34)	0.699
Number of Male	Mean(SD)	2.67(1.43)	2.53(1.29)	0.482
Number of Female	Mean(SD)	2.75(1.37)	2.8(1.43)	0.788
Family size	Mean(SD)	4.8(2.2)	4.7(2.6)	.744
Number of under-five years of age children	1	44	40	0.361
	2	37	38	
	≥3	17	13	
Household Head	Wife/Woman	4	3	0.521
	Husband/Man	95	86	
	other	-	2	
Family Size	≥3 Members	29	31	0.801
	4-5 Members	35	30	
	≥6 Members	34	30	
Estimated annual income, in ETB	≤10000ETB	63	63	0.668
	(10000, 20000]ETB	26	19	
	>20000ETB	10	9	
Husband Age, in years	Mean(SD)	31.4(5.4)	32.7(6.4)	.164
Husband Occupation (n=187)	Farmer	48	57	<0.001*
	Merchant	23	5	
	Employed for Wedge	17	6	
	Civil Servant/Gov't Employee	4	8	
	Others	6	13	
Husband Education (n=185)	No Education	8	10	0.875
	Grade 1-5	22	22	
	Grade 6-10	59	49	
	Grade 11-12	1	2	
	Attended Higher Education	6	6	
Food Insecurity	Secure	23	15	0.245
	Insecure	76	76	

About 41% and 28% of the households owned half or less and more than a half up to one hectare of agricultural land, respectively. Majority (82.6%) of the households did not own back yard or front yard vegetable garden. More than half (54.1%) of the households did not own back yard or front yard fruit garden. Concerning crop production, it was reported that 71.6% of the households produce cereals, 58.2% produce cash crops, 48.4% produce fruits, 41.6% produce vegetable, 36.3% produce root crops and 33.2% produce legumes. Cows (39.5%), chicken (28.9%) and oxen (18.9%) were among the owned domestic animals. At baseline, the households in the treatment and control group were similar for agricultural land ownership (p. =0.063), backyard or front yard fruit (p. =0.514) or vegetable (p. =0.489) garden ownership, and cash crops (p. =0.403), fruit (p. =0.253), vegetable (p. =0.962), legumes (p. =0.027), root crops (p. =0.555) and cereal (p. =0.549) production. They were also similar (p. >0.05) for domestic animal ownership; chicken (p. =0.395), cows (p. =0.537), ox (p. =0.406), donkey (p. =0.829) and goats (p. =0.358). But they were different (p. =0.027) in legume production (**Table 20**).

Table 20 Comparison of baseline agriculture related practices and characteristics of the households in the treatment and control groups (n=190)

		Group		
Characteristics		**Treatment (n=99)**	**Control (n=91)**	***p.***
Agricultural land	No Land	8	6	0.063
Ownership in hectare	≤0.5	30	47	
	(0.5, 1]	30	23	
	(1, 1.5]	4	2	
	(1.5, 2]	15	6	
	>2Hr	12	7	
Backyard or front yard	No	80	77	0.489
vegetable garden?	Yes	19	14	
Backyard or front yard	No	53	53	0.514
fruit garden?	Yes	46	38	
Cash Crops Production	No (42.6%)	44	35	0.403
	Yes (58.4%)	55	56	
Fruit Production	No	55	43	0.253
	Yes (48.4%)	44	48	
Vegetable Production	No	58	53	0.962
	Yes (41.6%)	41	38	
Legume/Pulse	No	59	68	0.027
Production	Yes (33.2%)	40	23	
Root crops production	No	65	56	0.555
	Yes (36.3%)	34	35	
Cereal Production	No	30	24	0.549
	Yes (71.6%)	69	67	
Chicken Ownership	No	73	62	0.395
	Yes (28.9%)	26	29	
Donkey Ownership	No	86	80	0.829
	Yes (12.6%)	13	11	
Goat Ownership	No	91	80	0.358
	Yes (10%)	8	11	
Cow Ownership	No	62	53	0.537
	Yes (39.5%)	37	38	
Ox Ownership	No	78	76	0.406
	Yes (18.9%)	21	15	

Maternal Nutrition

At baseline, mothers in the treatment and control groups were not different (p. >0.05) for consumption of specific food groups and overall ASF, achievement of minimum dietary diversity of women (MDDW), number of meals in a day and body mass index (BMI). But they were marginally different (p. =0.04) for weight.

After the nutrition education intervention, higher proportion of mothers who were in the treatment group consumed dairy (p. =0.042), eggs (p. =0.016), dark green leafy vegetables (p. =0.036) than mothers who were in the control group. The proportion for overall ASF consumption was also higher (p. =0.007) for mothers in the treatment than mothers in the control group. Proportion of mothers who consumed from the minimum recommended food groups (consumed from five or more food groups) was higher (p. = 0.001) for mothers who were in the treatment group than mothers in the control group. Mean score for MDDW for mothers who were in the treatment group was also significantly higher (p. 0.001) for mothers in the treatment group than mothers in the control group (**Table 21**).

Table 21 Comparison of maternal nutrition before and after a nutrition education intervention

Variables	Baseline (n=190)					Endline (n=173)				
	Treatment n=99		Control n=91		p	Treatment n=89		Control n=84		p
	N	%	N	%		N	%	N	%	
Grains, white roots and tubers, and plantains	98	99	91	100	0.34	89	100	82	97.6	0.143
Pulses (beans, peas, and lentils)	48	48.5	42	46.2	0.75	53	59.6	40	47.6	0.116
Nuts and seeds	4	4	6	6.6	0.43	4	4.5	4	4.8	0.933
Dairy	43	43.4	37	40.7	0.70	47	52.8	31	36.9	0.042*
Meat, poultry, and fish	6	6.1	11	12.1	0.15	10	11.2	6	7.1	0.353
Eggs	16	16.2	11	12.1	0.42	22	24.7	9	10.7	0.016*
Dark-green leafy vegetables	74	74.7	70	76.9	0.73	70	78.7	54	64.3	0.036
Other vitamin A–rich fruits and vegetables	34	34.3	27	29.7	0.49	29	32.6	20	23.8	0.2
Other vegetables	74	74.7	68	74.7	0.99	64	71.9	63	75	0.646
Other fruit	26	26.3	27	29.7	0.60	18	20.2	20	23.8	0.569
Overall ASFs	51	51.5	47	51.6	0.99	61	68.5	40	48.2	0.007**
MDDW: ≥5 Food Groups	37	37.4	37	34.1	0.64	47	52.8	24	28.6	0.001**
MDDW: ≤4 Food Groups	62	62.6	60	65.9		42	47.2	60	71.4	
Number of meals/day: ≥5	8	8.1	9	9.9	0.66	13	14.6	9	10.7	0.442
Number of meals/day: ≤4	91	91.9	82	90.1		76	85.4	75	89.3	
MDDW [mean(SD)]	4.27(1.52)		4.28(1.68)		0.96	4.56(1.16)		3.93(1.14)		0.001**
Number of meals/day	3.47(0.73)		3.60(0.76)		0.23	3.73(0.85)		3.58(0.85)		0.258
Weight [mean(SD)]	51.13(8.41)		48.9(6.54)		0.04*	51.48(8.34)		49.24(6.34)		0.054
BMI [mean(SD)]	20.79(2.95)		20.24(2.48)		0.17	20.20(2.46) (n=87)		20.94(3.05) (n=80)		0.086

MDDW: Minimum Dietary Diversity of Women; BMI: Body Mass Index

*: significant at p. <0.05; **: significant at p. <0.01

Nutrition of Infants and Young Children

Before the nutrition education intervention proportion of infant and children who consumed either of the seven food groups was similar (p. >0.05) in the treatment and control groups. But proportion for consumption of overall ASF was different (p. =0.02) for the two groups. Mean scores for the minimum dietary diversity (MDD) of children was not different (p. =0.65) between treatment and control groups. Mean scores for weight (p. =0.13), length (p. =0.82), WHZ (p. =0.20), HAZ (p. =0.10) and WAZ (p. =0.06) were also similar.

Nutrition of children was evaluated after nutrition education intervention. Consumption proportions for legume and nut foods (p. =0.001), vitamin A rich fruits and vegetables (p. =0.002), dairy (p. =0.001) and eggs (p. =0.015) were significantly higher for children in the treatment group than children in the control group. Mean score for MDD was significantly higher (p. <0.001) for children in the treatment group than children in the control group. Mean scores for weights of children was higher for children in the treatment group with marginal significance (p. =0.048) than mean score for weights of children in the control group. Mean scores for WHZ (p. =0.003) and WAZ (0.022) were significantly higher for children in the treatment group than children in the control group (**Table 22**).

Table 22 Comparison of children nutrition before and after nutrition education intervention

Variables	Baseline (n=190)					Endline (n=173)				
	Treatment n=99		Control n=91		p	Treatment, n=89		Control, n=84		p
	N	%	N	%		N	%	N	%	
Cereals and Roots	82	82.8	84	92.3	0.052	84	92.3	79	94	0.649
Legumes and Nut Foods	27	27.3	24	26.4	0.89	34	37.4	22	26.2	0.001*
Vitamin A Rich Fruits and Vegetables	40	40.4	28	30.8	0.17	48	52.7	25	29.8	0.002*
Other Fruits and Vegetables	22	22.2	24	26.4	0.51	35	38.5	24	28.6	0.167
Dairy Products	62	62.6	44	48.4	0.053	66	72.8	41	48.8	0.001*
Eggs	27	27.3	26	28.6	0.84	41	45.1	23	27.4	0.015*
Meat/Flesh Foods	1	1	1	1.1	0.95	6	6.7	5	6	0.832
Overall ASF	71	71.7	50	51.9	0.02*	79	86.8	55	65.5	0.001*
MDD: Consumed 4 or more food groups	28	28.3	24	26.4	0.77	45	50.6	21	25	0.001*
MDD: Consumed 3 or less food groups	71	71.7	67	73.6		44	49.4	63	75	
MDD score [mean(SD)]	2.64(1.48)		2.54(1.46)		0.65	3.43(1.09)		2.61(1.25)		<0.001**
Weight [mean(SD)]	8.57(1.58)		8.24(1.29)		0.13	11.03(1.79)		10.54(1.47)		0.048*
Height [mean(SD)]	70.98(4.29)		70.83(4.93)		0.82	82.34(4.23)		81.80(4.25)		0.40
WHZ [mean(SD)]	-0.06(1.67)		-0.33(1.21)		0.20	0.26(1.43)		-0.34(1.14)		0.003*
HAZ [mean(SD)]	-0.99(1.40)		-1.33(1.28)		0.10	-0.87(1.32)		-1.23(-1.32)		0.949
WAZ [mean(SD)]	-0.58(1.48)		-0.85(1.26)		0.06	-0.42(1.28)		-0.85(1.15)		0.022*

MDD, Minimum Dietary Diversity; WHZ, Weight for Height Z-score; HAZ, Height for Age Z-score; WAZ, Weight for Age Z-score

*: significant at p. <0.01; **: significant at p. <0.001

Discussion

Intergenerational or cyclic nature of malnutrition is a well documented fact in which nutrition analysis looks for feasible but impactful nutrition interventions. It is also an evidence in which schalors look for period of opportunity by when to implement identified nutrition interventions to break the cycle (Ramakrishnan *et al.*, 1999). In the cycle, the first 1000 days, period from the first day of pregnancy to second birth day of a child, are critical for infant and young children and too important for the lactating mothers who naturally and physically care for the growing children (UNDP, 2012; Hoddinott *et al.*, 2013; Martorell, 2017). So, nutrition interventions are highly encouraged to focus on the first two years of life, long portion of the first 100 days, to prevent and correct nutrition related problems happened before and to let positive outecomes to sustain (WHO, 2013a). Ethiopia, a country with significant proportion of undernourished population (CSA, 2016a; EPHI, 2019), have framed national nutrition policy (FDRE, 2018) and program (FDRE, 2016) that gave due attention to the nutrition of women and children. In line with the global and national directions, in the current study it was tried to evaluate the effect of nutrition education intervention with a low healthy literacy approach on the consumption of ASF, dietary diversity and nutritional status of six to twenty three months old children and lactating mothers from rural districts of Ethiopia.

The result of the current study showed that at baseline proportion of mothers and children who consumed dairy, eggs and meat were not significantly different between treatment and control groups. Similarly, mean score for dietary diversity of mothers and children was not different between treatment and control group. Nutritional status of mothers as determined by BMI was not different for lactating mothers in the treatment and control groups. Statistical mean scores for WHZ, HAZ and WAZ were similar for children in the treatment and children in the control groups. However, improvements on nutrition (ASF consumption, dieatary diversity, WHZ and WAZ) of mothers and children were observed after five months of intervention, as it is recommended in a systematic review done by Murimi *et al*., (2017), since the baseline data were collected: one month for preparation for nutrition education, two months for nutrition education delivery and two months for follow-ups after the nutrition education intervention for nutrition related behavioral changes practiced and nutritional status changes took place.

After the nutrition education intervention, proportion of children who consumed eggs and dairy were higher in the treatment group than proportion of children in the control group who consumed eggs and dairy. But the intervention did not improve proportion of children who consumed meat. In agreement with the findings of the present study, a randomized controlled trial conducted in Rwanda with a social and behavioral change communication through community health workers also reported that the odds of ASF consumption for children in the treatment group was two times higher than the odds for children in the control group (Flax *et al.*, 2021). Similarly, a study conducted in Burkina Faso reported increase in eggs consumption pattern for children whose mothers received behavioral change communication (BCC) than children whose mothers did not received it (McKune *et al.*, 2020). Mean score for dietary diversity of children significantly increased for children in the treatment group than children in the control group. Consistent to the finding of the current study, studies from Ethiopia found that nutrition education intervention improved dietary diversity of children (Negash *et al.*, 2014; Teshome *et al.*, 2020). The third child nutrition outcome indicator that was evaluated by the current study was physical growth. It was observed that the nutrition education significantly improved mean scores for WHZ and WAZ of children in the treatment group than children in the control group. But the mean score for HAZ of children in the treatment and control group was similar after the nutrition education intervention. A research conducted in south Ethiopia similarly found that a nutrition education intervention improved WHZ and WAZ of children studied (Tariku *et al.*, 2015). On the other hand, consistent to the finding of this study, a research conducted in Malawi figuredout that a community based nutrition education did not positively impacted HAZ of children (Kuchenbecker *et al.*, 2017). The no effect on children's HAZ could be attributed to chronic (that needs more time for significant positive changes) and multifactorial nature of stunting (Prendergast and Humphrey, 2014; Aguayo and Menon, 2016).

Lactating mothers were the other group of participants who were expected to benefit from the intervention and animal source foods consumption, dietary diversity and nutritional status of lactating mothers were the nutritional outcome indicators expected to be impacted by the intervention. As to the result of this study, proportions of mothers who consumed eggs and dairy were significantly higher in the treatment group than proportion of mothers in the control. But the proportion of mothers who consumed meat did not differ for mothers in the treatment and control group after the nutrion education intervention. In agreement to the finding of this study, studies

from North-Ethiopia (Demilew, Alene and Belachew, 2020) and Iran (Goodarzi-Khoigani *et al.*, 2018) reported improved ASF consumption pattern for women who attended a nutrition education intervention. But a nutrition education interventional study conducted in Kenya reported no significant change on the proportion of women who ate eggs and diary (Colleen *et al.*, 2017). The variation might be subjected to difference in the central interest of the respective researches, though they commonly reported effect on ASF consumption. Primary outcome of the current research is improving the inclusion of animal source foods in diversified diets, while improving intake of specific micronutrients was the primary outcome for the study conducted in Kenya. The no effect on the consumption of meat by the lactating mothers and by the infants and young children could be subjected to constriants like unavailability, non-affordability, limited consumption tradition and its higher price as compared with price of plant-based food as identified by **Daba** *et al*., (2021) and reported in Paper I in this document in Chapter Four. The result of this study also showed improvement mean score of dietary diversity for lactating mothers in the treatment group than lactating mothers in the control group. The finding is consistent with results of others nutrition education interventional studies conducted in Ethiopia (Diddana *et al.*, 2018; Demilew, Alene and Belachew, 2020).

Period of interventions that lasted for five or more months; having three and less focused objectives/identified specific behavior to be modified; appropriate design-use of randomization; use of theories; devotion in interventions that is assured through recruitment and training of experts to deliver the intervention; engagement of parents through a face-to face sessions; adequate dosage; and management for worksite environmental interventions are major factors and strengths that this study shares, identified by systematic reviews (Murimi *et al.*, 2017, 2018) to enhance efficacy of nutrition education interventions. Agriculture is a critical focus area for food and nutrition security of rural communities like in Ethiopia. The role agriculture plays as a source of food and source of income for food and non-food investment, its effect on food price and market, the opportunity it creates for nutrition sensitive interventions like nutrition education allied with other agricultural intervention are among the pathways it impact nutrition (Wordofa and Sassi, 2020). These multiple pathways through which agriculture and nutrition are related increases the need for implementation of collaborative multisectoral activities to improve food and nutrition conditions. But the current study mainly focused only on the need for a nutrition education, and with that limitation has demonstrated positive effect of nutrition education on the consumption of ASF (dairy and eggs) and

dietary diversity of lactating mothers and infant and young children. It has also WHZ WAZ of infant and young children.

Conclusions

In general, a low health literacy approach nutrition education intervention improved nutrition of mother-child pairs. It has improved dietary diversity of infant and young children and lactating mothers. It also positively impacted the inclusion of ASF (eggs and dairy) in diversified diets of lactating mothers and children, but not meat. Beyond improvement on the consumption practice of mothers and children, the approach improved nutritional status of children as measured by WHZ and WAZ. More research is warranted to widely implement and evaluate sustainability of the observed positive effect. Future researches shall also consider integration of nutrition sensitive agricultural and market extension activities integrated with behavioral change communications for nutrition to evaluate their effects on HAZ of children, nutritional status of lactating mothers and effect on the consumption of meat.

CHAPTER EIGHT

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1. General Discussion

Animal source foods are important segments of a healthy diet. They are recommended to be consumed on daily basis as part of diversified diets (FAO, 2010). In view of this, the purpose of the present study was to determine dietary behavior related to the consumption of ASF; to identify facilitators, constriants and determinants to the consumption of ASF at household level and by women and children; and to improve the consumption of ASF by women and children through promotion of inclusion of ASF in diversified diets.

Household-level ASF consumption frequency was assessed over a month period using ASF consumption frequency screener and consumption of ASF by women and children was assessed using a standard dietary diversity assessment tool through consumption recalls over 24hours period before the date of the survey (FANTA, 2007; FAO, 2010) to adress the firs interest of this study, to determine dietary behavior related to the consumption of ASF. Accordingly, it was found that poultry was not consumed by 92% of the households, and meat was not consumed by 60% of the households over a one-month period. The findings are in agreement with a paper (Delgado *et al.*, 1999; Abegaz, Hassen and Minten, 2018) in which limited inclusion of ASF in diets of families in low and middle income countries is limited (India, China, Latin America). However, there are studies from Ethiopia and Sudan in which better meat consumption patterns were reported. In south Ethiopia, once in a month consumption of meat was reported for 80%, 72% and 26.8% of households in Wolaita Sodo (Amistu K, Ermias B and Asrat A, 2017), Mirab Abaya (Yibrah and Esheti, 2017) and Hawassa towns (Lijalem, Beyan and Banerjee, 2013). As the studies were conducted in towns, the difference could be subject to the availability of retailer butcher houses and households' interest to pay and purchasing power. The habit of frequent meat consumption in the immediate local culture may also have contributed (Amistu K, Ermias B and Asrat A, 2017). A study from Sudan (Khalid *et al.*, 2017) also reported once per-week meat consumption frequency for more than two-thirds (68%) of the households. Overall, in the present study meat consumption was constrained by the reported unavailability (70%) and unaffordability (80%) of the food product (Daba *et al.*, 2021).

About a quarter of the studied households consumed milk once per-day (21%) or 1-2 times per-week (26%). However, more consumption frequency was reported bay a study conducted in East Shoa Zone in Ethiopia. According to the study, 67-100% of households from urban areas and 67-87% of households from peri-urban areas consumed milk 3-6 times per-week (Melesse and Beyene, 2009). The variations could be due to study setting, socioeconomic and food habit differences in urban and rural scenarios. A study conducted in China identified that urban dwellers consume more ASF than dwellers in rural areas. In addition the study pointed that consumption of animal products increased in response to income growth (Streeter, 2017).

Eggs were consumed 1-2 times per-week (20%) or 1-2 times per-month (19%) by about one-fifths of the households during the one month period. In the present study, egg consumption was found to be better than poultry, meat, and fish. This could be because of relative availability (78%) and affordability (60%) of eggs as many of the participants reported. However, egg consumption frequency in this study was lower than a report from Hyderabad district in India, where daily egg consumption was reported for half (51%) of the households (Memon *et al.*, 2009). Egg consumption habit, higher price as compared to plant-based food items, and poultry production primarily for income generation (Hundie *et al.*, 2019; Haileselassie *et al.*, 2020) might have constrained the consumption of egg.

Findings of the present study showed that dairy, eggs and meat were consumed by 27.6%, 5.4% and 5.1 of the lactating mothers in the day before the survey, respectively. Proportion of lactating mothers who consumed eggs was equivalent to finding (5.2%) from north Ethiopia (Desalegn *et al.*, 2018). With regard to the consumption of dairy, almost similar proportion (21.2%) was reported by study conducted in south Ethiopia (Bosha *et al.*, 2019). But meat consumption practice varies across the studies (Desalegn *et al.*, 2018; Bosha *et al.*, 2019). Religious norms, consumption culture, period by when the study conducted and fasting practice (Desalegn et al., 2018) of the study participants might have contributed to the differences. Overall, the less consumption of ASF by the lactating mothers in area where the present study conducted is subjected to constraints identified by **Daba** *et. al.*,(2021)

To the result of this research, less than half (48.3%) of the children consumed at least one of the ASF (dairy or eggs or flesh/meat). Dairy (41.2%) was better consumed than eggs (16.4%) and flesh (1.8%). The proportion of children who consumed flesh is comparable with reports from Aleta Wondo (Dafursa and Gebremedhin, 2019), Gorche (Dangura and Gebremedhin, 2017), Dangila

(Beyene, Worku and Wassie, 2015), Wollo (Gebremedhin *et al.*, 2017) districts in Ethioia, but lower than proportions from Addis Ababa city (Solomon, Aderaw and Tegegne, 2017), Afar (Wuneh *et al.*, 2019), Bale (Tegegne *et al.*, 2017) and Wolaita Sodo (Mekonnen *et al.*, 2017) towns in Ethiopia. The observed difference might be subjected to study setting differences as studies with higher proportion are conducted in acity and towns where ASF consumption enabling factors are better (Streeter, 2017). Eggs are consumed by lower proportion of children than study done in Wollo (Gebremedhin *et al.*, 2017), Dejen (Kumera, Tsedal and Ayana, 2018) and Afar (Wuneh *et al.*, 2019). It was also consumed by a lesser proportion of children than children studied by studies from Woliata Sodo (Mekonnen *et al.*, 2017), Aleta Wondo (Dafursa and Gebremedhin, 2019), Addis Ababa (Solomon, Aderaw and Tegegne, 2017) and Bale (Tegegne *et al.*, 2017) towns in Ethiopia. But researches conducted in Gorche (Dangura and Gebremedhin, 2017), Sinan (Temesgen, Yeneabat and Teshome, 2018) and Dangila (Beyene, Worku and Wassie, 2015) districts in Ethiopia reported almost equal proportion of children who consumed eggs compared with proportion found by this study.

Meat was unavailable in the rural settings as it was reported by more than two-thirds of research participants (70%) where they usually shop, while 80% could not afford the price. Plant-based food products were more affordable than meat as it was reported by 92% of the respondents. The present findings are supported by reports (Pachón *et al.*, 2007; Haileselassie *et al.*, 2020) that identified poverty and high price of nutritious foods including animal products as constraints of ASF consumption. A study from Ghana (Colecraft *et al.*, 2006) identified low income and lack of market access as contributing factors for low ASF consumption.

Relative availability, positive attitudes to its quality, relative affordability, less effort needed to prepare and cook, storage, and favorable beliefs about health benefits were found to be facilitators for consumption of eggs. However, income generation priority from poultry rearing, and higher price of egg (93%) as comparison to plant-based food were the constraints identified. A large proportion of households (91%) in Ethiopia rear chickens for the sake of income generation and savings (Hundie *et al.*, 2019; Haileselassie *et al.*, 2020) rather than household-level consumption similar to the current findings.

Unlike the findings from the Amhara (Kim *et al.*, 2019) and Tigray (Haileselassie *et al.*, 2020) regions of Ethiopia with more Orthodox Christians, and from a review on meat consumption (Seleshe, Jo and Lee, 2014) religion and related fasting did not hinder the use of ASF in the present

study. This could be because of the dominating Protestant (67%) and Muslim (28%) religion followers in the present study areas, who do not abstain from consumption of ASF during their fasting seasons.

Household food in/security status was associated with household-level ASF consumption frequency and maternal and child ASF consumption practices. Food insecure households were less likely to consume poultry, meat, eggs, milk and milk products than food secure households. The chance for meat, egg, dairy and overall ASF consumption was higher for lactating mothers who lived in food secure households than lactating mothers who lived in food insecure households. Household food security also constantly increased probability of dairy, flesh and eggs consumption by the infants and young children. In Ethiopia 40-70% price increment was documented for nutritious food commodities like eggs, meat, dairy and other food items like fruits since the year of 2005 (Minten and Fantu, 2020). Studies from Jimma in Ethiopia (Asesefa Kisi *et al.*, 2018) and Sierra Tarahumara in Mexico (Cordero-Ahiman, Santellano-Estrada and Garrido, 2018) identified that households shift to inexpensive food items as a coping strategy for food insecurity. The increase on the price of ASF and the identified coping mechanish could explain the inverse association between household food insecurity and ASF consumption patterns of households, lactating mothers and infant and young children observed in the present study districts.

The consumption of ASF is expected to increase when a household owns domestic animals that can serve as sources of ASF and income for diversified diets. Accordingly, in the present study livestock (cow, chicken and donkey) ownership was positively associated with families', lactating mothers' and infant and young childrens' ASF consumption practice. Households that owned cow were more likely to consume milk and milk products more frequently than households that did not own cow. Households with chickens were also more likely to consume eggs than households with no chickens. Households with donkey were more likely to consume poultry, meat and eggs than households without donkey. Studies (Marshall and Ali, 2000; Angara., Ismail and Ibrahim, 2011; Valette, 2015; Geiger *et al.*, 2020) from Ethiopia have identified that donkeys contribute to human livelihood and household food security through their role in income generation and gender empowerment. The positive role that donkeys play in human livelihood and household food security might have contributed to the observed positive associations between donkey ownership and ASF consumption frequency.

Agriculture contributes to food and nutrition security through different pathways (Wordofa and Sassi, 2020). Farmland is one of the must resources to have for that and crops are among the products agriculture to impact food and nutrition security. Inline, lesser farmland size and cash crop production practice were inversely associated with household-level dairy product consumption frequency. Larger land allows households to rear cows on free grazing (Duressa *et al.*, 2014) to serve as source of dairy products (Rahman, SMR., Hashan, S., Shahjahan, MD. and Islam, 2001). On the other hand cash crops may constantly take over the limited land holding and make it unfit for traditional livestock farming that would contribute to ASF availability and access.

Education is an important tool of empowering human being to positively influence livelihood (Miller *et al.*, 2017; Tran *et al.*, 2020). In the present study, households with women with better education achievement were more likely to consume eggs than households with women who never attended formal education.

Larger family size has been discussed for its negative effect on household food security (Harris-Fry *et al.*, 2017; Agidew and Singh, 2018) and that may be because it constrains households' food purchasing power and challenges intra-household food distribution. Correspondingly, in the current study, more family size was negatively associated with household-level poultry, meat and egg consumption. This may call for food-based interventions on improvement of diversified agricultural production, family planning, and income generation with nutrition education for the public at large.

Less household-level egg, meat, and milk consumption frequencies were associated with estimated annual income of 5000ETB or less. In line with the observed negative association between earning income in the lower category and household-level ASF consumption in this study, a global analysis on affordability of dietary recommendations (Hirvonen *et al.*, 2020) mentioned that diets in low and middle income countries might face limitations for nutritious foods like eggs, meat, fish, dairy, fruits and vegetables as they are high-cost food groups.

Maternal occupation and education, MDDW, number of meals in a day, household income, cash and root crops production, and cow and chicken ownership were associated with ASF consumption by the lactating mothers. Finding of the current study revealed that cash crop production increased the chance of meat consumption by the lactating mothers, while root crops production did the same on egg consumption. This might be explained by the direct cash that can be earned from the sale of the crops, which can be invested to the purchase of food commodities including ASF (Immink and

Alarcon, 1993; Govereh and Jayne, 2003; Goshu, Kassa and Ketema, 2012; Cockburn *et al.*, 2014; Adjimoti and Kwadzo, 2018; Mango *et al.*, 2018; Rubhara *et al.*, 2020). Cash crops like coffee, sugarcane, khat cannot be easily destroyed by chickens and can serve as a shed where to allow hens to look for feed freely. In agreement to findings on livestock's contribution to the availability, accessibility and utilization of ASF (Hetherington *et al.*, 2017; Wodajo *et al.*, 2020), the current study found that mothers from cow owning households were two more likely to consume dairy. Overall ASF consumption was predicted by cow or chicken ownership, maternal occupation and education. Mothers who lived in households that owned cow or chicken were more likely to consume at least one of the ASF than households that did not own the livestock. Mothers who attended school (grades five to eight or grade nine or above education) had more chance to consume at least one of the ASF than mother who never attended school. Being a merchant increased the chance of consumption of at least one of the ASF. For merchants, especially for pity traders, it is likely to have cash in hand in most days, and this might have given them the capacity to purchase ASF with their own decision.

Livestock ownership and maternal education were also associated with infant and young children's ASF consumption practice. Children who lived in households that owned cow or donkey or chicken were more likely to consume dairy than children in households that did not own the respective animal. As local market is the usual source of dairy products for majority of the children (63%), donkey's role in income generation might contributed to the positive association (Angara, T. E. E., Ismail, A. A. and Ibrahim, 2011; Valette, 2015). Similarly, odds for egg consumption were more for children from households that owned chicken. Mothers' educational achievements were also associated with more likelihood of dairy consumption by the infants and young children. In the present study, the analysis done to identify association between maternal educational achievement, cow or chicken ownership and income, and overall ASF consumption practice of children also showed a relationship. The findings are in line with associations obsereved in rusults of a study done in Amhara region-Ethiopia (Kim *et al.*, 2019).

Dietary diversity is a proxy indicator of food insecurity and qualitative indicator of nutrient adequacy (Rathnayake, Madushani and Silva, 2012). In this study, only 11% of the lactating mothers consumed from five or more food groups in the day before the survey. On the other hand, about 89% of the lactating mothers consumed from four or less food groups or did not meet the MDDW. Other studies conducted in Ethiopia also reported that considerable proportion of mothers

fall in low DDS. It was reported that 44.4% from west Ethiopia (Bekele, Jima and Regesu, 2020) and 94% from south Ethiopia (Bosha *et al.*, 2019) achieved low DDS. According to cross-sectional studies on DD of lactating mothers in south (52.2%) (Boke and Geremew, 2018) and north (56.4%) Ethiopia (Weldehaweria *et al.*, 2016), more than half of them were found to be with low DDS. Though the findings of the current and former studies agree on that significant proportion of mothers scored low DDS, they vary in the specific proportion they reported. The variation could be because of the different methods used to judge DD achievement of the mothers across the studies. The current study used cutoff for MDDW (Martin-prevel *et al.*, 2017), while the cited researches applied mean scores or above cutoff (FAO, 2010) to identify mothers who achieved the recommendations. The judgment for this research is against a standard of consumption from five or more food group cutoff, while judgments for the cited (Weldehaweria *et al.*, 2016; Boke and Geremew, 2018; Bosha *et al.*, 2019; Bekele, Jima and Regesu, 2020) Thus, the findings from the cited researches were respective study data distribution dependent and that is more likely to dissect the particcipants in to two equivalent proportions based on their DD achievement status.

By the present study, minimum dietary diversity was also assessed as part of IYCF practice. Thecurrent study figured out that only 15.5% of the infant and young children met the MDD. According to a study from Adea district-Ethiopia which assessed mothers' level of knowledge and practice on dietary diversity of IYC (Agize, Jara and Dejenu, 2017), only half (51%) of the mothers were identified being knowledgeable and one-sevenths (16%) of the mothers provided diversified diets to the IYC. On top of the agreement between the proportions of IYC who achieved MDD, the low level of maternal knowledge towards IYC dietary diversity might have contributed to the low proportion of children who met MDD. Result of the present study is comparable with findings from Aleta Wondo-12% (Dafursa and Gebremedhin, 2019), Dabat-17% (Belew *et al.*, 2017), Dangila-12.6% (Beyene, Worku and Wassie, 2015), Dejen-13.6% (Kumera, Tsedal and Ayana, 2018), Jimma-16.1% (Forsido *et al.*, 2019) and Sinan-13% (Temesgen, Yeneabat and Teshome, 2018) districts in Ethiopia. But lower proportion of children than this study met MDD in Gorche (10.6%) (Dangura and Gebremedhin, 2017), Halaba and Ziway (8.1 to 8.6%) (Ersino, Henry and Zello, 2016) and Wollo (7%) (Gebremedhin *et al.*, 2017) areas in Ethiopia. But higher proportion of children than the current finding met MDD in Addis Abab (59.9%) (Solomon, Aderaw and Tegegne, 2017), Afar (21.8%) (Wuneh *et al.*, 2019), Bale Zone (28.5%) (Tegegne *et al.*, 2017) and Wolaita Sodo (27.3%) (Mekonnen *et al.*, 2017) city or towns in Ethiopia.

In the present study, the chance to consume from five or more food groups almost doubles for lactating mothers who lived in root crops producing households than lactating mothers who lived in households that did not produce root crops. Compared to cash crops and cereal grains, length of time required to farm most root crops is less. A research finding also documented that women have the control over production of small scale agricultural productions like root crops, vegetables and fruits (Nyikahadzoi *et al.*, 2017). The less lengthy farming period that root crops require and women's control over the value chain might have contributed to the positive association directly through its contribution for household consumption and indirectly through income generation possibly to be used for purchase of food commodities to be counted to other food groups (Nguyen *et al.*, 2013; Emana *et al.*, 2015). This study has found a positive association between better maternal educational achievement and MDDW. Lactating mother with grade nine or above educational achievement were more likely to consume from five or more food groups than mothers who never attended school. Consistent to the result of this investigation, evidence from Ethiopia, Ghana, Vietnam and Bangladesh reported a similar relationship (Mirmiran *et al.*, 2002; Murakami *et al.*, 2009; Legesse *et al.*, 2010). According to the study in Ethiopia, mothers who cannot read and write were 2.5 times more likely to have low DDS than tmothers who had attended school. Similarly, a study conducted in Ghana found that women who had achieved primary education were about two times more likely to meet higher DDS as compared to women who never attended school. According to the results of this study, an association was also observed between estimated household annual income and MDDW. Consumption from five or more food groups was more likely for lactating mothers from households with estimated annual income of 10,001-15,000 ETB or greater than 20,000ETB, as compared to mothers from households with less than 5000ETB estimated annual income. This could be because of better purchasing power that households with higher income category have. Similarly, a study conducted in northern part of Ethiopia pointed that lactating mothers who had monthly income of less than 501 ETB or 501 to 1500 ETB were more likely to have low DD as compared to those who had a monthly income of above 1500 ETB (Weldehaweria *et al.*, 2016). Small animals like chickens can be reared in an easy way and with a limited resource and time to contribute to income, human livelihood and nutrition (Mammo, Berhan and Dessie, 2008; Reta, 2009; Dinka *et al.*, 2010; Wodajo *et al.*, 2020). In a similar way that rearing small animals is expected to contribute to nutrition, lactating mothers who lived in households that owned chickens were more likely to consume from five or more food groups than lactatin mothers who lived in households that did not own chicken.

Pertaining to the results of this study, children from food secure households were likely to meet MDD, and the finding is in line with associations found by studies conducted in Aleta Wondo district in Ethiopia (Dafursa and Gebremedhin, 2019) and Maharashtra in India (Chandrasekhar and Krishna, 2017). Small livestock like chickens play an important role to improve dietary diversity. They used to serve as frequent source of ASF and income. In line to finding from Gorche-Ethiopia (Dangura and Gebremedhin, 2017) on the role of livestock ownership, in the current study chicken ownership [AOR=2.01, p. =0.008] increased the odds of meeting MDD for infants and young children. As agriculture land ownership and size owned are also important assets to farming community, larger agricultural land size (half hectare or greater) ownership was found associated with increased IYC's probability to meet MDD. The chance to meet MDD was also more likely for children from root crop producing households than children from households that did not produce root crops. Women's control over the production and marketing value chain of the crop might have contributed to the positive association between child MDD and root crops production practice (Abebe and Mulu, 2017). In contrary, cash crop production practice of households reduced likelihood to meet MDD. The gender disparity over the control of cash crops' value chain (Mulema and Damtew, 2016; Zakaria, 2017) and its nature of taking land constantly/for long period of time could have contributed to the inverse association between cash crop production and MDD. Infants and young children from households in which both wife and husband together decides for daily household needs were more likely to meet MDD than IYC from households in which husband/other alone decides for daily household needs. The positive association is in line with results of another study from Ethiopia (Kuche *et al.*, 2020). Also, in agreement with the result of the current study, a finding from Ghana reported a positive association between women's say for deciding on household purchases and achieving a higher DD (Dickson A. Amugsi *et al.*, 2016).

The finding of this study revealed that 12.6% and 10.7% of the lactating mothers were undernourished as identified by BMI and MUAC, respectively. The prevalence is in agreement with results of different studies. A 17.4% prevalence was documented in Arbaminch (Tikuye *et al.*, 2019), 17.7% in Moyale (Bekele, Jima and Regesu, 2020), 13% in Samare (Haileslassie, Mulugeta and Girma, 2013) and 14.2% in Hula (Negash *et al.*, 2015) districts of Ethiopia. But it is far lower than prevalence (50.6%) reported for fasting lactating mothers in rural Tigray (Desalegn *et al.*, 2018). The fasting practice might have contributed to the difference. World health organization also

classifies prevalence of underweight (by BMI) as low (5-9%), medium (10-19%), high (20-39%) and very high (≥40%) public health problem (WHO, 2012).

Concerning nutritional status of the studied infant and young children, the prevalence of wasting was 5.6%, underweight was 13.6% and stunting was 25.8% according to the result of the present study. The observed proportions for wasting is lower than figures from Filtu and Awubare (Fekadu *et al.*, 2015; Kahsay *et al.*, 2018) and Kamba (Agedew and Shimeles, 2016), and slightly higher than Demba-Gofa (Mekonnen, 2017) and Tigray (Desalegn *et al.*, 2019) districts in Ethiopia. The prevalence of stunting is lower than figures reported for districts in Somali (Kahsay *et al.*, 2018), Tigray (Desalegn *et al.*, 2019) and southern nations, nationalities and people regional states (SNNPRS) (Mekonnen, 2017) of Ethiopia. But it is relatively comparable to the prevalence reported for Filtu town (Fekadu *et al.*, 2015) in Ethiopia. The prevalence of stunting reported for Kemba district (Agedew and Chane, 2015) is below the lower bound of the 95% confidence interval (95%CI) of this study. Studies conducted in Tigray (Desalegn *et al.*, 2019) and SNNPRS (Mekonnen, 2017) reported underweight prevalence that fall with in the 95%CI of finding of this study, while a study from Somali (Kahsay *et al.*, 2018) is below this study's lower bound of 95%CI for prevalence of underweight. According to world health organization's growth failure prevalence public health significance level cut offs, stunting and underweight are classified as low, medium, high and very high public health problems, and wasting is classified as acceptable, poor, serious and critical public health problem (WHO, 2012). According to the results of this study the prevalence of acute malnutrition measured by MUAC was 6.3% and it is lesser than the figure reported (16.5%) for children from Mali (Makamto Sobgui *et al.*, 2018).

This study discovered an association between maternal WASH practice and their nutritional status. Maternal hand washing practice after cleansing child's bottom was associated with BMI and MUAC. Mothers who did not practice hand washing after cleansing child's bottom were more likely to be undernourished as identified by MUAC and BMI. Water, hygiene and sanitation are key components of human life and were documented to associate with nutrition status (Rah *et al.*, 2015; Assefa *et al.*, 2017; Hossain *et al.*, 2018; Kwami *et al.*, 2019). Accordingly, the finding of this research revealed the need to consider child caring practice not only for the benefit of the growing children, but also in view of maternal safety, health and nutrition status. Despite achieving it for a while, sustainability of healthy nutritional status and practices are challenges all concerned bodies including individuals have to focus on to let healthy outcomes continue. In the present study age of

indexed child was associated with MDDW and BMI. The chance to meet MDDW doubles for mothers with children in the age range of six to eight months or nine to eleven months than mothers with children in the age range of twelve to twenty three months. This could be because of non-sustainability of cares lactating mothers receive throughout their breastfeeding period. In addition, this study found that mothers with children in the age range of nine to eleven or twelve to twenty three months had increased probabilities for being undernourished as measured by BMI. The high chance of undernourishment for mothers with children in the upper age category might be subjected to depletion of their nutrition reserves, non-sustainability of cares rendered to lactating mothers throughout the breastfeeding period, and the increased need for care and nutrition by the growing children (Dewey, 2004).

The other focus of this study was determinants of child growth failures. Accordingly, educational status of the mothers, occupation of the mothers, sickness status of the mothers, childhood diarrhea, family size, child sex and child age were associated with child growth failures. Being with mothers who achieved grades five up to eight ducation increased the chance of wasting by about seven times and being with mothers who never attended school increased the chance of stunting by more than two times as compared to being with mother who achieved grade nine or above education. Regarding mothers' occupation, being a farmer increased the odds of a child to be wasted. Mothers' sickness history in two weeks period before the date of the survey increased the probability of wasting by more than four times, while childhood diarrhea did the same by more than two times for underweight. The odds of being underweight for children from households with six or above family size was two times higher than children from households with five or less family size. Being female and being in the age range of 12-23 months were also associated with stunting and wasting, respectively. The associations are in agreement with findings of studies conducted in Ethiopia (Agedew and Chane, 2015; Fekadu *et al.*, 2015; Mekonnen, 2017; Desalegn *et al.*, 2019) and Mali (Makamto Sobgui *et al.*, 2018).

No consumption of pulses/legumes predicted wasting, and other fruits and vegetables predicted underweight. No vegetable production practice was found being protective of stunting and underweight. Women are highly engaged in child care and feeding than men (S. Bilal *et al.*, 2016; S. M. Bilal *et al.*, 2016; Abate and Belachew, 2017; Kansiime *et al.*, 2017), and they are also mandated to play the roles for vegetable farming in the study area (Abebe and Mulu, 2017).

Women's engagement in the strict day-to-day vegetable farming activity might have competed for time to be invested for child care and feeding, which might have increased probability of stunting.

This research shares the common attributes, strengths and limitations, to exist in any research. Among those: (1) assessing nutrition of lactating mothers and infant and young children in rural areas of Ethiopia from different backgrounds focusing on different perspectives like meal frequency in a contextual way, consumption of ASF, dietary diversity of, nutritional status through more than one indicator and considering other livelihood issues like women empowerment, agriculture practices, livestock ownership and WASH comprehensively were the strengths of the cross-sectional study conducted among lactating mothers and young children, while (2) applying ASF consumption frequency screener to assess household-level ASF consumption pattern over a month period and quantitatively addressing facilitators and constraints to the consumption of ASF are strengths of the cross-sectional study conducted among the households. However, cross-sectional nature of the study and a single 24hours (one day before the survey day) consumption recall for data on meal frequency, MDDW, ASF consumption by mothers and children can be considered as the limitations. It cannot identify causal relationships between the identified predictors and respective ASF consumption (Mark, 1999; Jorn *et al.*, 2010). In addition, it would have been more significant if the analysis on facilitators and constraints to ASF consumption would have included qualitative data. Interpretation of the results must also consider the unavoidable methodologic limitations (Gibson, 2005) of consumption frequency assessment like increased probability of recall bias as the period for which respondents had to remember was a full month. It is also good to consider possibility of respondents' desire to show being needy regardless of status.

Lastly, coming to the discussion of results from the randomized control trial, intergenerational or cyclic nature of malnutrition is a well documented fact in which nutrition analysis looks for feasible but impactful nutrition interventions. It is also an evidence in which scholars look for period of opportunity by when to implement identified nutrition interventions to break the cycle (Ramakrishnan *et al.*, 1999). In the cycle, the first 1000 days, period from first day of pregnancy to second birth day of a child are critical for IYC and too important for the lactating mothers who care for the growing children (UNDP, 2012; Hoddinott *et al.*, 2013; Martorell, 2017). So, nutrition interventions are highly encouraged to focus on the first two years of life, long portion of the first 1000 days, to prevent malnutriotn, to correct nutrition related problems happened before and to let positive outcomes to sustain (WHO, 2013a). Ethiopia, a country with significant proportion of

undernourished population (CSA, 2016a; EPHI, 2019), have framed national nutrition policy (FDRE, 2018) and program (FDRE, 2016) that gave due attention to the nutrition of women and children. In line with the global and national directions, in the current study it was tried to evaluate the effect of nutrition education intervention with a low health literacy approach on the consumption of ASF, dietary diversity and nutritional status of IYC and lactating mothers from rural districts of Ethiopia.

Accordingly, improvements on nutrition of mothers and children were observed after five months, as it is recommended in a systematic review done by Murimi *et al*., (2017), since the baseline data were collected. After the nutrition education intervention, proportion of children who consumed eggs and dairy were higher in the treatment group than proportion of children who were in the control group. But the intervention did not improve proportion of children who consumed meat. In agreement with the findings of the present study, a randomized controlled trial conducted in Rwanda with a social and behavioral change communication through community health workers also reported that the odds of ASF consumption for children in the treatment group was two times higher than the odds for children in the control group (Flax *et al.*, 2021). Similarly, a study conducted in Burkina Faso reported increase in eggs consumption for children whose mothers received behavioral change communication (BCC) than children whose mothers did not received it (McKune *et al.*, 2020). Mean score for dietary diversity of IYC significantly increased for IYC in the treatment group than IYC in the control group. Consistent to the finding of the current study, studies from Ethiopia found that nutrition education intervention improved dietary diversity of children (Negash *et al.*, 2014; Teshome *et al.*, 2020). The third child nutrition outcome indicator that was evaluated by the current study was effect on child physical growth. It was observed that the nutrition education significantly improved mean scores for WHZ and WAZ of children in the treatment group than children in the control group, but not the mean score for HAZ. A research conducted in south Ethiopia similarly found that a nutrition education intervention improved WHZ and WAZ of children (Tariku *et al.*, 2015). On the other hand, consistent to the finding of this study, a research conducted in Malawi figured out that a community based nutrition education did not positively impacted HAZ of children (Kuchenbecker *et al.*, 2017). The no effect on children's HAZ could be attributed to chronic and multifactorial nature of stunting (Prendergast and Humphrey, 2014; Aguayo and Menon, 2016).

Animal source foods consumption, dietary diversity and nutritional status of lactating mothers were the other nutrition outcome indicators expected to be impacted by the intervention conducted to realize this research work. As to the result of this study, proportions of mothers who consumed eggs and dairy were significantly higher for lactating mothers in the treatment group than lactating mothers in the control group. But the proportion of mothers who consumed meat did not differ for mothers in the treatment and control group. In agreement to the finding of this study, studies from North-Ethiopia (Demilew, Alene and Belachew, 2020) and Iran (Goodarzi-Khoigani *et al.*, 2018) reported improved ASF consumption pattern for women who attended a nutrition education intervention. But a nutrition education interventional study conducted in Kenya reported no significant change on the proportion of women who ate eggs and diary (Colleen *et al.*, 2017). The variation might be subjected to difference in the central interest of the respective researches, though they commonly reported effect on ASF consumption. Primary outcome of the current research is improving the inclusion of animal source foods in a diversified diet, while improving intake of specific micronutrients was the primary outcome for the study conducted in Kenya. The no effect on the consumption of meat by the lactating mothers and the IYC could be subjected to constraints like unavailability, non-affordability, its higher price as compared with price of plant-based food and limited consumption tradition as identified by **Daba** *et al.*, (2021). The result of this study also showed improvement in dietary diversity of mothers in the treatment group than mothers in the control group. The finding is consistent with results of nutrition education intervention studies conducted at districts in Ethiopia (Diddana *et al.*, 2018; Demilew, Alene and Belachew, 2020).

Period of interventions that lasted for five or more months; having three and less focused objectives/identified specific behavior to be modified; appropriate design (use of randomization); use of theories; devotion in interventions that is assured through recruitment and training of experts to deliver the intervention; engagement of parents through a face-to face sessions; adequate dosage; and management for worksite environmental interventions are major factors identified by systematic reviews (Murimi *et al.*, 2017, 2018) to enhance efficacy of nutrition education interventions and they are strengths that this study shares. Agriculture is a critical focus area for food and nutrition security of rural communities like in Ethiopia. The role agriculture plays as a source of food and source of income for food and non-food investment, its effect on food price and market, the opportunity it creates for nutrition sensitive interventions like nutrition education allied with other agricultural intervention are among the pathways it impact nutrition (Wordofa and Sassi,

2020). These multiple pathways through which agriculture and nutrition are related increases the need for implementation of collaborative multisectoral activities to improve food and nutrition conditions. But the current study mainly focused only on the need for a nutrition education, and with that limitation has demonstrated positive effect of nutrition education that was deliverd with a low health literacy approach on the consumption of ASF (dairy and eggs) and dietary diversity of lactating mothers and IYC; and nutritional status of IYC.

5.2. Conclusions and Recommendations

At household-level meat, poultry and fish were consumed less frequently than dairy and eggs. The consumption of poultry, meat and fish was nutritionally negligible. In general, ASF were not consumed often by households in the studied rural districts of Ethiopia. Unavailability, unaffordability, limited ASF consumption tradition, income generation priority from livestock rearing and higher price of ASF than plant-based foods were constraints identified. Religion and related fasting does not hinder the consumption of ASF.

Eggs, meat, and nuts were consumed by lesser proportion of the lactating mothers and IYC than other food groups. A very small proportion of children consumed eggs and flesh foods. Low proportion of the lactating mothers consumed the recommended number of meals in a day and achieved MDDW. Similary, considerable proportion of IYC did not met the recommended minimum dietary diversity.

Poverty as determined by food insecurity, income and property ownership was associated with infrequent household-level ASF consumption. Cow, chicken and donkey ownership amplified selected ASF consumption frequencies. Poultry, meat and eggs were less frequently consumed by households with lowest estimated annual income category. Women's lack of formal schooling and larger family size also contributed to the less frequent consumption of some types of ASF.

Mothers from food secure households consumed all types of ASF than mothers in severely food insecure households. Regarding farming practices, cash crop production was positively associated with meat consumption and so did root crops production for eggs. Consumption of five or more meals in a day, being educated, being a merchant, cow or chicken ownership and household food security increased the chance of overall ASF consumption by lactating mothers. Probability of dairy consumption was higher for merchant mothers than housemakers.

Generally low household level socio-economic status and maternal education affected ASF consumption practice of infants and young children . Household food security was positively associated with consumption of all forms of ASF and overall ASF consumption by the children. Livestock (cow, chicken and donkey) ownership, grades five to eight and grade nine or above educational achievement of the mothers and household income in the category of 20001-30000 increased children's dairy consumption chance. Root crops production and chicken ownership were

positively related to egg consumption by children. Overall ASF consumption was determined by livestock ownership, household annual income and maternal education.

In the study area, underweight was a medium level public health problem of lactating mothers. Child growth failures were prevalent in the study area. Stunting and underweight were medium level public health problems, while wasting ranked for a level of poor situation.

A low health literacy approach nutrition education intervention improved nutrition of mother-child pairs. It has improved dietary diversity of infant and young children and lactating mothers. It also positively impacted the inclusion of ASF (eggs and dairy) in diversified diets of lactating mothers and children, but not meat.

Thus, national policy and future nutrition researches should focus on nutrition education and can use a low health literacy approach to do promotion on the need for the inclusion of ASF in diversified diets integrated with activities to (1) boost healthy agricultural productivity including livestock productivity, (2) revise active nutrition and food security programs in rural settings, (3) create jobs opportunities in rural settings for income generation (4) empower women through education and engagement in small scale businesses like livestock husbandry, feed production and others, and (5) provide reproductive health services including family planning. Looking for strategies to avail ASF in the local markets of rural setting of Ethiopia on program bases may also benefit, especially for meat. More researches are warranted to further understand the observed protective relationship between no vegetable production practice and stunting and underweight. Mixed relationship of cashcrop production practice with household, maternal and child nutrion is also in need of further research for clarity. Multisectoral interventional researches that can be conducted for a longer period than the period for this study shall also be considered to determine their effect on HAZ of children and nutriotnal status of lactating mothers.

References

Abate, K. H. and Belachew, T. (2017) "Women's autonomy and men's involvement in child care and feeding as predictors of infant and young child anthropometric indices in coffee farming households of Jimma Zone, South West of Ethiopia," *PLoS ONE*, 12(3), pp. 1–16. doi: 10.1371/journal.pone.0172885.

Abebe, T. and Mulu, D. (2017) "The Role of Women in the Management and Utilization of Home Garden : The Case of Dale District , in Southern Ethiopia," *Pelagia Research Library, Asian Journal of Plant Science and Research*, 7(4), pp. 41–54.

Abegaz, G. A., Hassen, I. W. and Minten, B. (2018) Consumption of animal-source foods in Ethiopia: Patterns, changes, and determinants. Available at: http://www.worldreligiondatabase.org/wrd_home.asp%0Ahttp://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/131369%0Ahttp://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/132252.

Adesogan, A. T. *et al.* (2020) "Animal source foods: Sustainability problem or malnutrition and sustainability solution? Perspective matters," *Global Food Security*, 25(October 2019). doi: 10.1016/j.gfs.2019.100325.

Adjimoti, G. O. and Kwadzo, G. T. M. (2018) "Crop diversification and household food security status: Evidence from rural Benin," *Agriculture and Food Security*. BioMed Central, 7(1), pp. 1–12. doi: 10.1186/s40066-018-0233-x.

Aemro, M. *et al.* (2013) "Dietary diversity and meal frequency practices among infant and young children aged 6-23 months in Ethiopia: A secondary analysis of Ethiopian Demographic and Health Survey 2011," *Journal of Nutrition and Metabolism*, 2013, pp. 1–8. doi: 10.1155/2013/782931.

Aemro, M. *et al.* (no date) "Dietary diversity and meal frequency practices among infant and young children age 6-23 months in Ethiopia : A secondary analysis of Ethiopian Demographic and Health Survey 2011."

African Union (2005) "African regional nutritional strategy 2005-2015," *Commissioner for Social Affairs*, pp. 1–28.

Agedew, E. and Chane, T. (2015) "Prevalence of Stunting among Children Aged 6–23 Months in Kemba Woreda, Southern Ethiopia: A Community Based Cross-Sectional Study," *Advances in Public Health*, 2015, pp. 1–6. doi: 10.1155/2015/164670.

Agedew, E. and Shimeles, A. (2016) "Acute undernutrition (Wasting) and Associated Factors among Children aged 6-23 Months in Kemba Woreda, Southern Ethiopia: A community based Cross-Sectional Study," *International Journal of Nutritional Science and Food Technology*, 2(2), pp. 59–66.

Agidew, A. A. and Singh, K. N. (2018) "Determinants of food insecurity in the rural farm households in South Wollo Zone of Ethiopia: the case of the Teleyayen sub-watershed," *Agricultural and Food Economics*. Agricultural and Food Economics, 6(1). doi: 10.1186/s40100-018-0106-4.

Agize, A., Jara, D. and Dejenu, G. (2017) "Level of knowledge and practice of mothers on minimum dietary diversity practices and associated factors for 6-23-month-old children in Adea

Woreda, Oromia, Ethiopia," *BioMed Research International*. Hindawi, 2017. doi: 10.1155/2017/7204562.

Aguayo, V. M. and Menon, P. (2016) "Stop stunting: Improving child feeding, women's nutrition and household sanitation in South Asia," *Maternal and Child Nutrition*, 12, pp. 3–11. doi: 10.1111/mcn.12283.

Ahmed, R. S., Imran, A. and Hussain, M. B. (2016) "Nutritional Composition of Meat," *Meat Science and Nutrition*, pp. 61–77. doi: http://dx.doi.org/10.5772/57353.

Ahmed, W. A. M. *et al.* (2014) "Nutritional Status of Mothers and Its Determinants in Alemtidad Area, Khartoum," *Food and Nutrition Sciences*, 05(22), pp. 2203–2208. doi: 10.4236/fns.2014.522233.

Aiga, H. *et al.* (2020) "Spectrum of nutrition-specific and nutrition-sensitive determinants of child undernutrition: A multisectoral cross-sectional study in rural Mozambique," *BMJ Nutrition, Prevention and Health*, 3(2), pp. 320–338. doi: 10.1136/bmjnph-2020-000182.

Aihara, Y. and Minai, J. (2011) "Barriers and catalysts of nutrition literacy among elderly Japanese people," *Health Promotion International*, 26(4), pp. 421–431. doi: 10.1093/heapro/dar005.

Akombi, B. J. *et al.* (2017) "Stunting, wasting and underweight in Sub-Saharan Africa: A systematic review," *International Journal of Environmental Research and Public Health*, 14(8), pp. 1–18. doi: 10.3390/ijerph14080863.

Aletor, O. (2017) "Vitamins, Amino Acids, Lipids and Sterols of Eggs from Three Different Birds Genotypes," *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 11(03), pp. 41–47. doi: 10.9790/2402-1103014147.

Altamirano Martínez, M. B. *et al.* (2015) "A review of graphical representations used in the dietary guidelines of selected countries in the Americas, Europe and Asia," *Nutricion Hospitalaria*, 32(3), pp. 986–996. doi: 10.3305/nh.2015.32.3.9362.

Amare, B. *et al.* (2012) "Nutritional status and dietary intake of urban residents in Gondar, Northwest Ethiopia," *BMC Public Health*, 12(1). doi: 10.1186/1471-2458-12-752.

Amistu K, Ermias B and Asrat A (2017) "Consumer Preference of Raw Beef ('Kurt') in Wolaita Sodo Town, Southern Ethiopia," 5(4), pp. 7–13.

Amugsi, Dickson A *et al.* (2016) "Dietary diversity, socioeconomic status and maternal body mass index (BMI): quantile regression analysis of nationally representative data from Ghana, Namibia and Sao Tome and Principe," *BMJ Open*, 6(9), p. e012615. doi: 10.1136/bmjopen-2016-012615.

Amugsi, Dickson A. *et al.* (2016) "Women's participation in household decision-making and higher dietary diversity: findings from nationally representative data from Ghana," *Journal of health, population, and nutrition*. Journal of Health, Population and Nutrition, 35(1), p. 16. doi: 10.1186/s41043-016-0053-1.

Amugsi, D. A., Mittelmark, M. B. and Oduro, A. (2015) "Association between maternal and child dietary diversity: An analysis of the Ghana Demographic and Health Survey," *PLoS ONE*, 10(8), pp. 1–12. doi: 10.1371/journal.pone.0136748.

Anato, A., Tafese, Z. and Stoecker, B. J. (2019) "Maternal depression is associated with child

undernutrition : A cross-sectional study in Ethiopia," *Maternal and Child Nutrtion*, 2019(e12934), pp. 1–9. doi: 10.1111/mcn.12934.

Angara, T. E. E., Ismail, A. A. and Ibrahim, A. M. (2011) "The Role of Donkeys in Income Generation and the Impact of Endoparasite on their Performance," *Journal of veternary medicine and Animal Production*, 2(2), pp. 65–89. Available at: http://onlinejournals.uofk.edu/index.php/vet/article/view/288/277.

Arimond, M. and Ruel, M. T. (2004) "Dietary Diversity Is Associated with Child Nutritional Status: Evidence from 11 Demographic and Health Surveys," *The Journal of Nutrition*, 134(10), pp. 2579–2585. doi: 10.1093/jn/134.10.2579.

Arnold, T. (2016) "Nutrition-Specific and Nutrition-Sensitive Interventions," pp. 276–288. doi: 10.1159/000452392.

Arora, R., Bhojak, N. and Joshi, R. (2013) "Comparative aspacts of goat and cow milk," *Int. J. Engineering Sci. Invention*, 2(1), pp. 7–10.

Asesefa Kisi, M. *et al.* (2018) "Household food insecurity and coping strategies among pensioners in Jimma Town, South West Ethiopia," *BMC Public Health*. BMC Public Health, 18(1), pp. 1–8. doi: 10.1186/s12889-018-6291-y.

Assefa, S. *et al.* (2017) "Household sanitation practice associated with nutritional status of pre-school children aged 24-59 months in Hawassa Zuria Woreda, South Ethiopia: A cross-sectional study," *Current Pediatric Research*, 21(2), pp. 291–297.

Attia, Y. A., Al-Harthi, M. A. and Shiboob, M. M. (2014) "Evaluation of quality and nutrient contents of table eggs from different sources in the retail market," *Italian Journal of Animal Science*, 13(2), pp. 369–376. doi: 10.4081/ijas.2014.3294.

Ayele, Z. and Peacock, C. (2003) "Improving Access to and Consumption of Animal Source Foods in Rural Households: The Experiences of a Women-Focused Goat Development Program in the Highlands of Ethiopia," *Journal of Nutrition*, 133(11 SUPPL. 2), pp. 3981–3986. doi: 10.1093/jn/133.11.3981s.

Azzarri, C. *et al.* (2015) "Does Livestock Ownership Affect Animal Source Foods Consumption and Child Nutritional Status? Evidence from Rural Uganda," *Journal of Development Studies*. Routledge, 51(8), pp. 1034–1059. doi: 10.1080/00220388.2015.1018905.

B. Torun *et al.* (1996) "Energy requirements and dietary energy recommendations for children and adolescents 1 to 18 years old," *European Journal of Clinical Nutrition*, 50, pp. S37–S81.

Barker, D. J. P. (2012) "Developmental origins of chronic disease," *Public Health*. Elsevier Ltd, 126(3), pp. 185–189. doi: 10.1016/j.puhe.2011.11.014.

Bartter, J. *et al.* (2018) "Use of chicken eggshell to improve dietary calcium intake in rural sub-Saharan Africa," *Maternal and Child Nutrition*, 14(May), pp. 1–10. doi: 10.1111/mcn.12649.

BBC Amharic (no date) "የ1 ኢትዮጵያዊ ዓመታዊ የስጋ ፍጆታ 7 ኪሎ ግራም ሲሆን፥ ካደጉት ሀገራት አንጻር ሲታይ በ10 እጥፍ ያንሳል." Available at: https://fanabc.com/2019/02/የኢትዮጵያውያን-ዓመታዊ-የስጋ-ፍጆታ-7-ኪሎ/?fbclid=IwAR1RyCRvHnq48t9BUvaCUMd2cKdJkMA7pveCH63vNlAeiIm--SI3sq7Oc6M.

Bekele, H., Jima, G. H. and Regesu, A. H. (2020) "Undernutrition and Associated Factors among Lactating Women: Community-Based Cross-Sectional Study in Moyale District, Borena Zone, Southern Ethiopia," *Advances in Public Health*, 2020, pp. 1–10. doi: 10.1155/2020/4367145.

Belew, A. K. *et al.* (2017) "Dietary diversity and meal frequency among infant and young children: A community based study," *Italian Journal of Pediatrics*. Italian Journal of Pediatrics, 43(1), pp. 6–15. doi: 10.1186/s13052-017-0384-6.

Belton, B. and Thilsted, S. H. (2014) "Fisheries in transition: Food and nutrition security implications for the global South," *Global Food Security*. Elsevier, 3(1), pp. 59–66. doi: 10.1016/j.gfs.2013.10.001.

Bendel, R. B. and Afifi, A. A. (1977) "Comparison of stopping rules in forward 'stepwise' regression," *Journal of the American Statistical Association*, 72(357), pp. 46–53. doi: 10.1080/01621459.1977.10479905.

Benton, D. (2008) "The influence of children's diet on their cognition and behavior," *European Journal of Nutrition*, 47(SUPPL.3), pp. 25–37. doi: 10.1007/s00394-008-3003-x.

Berman, M. and Lavizzo-mourey, R. (2008) "Obesity Prevention in the Information Age," *JAMA*, 300(4), p. 433. doi: 10.1001/jama.300.4.433.

Beyene, M., Worku, A. G. and Wassie, M. M. (2015) "Dietary diversity, meal frequency and associated factors among infant and young children in Northwest Ethiopia: A cross-sectional study," *BMC Public Health*. BMC Public Health, 15(1). doi: 10.1186/s12889-015-2333-x.

Bhandari, S. *et al.* (2016) "Dietary intake patterns and nutritional status of women of reproductive age in Nepal: Findings from a health survey," *Archives of Public Health*. Archives of Public Health, 74(1), pp. 1–11. doi: 10.1186/s13690-016-0114-3.

Bier, D. (2008) "Growth in the first two years of life," *Nestle Nutrition Workshop Series: Pediatric Program*, 61, pp. 135–142. doi: 10.1159/000113364.

Bilal, S. *et al.* (2016) "Fathers' Perception, Practice, and Challenges in Young Child Care and Feeding in Ethiopia," *Food and Nutrition Bulletin*, 37(3), pp. 329–339. doi: 10.1177/0379572116654027.

Bilal, S. M. *et al.* (2016) "The influence of father's child feeding knowledge and practices on children's dietary diversity: a study in urban and rural districts of Northern Ethiopia, 2013," *Maternal and Child Nutrition*, 12(3), pp. 473–483. doi: 10.1111/mcn.12157.

Birhanu, A. F. (2019) "A Review on Ethiopian Meat production trends, consumption and meat quality parameters," *International Journal of Food Science and Agriculture*, 3(3), pp. 267–274. doi: 10.26855/ijfsa.2019.10.002.

Black, R. E., Makrides, M. and Ong, K. K. (2016) "Complementary Feeding: Building the Foundations for a Healthy Life," *World*. Singapore: Nestlé Nutr Inst Workshop Ser. Nestec Ltd., pp. 1–12.

Blitstein, J. L. and Evans, W. D. (2006) "Use of Nutrition Facts Panels among Adults Who Make Household Food Purchasing Decisions," *Journal of Nutrition Education and Behavior*, 38(6), pp. 360–364. doi: 10.1016/j.jneb.2006.02.009.

Bogard, J. R. *et al.* (2015) "Nutrient composition of important fish species in Bangladesh and potential contribution to recommended nutrient intakes," *Journal of Food Composition and Analysis*. Elsevier Inc., 42, pp. 120–133. doi: 10.1016/j.jfca.2015.03.002.

Boke, M. M. and Geremew, A. B. (2018) "Low dietary diversity and associated factors among lactating mothers in Angecha districts, Southern Ethiopia: Community based cross-sectional study," *BMC Research Notes*. BioMed Central, 11(1), pp. 1–6. doi: 10.1186/s13104-018-4001-6.

Bornaz, S. *et al.* (2009) "Physicochemical characteristics and renneting properties of camels' milk: A comparison with goats', ewes' and cows' milks," *International Journal of Dairy Technology*, 62(4), pp. 505–513. doi: 10.1111/j.1471-0307.2009.00535.x.

Bosha, T. *et al.* (2019) "Dietary diversity and anthropometric status of mother–child pairs from enset (False banana) staple areas: A panel evidence from southern Ethiopia," *International Journal of Environmental Research and Public Health*, 16(12). doi: 10.3390/ijerph16122170.

Brandsma, W. *et al.* (2012) "The Major Ethiopian Milksheds; Wageningen, Wageningen UR (University & Research centre) Livestock Research, Livestock Research Report 735, 245 blz," *Wageningen University*, pp. 1–245.

Brooks, N. and Begley, A. (2014) "Adolescent food literacy programmes: A review of the literature," *Nutrition and Dietetics*, 71(3), pp. 158–171. doi: 10.1111/1747-0080.12096.

Broussard, N. H. (2019) "What explains gender differences in food insecurity?," *Food Policy*. Elsevier, 83(November 2018), pp. 180–194. doi: 10.1016/j.foodpol.2019.01.003.

Bruce, C. (2003) "Anthropometric Indicators Measurement Guide." Washnigton, D.C.,: Food and Nutrition Technical Assistance Project, Academy for Educational Development. Available at: https://www.researchgate.net/publication/237442266_Anthropometric_Indicators_Measurement_Guide.

Brun, L. R. *et al.* (2013) "Chicken eggshell as suitable calcium source at home," *International Journal of Food Sciences and Nutrition*, 64(6), pp. 740–743. doi: 10.3109/09637486.2013.787399.

Busert, L. K. *et al.* (2016) "Dietary Diversity Is Positively Associated with Deviation from Expected Height in Rural Nepal," *The Journal of Nutrition*, 146(7), pp. 1387–1393. doi: 10.3945/jn.115.220137.

Calloway, D. H., Murphy, S. P. and Woerner, J. (1994) *World Food Dietary Assessment System User's Guides*. Berkeley, CA: The University of California.

Canada Health (2019) "Canada's Dietary Guideline for Health Professionals and Policy Makers."

Carbone, E. T. and Zoellner, J. M. (2012) "Nutrition and health literacy: A systematic review to inform nutrition research and practice," *Journal of the Academy of Nutrition and Dietetics*. Elsevier, 112(2), pp. 254–265. doi: 10.1016/j.jada.2011.08.042.

Carrara, A. and Schulz, P. J. (2018) "The role of health literacy in predicting adherence to nutritional recommendations: A systematic review," *Patient Education and Counseling*. Elsevier Ireland Ltd, 101(1), pp. 16–24. doi: 10.1016/j.pec.2017.07.005.

Cawthorn, D.-M. and Hoffman, L. C. (2014) "The role of traditional and non-traditional meat animals in feeding a growing and evolving world," *Animal Frontiers*, 4(4), pp. 6–12. doi:

10.2527/af.2014-0027.

Central Statistical Agency (CSA) [Ethiopia] (2007a) "Population and Housing Cencus for Oromia Regional State of Ethiopia," *Federal democratic republic of Ethiopia population census commission*, pp. 1–1084. Available at: https://www.statsethiopia.gov.et/wp-content/uploads/2019/06/Statistical_SNNPR.pdf.

Central Statistical Agency (CSA) [Ethiopia] (2007b) *Population and Housing Cencus for Southern Nationa, Nationalities and Peoples Regional State of Ethiopia*. Available at: https://www.statsethiopia.gov.et/wp-content/uploads/2019/06/Statistical_SNNPR.pdf.

Central Statistical Agency (CSA) [Ethiopia] and ICF (2016a) *Demographic and Health Survey*. Addis Ababa. CSA and ICF.

Central Statistical Agency (CSA) [Ethiopia] and ICF (2016b) *Demographic and Health Survey Key Indicators*. Addis Ababa. CSA and ICF.

Cervera, P. and Ngo, J. (2001) "Dietary guidelines for the breast-feeding woman," *Public Health Nutrition*, 4(6a), pp. 1357–1362. doi: 10.1079/phn2001218.

Chan, C. Y. *et al.* (2019) "Prospects and challenges of fish for food security in Africa," *Global Food Security*. Elsevier B.V., 20(May 2018), pp. 17–25. doi: 10.1016/j.gfs.2018.12.002.

Chandan, R. C., Attaie, R. and Shahani, K. M. (1992) Nutritional aspects of goat milk and its products. New Delhi, India: In: Proceedings of 5th Int. Conf. on Goats.

Chandrasekhar, S. and Krishna, V. (2017) "Household food insecurity and children ' s dietary diversity and nutrition in India . Evidence from the comprehensive nutrition survey in Maharashtra," 13(October 2016), pp. 1–8. doi: 10.1111/mcn.12447.

Chen, S. (1989) "Impact of a School Milk Programme on the Nutritional Status of School Children," *Asia Pacific Journal of Public Health*, 3(1).

Claeys, W. L. *et al.* (2014) "Consumption of raw or heated milk from different species: An evaluation of the nutritional and potential health benefits," *Food Control*, 42, pp. 188–201.

Cockburn, J. J. *et al.* (2014) "Exploring the Role of Sugarcane in Small-scale Farmers' Livlihood in the Noodsbergarea, Kwazulu-natal, South Africa" 42, pp. 80–97.

Colecraft, E. *et al.* (2006) "Constraints on the use of animal source foods for young children in Ghana: A participatory rapid appraisal approach," *Ecology of Food and Nutrition*, 45(5), pp. 351–377. doi: 10.1080/03670240600985464.

Colleen, W. *et al.* (2017) "Effect of nutrition education and dairy group membership on nutrition knowledge, practices and diet quality for rural Kenyan farm women," *African Journal of Food, Agriculture, Nutrition and Development*, 17(3), pp. 12343–12361. doi: 10.18697/ajfand.79.15350.

Cordero-Ahiman, O. V., Santellano-Estrada, E. and Garrido, A. (2018) "Food access and coping strategies adopted by households to fight hunger among indigenous communities of Sierra Tarahumara in Mexico," *Sustainability (Switzerland)*, 10(2), pp. 1–14. doi: 10.3390/su10020473.

Cornelsen, L. *et al.* (2016) "Cross-sectional study of drivers of animal-source food consumption in low-income urban areas of Nairobi, Kenya," *BMC Nutrition*. BMC Nutrition, 2(1), pp. 1–13. doi:

10.1186/s40795-016-0109-z.

Correia, L. L. *et al.* (2014) "Prevalence and determinants of child undernutrition and stunting in semiarid region of Brazil," *Revista de Saude Publica*, 48(1), pp. 19–28. doi: 10.1590/S0034-8910.2014048004828.

Daba, A. K. *et al.* (2021) "Determinants and constraints to household-level animal source food consumption in rural communities of Ethiopia," *Journal of Nutrtional Science*, 10(e58), pp. 1–10. doi: 10.1017/jns.2021.52.

Dafursa, K. and Gebremedhin, S. (2019) "Dietary Diversity among Children Aged 6-23 Months in Aleta Wondo District, Southern Ethiopia," *Journal of Nutrition and Metabolism*, 2019. doi: 10.1155/2019/2869424.

Dangura, D. and Gebremedhin, S. (2017) "Dietary diversity and associated factors among children 6-23 months of age in Gorche district, Southern Ethiopia: Cross-sectional study," *BMC Pediatrics*. BMC Pediatrics, 17(1), pp. 1–7. doi: 10.1186/s12887-016-0764-x.

Darapheak, C. *et al.* (2013) "Consumption of animal source foods and dietary diversity reduce stunting in children in Cambodia," *International Archives of Medicine*. International Archives of Medicine, 6(1), p. 1. doi: 10.1186/1755-7682-6-29.

Dasi, T. *et al.* (2019) "Animal source foods for the alleviation of double burden of malnutrition in countries undergoing nutrition transition," *Animal Frontiers*, 9(4), pp. 32–38. doi: 10.1093/af/vfz031.

Delgado, C. *et al.* (1999) *Livestock to 2020 The Next Food Revolution*. 28.

Demilew, Y. M., Alene, G. D. and Belachew, T. (2020) "Effect of guided counseling on dietary practices of pregnant women in West Gojjam Zone, Ethiopia," *PLoS ONE*, 15(5), pp. 1–14. doi: 10.1371/journal.pone.0233429.

Departmnet:Health Republic of South Africa (2013) "Food-Based Dietary Guideline for South Africa," *S Afr J Clin Nutr*, 26(3), pp. S1-164.

Desalegn, B. B. *et al.* (2018) "Ethiopian orthodox fasting and lactating mothers: Longitudinal study on dietary pattern and nutritional status in rural tigray, Ethiopia," *International Journal of Environmental Research and Public Health*, 15(8), pp. 1–20. doi: 10.3390/ijerph15081767.

Desalegn, B. B. *et al.* (2019) "Feeding practices and undernutrition in 6–23-month-old children of orthodox christian mothers in rural tigray, ethiopia: Longitudinal study," *Nutrients*, 11(1), pp. 1–15. doi: 10.3390/nu11010138.

Desta, D. *et al.* (2019) "Proximate Analysis of Nile Tilapia , (Oreochromisniloticus), Fish Fillet Harvested from Farmers Pond and Lake Hawassa , Southern Ethiopia," *International Journal for Research & Development in Technology*, 11(1), pp. 94–99.

Destoumieux-Garzón, D. *et al.* (2018) "The one health concept: 10 years old and a long road ahead," *Frontiers in Veterinary Science*, 5(FEB), pp. 1–13. doi: 10.3389/fvets.2018.00014.

Devadason, C. *et al.* (2016) "Comparative analysis of lipid content and fatty acid composition of commercially important fish and shellfish from Sri Lanka and Japan," *Journal of Oleo Science*, 65(7), pp. 543–556. doi: 10.5650/jos.ess16056.

Dewey, K. G. (2004) "Impact of breastfeeding on maternal nutritional status," *Advances in Experimental Medicine and Biology*, 554, pp. 91–100. doi: 10.1007/978-1-4757-4242-8_9.

Dhaneesh, K. V., Noushad, K. M. and Ajith Kumar, T. T. (2012) "Nutritional Evaluation of Commercially Important Fish Species of Lakshadweep Archipelago, India," *PLoS ONE*, 7(9), pp. 1–7. doi: 10.1371/journal.pone.0045439.

Diddana, T. Z. *et al.* (2018) "Effect of Nutrition Education Based on Health Belief Model on Nutritional Knowledge and Dietary Practice of Pregnant Women in Dessie Town, Northeast Ethiopia: A Cluster Randomized Control Trial," *Journal of Nutrition and Metabolism*. Hindawi, 2018. doi: 10.1155/2018/6731815.

Dinka, H. *et al.* (2010) "Major constraints and health management of village poultry production in rift valley of Oromia, Ethiopia," *Global Veterinaria*, 5(1), pp. 6–10.

Don, N. (2009) "Defining and measuring health literacy: What can we learn from literacy studies?," *International Journal of Public Health*, 54(5), pp. 303–305. doi: 10.1007/s00038-009-0050-x.

Don, N. (2015) "Defining, measuring and improving health literacy," *HEP*, 42(4), pp. 450–456.

Donnen, P. *et al.* (1997) "Effects of cow's milk supplementation on milk output of protein deficient lactating mothers and on their infants' energy and protein status," *Tropical Medicine and International Health*, 2(1), pp. 38–46. doi: 10.1046/j.1365-3156.1997.d01-121.x.

Duressa, D. *et al.* (2014) Assessment of livestock production system and feed resources availability in three villages of Diga district Ethiopia, International Livestock Research Institute (ILRI). doi: 10.13140/RG.2.1.3551.2722.

E. van den, H., Murphy, J. L. and Appleton, K. M. (2015) "Exploring the barriers and facilitators to the consumption of eggs and other protein rich foods using focus groups," in *Proceedings of the Nutrition Society*. doi: 10.1017/s0029665115003614.

Eaton, J. C. *et al.* (2019) "Effectiveness of provision of animal-source foods for supporting optimal growth and development in children 6 to 59 months of age," *The Cochrane database of systematic reviews*, 2, p. CD012818. doi: 10.1002/14651858.CD012818.pub2.

El-Hatmi, H. *et al.* (2015) "Comparison of composition and whey protein fractions of human, camel, donkey, goat and cow milk," *Mljekarstvo*, 65(3), pp. 159–167. doi: 10.15567/mljekarstvo.2015.0302.

Emana, B. *et al.* (2015) "Characterization and assessment of vegetable production and marketing systems in the humid tropics of Ethiopia," *Quarterly Journal of International Agriculture*, 54(2), pp. 163–187.

Ersino, G., Henry, C. J. and Zello, G. A. (2016) "Suboptimal Feeding Practices and High Levels of Undernutrition among Infants and Young Children in the Rural Communities of Halaba and Zeway, Ethiopia," *Food and Nutrition Bulletin*, 37(3), pp. 409–424. doi: 10.1177/0379572116658371.

Ethiopia, M. of H. F. D. R. of (2010) "Infant & Young Child Feeding."

Ethiopian Public Health(EPHI) and ICF (2019) *Mini Demographic and Health Survey Key Indicators*.

Ethiopian Public Health Institute (2013) *Ethiopia National Food Consumption Survey*. Addis Ababa.

Eva, G. E. N. (1981) "Guidelines for training community health workers in nutrition," *World Health Organization Offset Publication*, No. 59.

Evans, B. R. and Leighton, F. A. (2014) "Very unfavorable institutional environment and serious, early, and lasting lack of maternal care," *Rev. sci. tech. Off. int. Epiz.*, 33(2), pp. 413–420.

Fabrizio, C. S., van Liere, M. and Pelto, G. (2014) "Identifying determinants of effective complementary feeding behaviour change interventions in developing countries," *Maternal and Child Nutrition*, 10(4), pp. 575–592. doi: 10.1111/mcn.12119.

Fantu N., B. and Bart, M. (2019) The rising costs of nutritious foods: The case of Ethiopia. Addis Ababa. doi: 10.1017/CBO9781107415324.004.

FAO (1992) "Meat and meat products in human nutrition in developing countries."

FAO (2004) Fishery Statistics:Aquaculture production. doi: 10.1017/CBO9781107415324.004.

FAO (2011) Complemantary Feeding for Children Age 6-23 months; *A Recipe Book for Mothers and Caregivers*. Available at: http://www.fao.org/3/am866e/am866e00.pdf.

FAO (2018) "Achieving food and nutrition security through fisheries and aquaculture," (July).

FAOSTAT, F. (2018) Statistics of the Food and Agriculture Organization of the United Nations, *Food and Agriculture Organization of the United Nations*. Available at: http://www.fao.org/faostat/en/#home%0Ahttp://www.fao.org/faostat/en/#rankings.

Fedaral Democrtic Republic of Ethiopia (2018) "Food and Nutrition Policy."

Federal Democratic Republic of Ethiopia (2016) "National Nutrition Program 2016–2020." Available at: http://www.youthpolicy.org/national/Ethiopia_2004_National_Youth_Policy.pdf.

Federal Democratic Republic of Ethiopia (2018) "Food and Nutrition Policy." doi: 10.1177/156482658600800310.

Federal Democratic republic of Ethiopia, M. of A. (2018) "National Nutrition Sensitive Agriculture Training Manual for Agriculture Development Agents."

Federal Democratic Repulic of Ethiopia (2019) "The Sequat Declaration Committed to Ending Stunting in Children under-two by 2030." Available at: https://www.bigwin.org/nm_pent_bigwp/wp-content/uploads/2019/10/ExtendedNote.pdf.

Federal Ministry of Health (2006) "Food-Based Dietry Guidelines for Nigeria; A guide to Healthy Eating."

Feed the Future (no date) "Linking Cattle Nutrition to Human Nutrition: A Value Chain Approach to Improving the Production, Handling, and Consumption of Animal Source Foods in Ethiopia." Available at: https://livestocklab.ifas.ufl.edu/media/livestocklabifasufledu/pdf-/ETH-Vipham-Linking-cattle-human-nutrition-leaflet.pdf.

Fekadu, Y. *et al.* (2015) "Factors associated with nutritional status of infants and young children in Somali Region, Ethiopia: A cross- sectional study Global health," *BMC Public Health*. BMC Public

Health, 15(1), pp. 1–9. doi: 10.1186/s12889-015-2190-7.

Fineman, R. M. (2005) Health literacy: a prescription to end confusion, *Choice Reviews Online*. Edited by N.-B. Lynn, M. P. Allison, and K. A. David. New England Journal of Medicine. doi: 10.5860/choice.42-4059.

Flax, V. L. *et al.* (2021) "Animal Source Food Social and Behavior Change Communication Intervention Among Girinka Livestock Transfer Beneficiaries in Rwanda : A Cluster Randomized Evaluation," 9(3), pp. 1–14.

Food and Agricultural Organization of the United Nations (2010) *Guidelines for measuring household and individual dietary diversity*. Rome, Italy. doi: 613.2KEN.

Food and Nutrition Technical Assistance (2007) Developing and Validating Simple Indicators of Dietary Quality of Infants and Young Children in Developing Countries : Additional Analysis of 10 Data Sets *September 2007 Working Group on Infant and Young Child Feeding Indicators*.

Food and Nutrition Technical Assistance III Project (FANTA) (2018) Training Guide for Community-Based Management of Acute Malnutrition (CMAM): Handouts. Washington, DC: FHI 360/FANTA.

Food and Nutrition Technical Assistance Project (FANTA) (2007) "Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide," *Journal of Chemical Information and Modeling*, 53(9), pp. 1689–1699. doi: 10.1017/CBO9781107415324.004.

Forsido, S. F. *et al.* (2019) "Complementary feeding practices, dietary diversity, and nutrient composition of complementary foods of children 6-24 months old in Jimma Zone, Southwest Ethiopia," *Journal of health, population, and nutrition*. Journal of Health, Population and Nutrition, 38(1), p. 14. doi: 10.1186/s41043-019-0172-6.

Gatahun, E. A. (2015) "Dietary Diversity Feeding Practice and Determinants among Children Aged 6-23 Months in Kemba Woreda, Southern Ethiopia Implication for Public Health Intervention," *Journal of Nutrition & Food Sciences*, s13. doi: 10.4172/2155-9600.s13-003.

Gebremedhin, S. *et al.* (2017) "Predictors of dietary diversity in children ages 6 to 23 mo in largely food-insecure area of South Wollo, Ethiopia," *Nutrition*. Elsevier Ltd, 33, pp. 163–168. doi: 10.1016/j.nut.2016.06.002.

Geiger, M. *et al.* (2020) "Understanding the Attitudes of Communities to the Social, Economic, and Cultural Importance of Working Donkeys in Rural, Peri-urban, and Urban Areas of Ethiopia," *Frontiers in Veterinary Science*, 7(February), pp. 1–13. doi: 10.3389/fvets.2020.00060.

Getachew, T. and Argaw, A. (2017) "Intestinal helminth infections and dietary diversity score predict nutritional status of urban schoolchildren from southern Ethiopia," *BMC Nutrition*. BMC Nutrition, 3(1), pp. 1–9. doi: 10.1186/s40795-017-0128-4.

Getnet, W., Aycheh, W. and Tessema, T. (2018) "Determinants of Food Taboos in the Pregnant Women of the Awabel District, East Gojjam Zone, Amhara Regional State in Ethiopia," *Advances in Public Health*, 2018, pp. 1–6. doi: 10.1155/2018/9198076.

Gewa, C. A., Oguttu, M. and Yandell, N. S. (2012) "Maternal nutrition in rural Kenya: Health and socio-demographic determinants and its association with child nutrition," *Maternal and Child Nutrition*, 8(3), pp. 275–286. doi: 10.1111/j.1740-8709.2011.00322.x.

Gibson, R. S. (2005) Principles of Nutritional Assessment. Second Edi. New York. Oxford University Press.

Gibson, R. S. and Hotz, C. (2001) "Dietary diversification/modification strategies to enhance micronutrient content and bioavailability of diets in developing countries," *British Journal of Nutrition*, 85(S2), pp. S159–S166. doi: 10.1079/bjn2001309.

Goodarzi-Khoigani, M. *et al.* (2018) "Impact of nutrition education in improving dietary pattern during pregnancy based on pender's health promotion model: A randomized clinical trial," *Iranian Journal of Nursing and Midwifery Research*, 23(1), pp. 18–25. doi: 10.4103/ijnmr.IJNMR_198_16.

Goran, G. V. *et al.* (2010) "Dynamics of Some Mineral Elements in Hen Eggs," *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca - Veterinary Medicine*, 67(2), pp. 88–95. doi: 10.15835/buasvmcn-vm:67:2:5928.

Goshu, D., Kassa, B. and Ketema, M. (2012) "Does crop diversification enhance household food security? Evidence from rural Ethiopia," *Advances in Agriculture, Sciences and Engineering Research*, 2(11), pp. 503–515.

Govereh, J. and Jayne, T. S. (2003) "Cash cropping and food crop productivity: Synergies or trade-offs?," *Agricultural Economics*, 28(1), pp. 39–50. doi: 10.1016/S0169-5150(02)00066-X.

Government of Ethiopia (2016) "National Nutrition Program 2016 - 2020," (June 2013). Available at: www.unicef.org/ethiopia/National_Nutrition_Programme.pdf.

Grace, D. *et al.* (2018) "The influence of livestock- derived foods on nutrition during the first 1 , 000 days of life," p. 67.

Grapci-Kotori, L. *et al.* (2019) "The composition, distribution and abundance of fish species according to the effects of water physicochemical parameters in the Livoq Lake, Kosovo," *Journal of Ecological Engineering*, 20(5), pp. 235–241. doi: 10.12911/22998993/105358.

Gurung, T. B. (2016) "Role of inland fishery and aquaculture for food and nutrition security in nepal," *Agriculture and Food Security*. BioMed Central, 5(1), pp. 1–9. doi: 10.1186/s40066-016-0063-7.

Guttersrud, O., Dalane, J. O. and Pettersen, S. (2014) "Improving measurement in nutrition literacy research using Rasch modelling: Examining construct validity of stage-specific 'critical nutrition literacy' scales," *Public Health Nutrition*, 17(4), pp. 877–883. doi: 10.1017/S1368980013000530.

Haddad, L. (1999) "Women's Status: Levels, Determinants, Consequences for Malnutrition, Interventions, and Policy," *Asian Development Review*, 17(08), pp. 96–131.

Hadley, C. *et al.* (2008) "Gender bias in the food insecurity experience of Ethiopian adolescents," *Social Science and Medicine*, 66(2), pp. 427–438. doi: 10.1016/j.socscimed.2007.08.025.

Hadush, Z. *et al.* (2017) "Foods tabooed for pregnant women in Abala district of Afar region, Ethiopia: An inductive qualitative study," *BMC Nutrition*. BMC Nutrition, 3(1), pp. 1–9. doi: 10.1186/s40795-017-0159-x.

Haileselassie, M. *et al.* (2020) "Erratum: Correction: Why are animal source foods rarely consumed by 6-23 months old children in rural communities of Northern Ethiopia? A qualitative study (PloS one (2020) 15 1 (e0225707))," *PloS one*, 15(3), p. e0230527. doi: 10.1371/journal.pone.0230527.

Haileslassie, K., Mulugeta, A. and Girma, M. (2013) "Feeding practices, nutritional status and associated factors of lactating women in Samre Woreda, South Eastern Zone of Tigray, Ethiopia.," *Nutrition journal*. Nutrition Journal, 12(1), p. 1. doi: 10.1186/1475-2891-12-28.

Hall, A. G. *et al.* (2017) "An animal-source food supplement increases micronutrient intakes and iron status among reproductive-age women in rural Vietnam," *Journal of Nutrition*, 147(6), pp. 1200–1207. doi: 10.3945/jn.116.241968.

Harris-Fry, H. *et al.* (2017) "Determinants of intra-household food allocation between adults in South Asia - A systematic review," *International Journal for Equity in Health*. International Journal for Equity in Health, 16(1), pp. 1–21. doi: 10.1186/s12939-017-0603-1.

Headey, D., Hirvonen, K. and Hoddinott, J. (2018) "Animal sourced foods and child stunting," *American Journal of Agricultural Economics*, 100(5), pp. 1302–1319. doi: 10.1093/ajae/aay053.

Heflin, L. E. *et al.* (2018) "Mineral content of eggs differs with hen strain, age, and rearing environment," *Poultry Science*, 97(5), pp. 1605–1613. doi: 10.3382/ps/pey025.

Herforth, A. *et al.* (2019) "A Global Review of Food-Based Dietary Guidelines," *Advances in Nutrition*. Oxford University Press, 10(4), pp. 590–605. doi: 10.1093/advances/nmy130.

Herron, K. L. and Fernandez, M. L. (2004) "Are the Current Dietary Guidelines Regarding Egg Consumption Appropriate?," *The Journal of Nutrition*, 134(1), pp. 187–190. doi: 10.1093/jn/134.1.187.

Hetherington, J. B. *et al.* (2017) "Livestock ownership, animal source foods and child nutritional outcomes in seven rural village clusters in Sub-Saharan Africa," *Agriculture and Food Security*. BioMed Central, 6(1), pp. 1–11. doi: 10.1186/s40066-016-0079-z.

Hirvonen, K. *et al.* (2020) "Affordability of the EAT–Lancet reference diet: a global analysis," *The Lancet Global Health*. The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY 4.0 license, 8(1), pp. e59–e66. doi: 10.1016/S2214-109X(19)30447-4.

Hoddinott, J. *et al.* (2013) "The economic rationale for investing in stunting reduction," *Maternal and Child Nutrition*, 9(S2), pp. 69–82. doi: 10.1111/mcn.12080.

Hoffman, J. R. and Falvo, M. J. (2004) "Protein - Which is best?," *Journal of Sports Science and Medicine*, 3(3), pp. 118–130.

Hooshmand, S. (2013) "Dietary Diversity and Nutritional Status of Urban Primary School Children from Iran and India," *Journal of Nutritional Disorders & Therapy*, 03(02), pp. 1–5. doi: 10.4172/2161-0509.s12-001.

Hossain, Sahadat *et al.* (2018) "Nutritional Status and Basic Hygiene Practices of Rural School Age Children of Savar Region, Dhaka, Bangladesh," *Central Asian Journal of Global Health*, 7(1). doi: 10.5195/cajgh.2018.282.

Huang, Z. and Hu, Y. M. (2020) "Dietary patterns and their association with breast milk macronutrient composition among lactating women," *International Breastfeeding Journal*. International Breastfeeding Journal, 15(1), pp. 1–10. doi: 10.1186/s13006-020-00293-w.

Hundie, D. *et al.* (2019) "Assessment on rural poultry production and marketing system of Horro chicken ecotypes in Western Ethiopia," 11(December), pp. 248–259. doi:

10.5897/JAERD2019.1046.

Hunter, D. and Fanzo, J. (2013) Introduction: Agricultural biodiversity, diverse diets and improving nutrition, Diversifying Food and Diets: Using Agricultural Biodiversity to Improve Nutrition and Health. doi: 10.4324/9780203127261.

Huybregts, L. and Lachat, C. (2019) "Drivers of Under-Five Stunting Trend in 14 Low- and Middle-Income Countries since the Turn of the Demographic and Health Surveys," *Nutrients*, 11(10), pp. 1–12. doi: 10.3390/nu11102485.

I.van 't, E. *et al.* (2017) "Overview of Elements within National Food-Based Dietary Guidelines," *European Journal of Nutrition & Food Safety*, 7(1), pp. 1–56. doi: 10.9734/ejnfs/2016/32645.

Iannotti, L. L. *et al.* (2017) "Eggs in early complementary feeding and child growth: A randomized controlled trial," *Pediatrics*, 140(1). doi: 10.1542/peds.2016-3459.

Ihab, A. *et al.* (2014) "The Impact of Animal Source food (ASF) on the Growth of Malnourished Children in Bachok, Kelantan: Randomized Controlled Intervention Trial," *Journal of Nutrition & Food Sciences*, 4(6), pp. 1–6. doi: 10.4172/2155-9600.1000321.

Immink, M. D. C. and Alarcon, J. A. (1993) "Household income, food availability, and commercial crop production by smallholder farmers in the western highlands of Guatemala," *Economic Development & Cultural Change*, 41(2), pp. 319–342. doi: 10.1086/452013.

Institute of Medicine (2000) "Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids." Washington, DC: National Academy Press.

Institute of Medicine (2001) "Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc." Washington, DC: National Academy Press.

International Food Policy Research Institute. (2016) "Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030.," p. 182.

International Food Policy Research Institute (2014) Is There a better way to track nutrition spending? In Global nutrition report 2014: Actions and accountability to accelerate the world's progress on nutrition. *Supplementary Online Material*. Available at: http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/128484/filename/128695.pdf%0Ahttp://dx.doi.org/10.7910/DVN/27857.

Islam, M. S. and Biswas, T. (2020) "Prevalence and correlates of the composite index of anthropometric failure among children under 5 years old in Bangladesh," *Maternal and Child Nutrition*, 16(2), pp. 1–12. doi: 10.1111/mcn.12930.

Jim, F., Garamumhango, P. and Musara, C. (2017) "Comparative analysis of nutritional value of Oreochromis niloticus (Linnaeus), Nile tilapia, meat from three different ecosystems," *Journal of Food Quality*, 2017. doi: 10.1155/2017/6714347.

Johanna T. Wong *et al.* (2018) "Factors influencing animal-source food consumption in Timor-Leste," 10(3), pp. 741–762. Available at: https://link.springer.com/article/10.1007/s12571-018-0804-5.

Johri, M. *et al.* (2016) "Maternal health literacy is associated with early childhood nutritional status

in India," *Journal of Nutrition*, 146(7), pp. 1402–1410. doi: 10.3945/jn.115.226290.

Jorn, O. *et al.* (2010) An Introduction to Epidemiology for Health Professinals. Second Edi. Edited by A. Wolfgang and P. Iris. Springer Science+Business Media, LLC.

Kahsay, M. *et al.* (2018) "Nutritional Status of under Two Years Old Infants in the Pastoral Community of Somali Regional State , Ethiopia : Case of Awbare District," 8(3), pp. 65–71. doi: 10.5923/j.fph.20180803.02.

Kaimila, Y. *et al.* (2019) "Consumption of animal-source protein is associated with improved height-for-age Z scores in rural malawian children aged 12–36 months," *Nutrients*, 11(2), pp. 1–21. doi: 10.3390/nu11020480.

Kang, Y. *et al.* (2017) "Implementation, utilization and influence of a community-based participatory nutrition promotion programme in rural Ethiopia: Programme impact pathway analysis," *Public Health Nutrition*, 20(11), pp. 2004–2015. doi: 10.1017/S1368980017000660.

Kansiime, N. *et al.* (2017) "Effect of Male Involvement on the Nutritional Status of Children Less Than 5 Years: A Cross Sectional Study in a Rural Southwestern District of Uganda," *Journal of Nutrition and Metabolism*, 2017. doi: 10.1155/2017/3427087.

Kaphur, R. (2019) "Australian Studies in School Performance." Available at: https://www.researchgate.net/publication/332875093_Types_of_Literacy.

Kasozi, N. *et al.* (2014) "Proximate composition and mineral contents of Pebbly fish, Alestes baremoze (Joannis, 1835) fillets in relation to fish size," *Uganda Journal of Agricultural Sciences*, 15(1), pp. 41–50.

Keefe, E. B. and Copeland, S. R. (2011) "What is literacy? the power of a definition," *Research and Practice for Persons with Severe Disabilities*, 36(3–4), pp. 92–99. doi: 10.2511/027494811800824507.

Kemkem, L. *et al.* (2015) "Low Dietary Diversity and Intake of Animal Source Foods among School Aged Children in," pp. 1–18. doi: 10.1371/journal.pone.0133435.

Khalid, F. A. *et al.* (2017) "Households' dietary habits and food consumption patterns in Hamishkoreib locality, Kassala State, Sudan," *Journal of Ethnic Foods*. Elsevier Ltd, 4(3), pp. 181–186. doi: 10.1016/j.jef.2017.08.009.

Khalili Tilami, S. and Sampels, S. (2018) *Nutritional Value of Fish: Lipids, Proteins, Vitamins, and Minerals*, *Reviews in Fisheries Science and Aquaculture*. Taylor & Francis. doi: 10.1080/23308249.2017.1399104.

Kim, S. S. *et al.* (2016) "Exposure to large-scale social and behavior change communication interventions is associated with improvements in infant and young child feeding practices in Ethiopia," *PLoS ONE*, 11(10), pp. 1–18. doi: 10.1371/journal.pone.0164800.

Kim, S. S. *et al.* (2019) "Maternal behavioural determinants and livestock ownership are associated with animal source food consumption among young children during fasting in rural Ethiopia," *Maternal and Child Nutrition*, 15(2), pp. 1–9. doi: 10.1111/mcn.12695.

Kountz, D. S. (2009) "Strategies for improving low health literacy," *Postgraduate Medicine*, 121(5), pp. 171–177. doi: 10.3810/pgm.2009.09.2065.

Kovacs-Nolan, J., Phillips, M. and Mine, Y. (2005) "Advances in the value of eggs and egg components for human health," *Journal of Agricultural and Food Chemistry*, 53(22), pp. 8421–8431. doi: 10.1021/jf050964f.

Krasevec, J. *et al.* (2017) "Diet quality and risk of stunting among infants and young children in low- and middle-income countries," *Maternal and Child Nutrition*, 13(December 2016), pp. 1–11. doi: 10.1111/mcn.12430.

Krause, C. *et al.* (2016) "Just a subtle difference? Findings from a systematic review on definitions of nutrition literacy and food literacy," *Health Promotion International*, 33(3), pp. 378–389. doi: 10.1093/heapro/daw084.

Kuang, H. *et al.* (2018) "The Impact of Egg Nutrient Composition and Its Consumption on Cholesterol Homeostasis," *Cholesterol*. Hindawi, 2018. doi: 10.1155/2018/6303810.

Kuche, D. *et al.* (2020) "Factors associated with dietary diversity and length-for-age z-score in rural Ethiopian children aged 6–23 months: A novel approach to the analysis of baseline data from the Sustainable Undernutrition Reduction in Ethiopia evaluation," *Maternal and Child Nutrition*, 16(1), pp. 1–11. doi: 10.1111/mcn.12852.

Kuchenbecker, J. *et al.* (2017) "Nutrition education improves dietary diversity of children 6-23 months at community-level: Results from a cluster randomized controlled trial in Malawi," *PLoS ONE*, 12(4), pp. 1–19. doi: 10.1371/journal.pone.0175216.

Kumera, G., Tsedal, E. and Ayana, M. (2018) "Dietary diversity and associated factors among children of Orthodox Christian mothers/caregivers during the fasting season in Dejen District, North West Ethiopia," *Nutrition and Metabolism*. Nutrition & Metabolism, 15(1), pp. 1–9. doi: 10.1186/s12986-018-0248-0.

Kwami, C. S. *et al.* (2019) "Water, sanitation, and hygiene: Linkages with stunting in rural Ethiopia," *International Journal of Environmental Research and Public Health*, 16(20). doi: 10.3390/ijerph16203793.

de La Peña, C. and Lawrance, B. N. (2011) "Introduction: Traversing the local/global and food/culture divides," *Food and Foodways*, 19(1–2), pp. 1–10. doi: 10.1080/07409710.2011.544156.

Langer, J. A. (1986) "A Sociocognitive Perspective on Literacy," *Educational Resource Information Center*.

Legesse, A. *et al.* (2017) "A Comparative Study on the Physicochemical Parameters of Milk of Camel, Cow and Goat in Somali Regional State, Ethiopia," *Chemical Sciences Journal*, 08(04), pp. 1–5. doi: 10.4172/2150-3494.1000171.

Legesse, G. *et al.* (2010) "Economic performance of small ruminants in mixed-farming systems of Southern Ethiopia," *Tropical Animal Health and Production*, 42(7), pp. 1531–1539. doi: 10.1007/s11250-010-9603-5.

Lemeshow, S. *et al.* (1991) "Adequacy of Sample Size in Health Studies.," *Biometrics*, p. 347. doi: 10.2307/2532527.

Lesnierowski, G. and Stangierski, J. (2018) "What's new in chicken egg research and technology for human health promotion? - A review," *Trends in Food Science and Technology*. Elsevier,

71(May), pp. 46–51. doi: 10.1016/j.tifs.2017.10.022.

Lijalem, T., Beyan, M. and Banerjee, S. (2013) "Meat Consumption Patterns in Hawassa City, Southern Ethiopia," *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS) ISSN (Print) American Scientific Research Journal for Engineering Technology, and Sciences (ASRJETS)*, 3(1), pp. 2313–4410. Available at: http://asrjetsjournal.org/.

M. Krajcovicova-Kudlackova, P. B. *et al.* (2000) "Homocysteine levels in vegetarians versus omnivores," *Annals of Nutrition and Metabolism*, 44, pp. 135–138.

M Chepkemoi, J. *et al.* (2017) "Physical characteristics and nutritional composition of meat and eggs of five poultry species in Kenya," *Livestock Reseatch for Rural Development*, 29(8). Available at: http://www.lrrd.org/lrrd29/8/somm29153.html.

Mackenzie, J. S. and Jeggo, M. (2019) "The one health approach-why is it so important?," *Tropical Medicine and Infectious Disease*, 4(2), pp. 5–8. doi: 10.3390/tropicalmed4020088.

Makamto Sobgui, C. *et al.* (2018) "Predictors of poor nutritional status among children aged 6–24 months in agricultural regions of Mali: a cross-sectional study," *BMC Nutrition*. BMC Nutrition, 4(1), pp. 1–13. doi: 10.1186/s40795-018-0225-z.

Malako, B. G. *et al.* (2019) "Stunting and anemia among children 6-23 months old in Damot Sore district, Southern Ethiopia," *BMC Nutrition*. BMC Nutrition, 5(1), pp. 1–11. doi: 10.1186/s40795-018-0268-1.

Mammo, M., Berhan, T. and Dessie, T. (2008) "Socio-economical contribution and labor allocation of village chicken production of Jamma district, South Wollo, Ethiopia," *Livestock Research for Rural Development*, 10. Available at: http://www.lrrd.org/lrrd20/10/meng20160.htm.

Mango, N. *et al.* (2018) "The role of crop diversification in improving household food security in central Malawi," *Agriculture and Food Security*. BioMed Central, 7(1), pp. 1–10. doi: 10.1186/s40066-018-0160-x.

Mark, W. (1999) *Epidemiology__Study_Design_and_Data_Analysis.pdf*. Edited by C. Chris and V. Z. Jim. New York Washington, D.C.: Chapman & Hall/CRC.

Marques, I., Botelho, G. and Guiné, R. (2019) "Comparative study on nutritional composition of fish available in Portugal," *Nutrition and Food Science*, (September). doi: 10.1108/NFS-11-2018-0311.

Marriott, B. P. *et al.* (2012) "World Health Organization (WHO) infant and young child feeding indicators: Associations with growth measures in 14 low-income countries," *Maternal and Child Nutrition*, 8(3), pp. 354–370. doi: 10.1111/j.1740-8709.2011.00380.x.

Marshall, K. and Ali, Z. (2000) "Gender issues in donkey use in rural Ethiopia," *The Nertheland*, p. 224.

Martin-prevel, Y. *et al.* (2017) "Development of a Dichotomous Indicator for Population-Level Assessment of Dietary Diversity in Women of Reproductive Age," (4), pp. 1–10.

Martorell, R. (2017) "Improved Nutrition in the first 1000 Days and Adult Human Capita and Health," *Physiology & behavior*, 29(2). doi: 10.1016/j.physbeh.2017.03.040.

Mathai, M. *et al.* (2000) "Integrated Management of Pregnancy and Childbirth (IMPAC)- Managing Complications in Pregnancy and Childbirth : A guide for midwives and doctors," *WHO - Department of Reproductive Health*, 00(7), pp. P71, P81, P83.

McKune, S. L. *et al.* (2020) "Behavior change, egg consumption, and child nutrition: A cluster randomized controlled trial," *Pediatrics*, 156(6). doi: 10.1542/peds.2020-007930.

McLean, E. D. *et al.* (2007) "Low Plasma Vitamin B-12 in Kenyan School Children Is Highly Prevalent and Improved by Supplemental Animal Source Foods," *The Journal of Nutrition*, 137(3), pp. 676–682. doi: 10.1093/jn/137.3.676.

McMahon, K. (2016) "Herding Livestock Programs toward Nutrition: A Critical Analysis with a Focus on Rwanda's Feed the Future Dairy Program," (November).

Mejia, C. R. *et al.* (2019) "Association of nutritional status and anemia with multi-micronutrient supplementation in young children in Peru," *Electronic Journal of General Medicine*, 16(5). doi: 10.29333/ejgm/114662.

Mekonnen, N. (2017) "Under Nutrition and its Association With Infant and Young Child Feeding Summary Index Among 6 to 23 Months In Demba Gofa Woreda, Southern Ethiopia," *Journal of Nutritional Health & Food Science*, 5(3), pp. 1–15. doi: 10.15226/jnhfs.2017.00197.

Mekonnen, T. C. *et al.* (2017) "Meal frequency and dietary diversity feeding practices among children 6-23 months of age in Wolaita Sodo town, Southern Ethiopia," *Journal of health, population, and nutrition*. Journal of Health, Population and Nutrition, 36(1), p. 18. doi: 10.1186/s41043-017-0097-x.

Mekuria, G., Wubneh, Y. and Tewabe, T. (2017) "Household dietary diversity and associated factors among residents of finote selam town, north west Ethiopia: a cross sectional study," *BMC Nutrition*. BMC Nutrition, 3(1), pp. 3–8. doi: 10.1186/s40795-017-0148-0.

Melesse, K. and Beyene, F. (2009) "Consumption pattern of milk and milk products in Ada'a woreda, East Shoa Zone, central Ethiopia," *Livestock Research for Rural Development*, 21(4).

Memon, A. *et al.* (2009) "Study on Consumption of Chicken Eggs in Hyderabad District," *Pakistan Journal of Nutrition*, pp. 1480–1485. doi: 10.3923/pjn.2009.1480.1485.

Mgongo, M. *et al.* (2017) "Underweight, stunting and wasting among children in Kilimanjaro region, Tanzania; a population-based cross-sectional study," *International Journal of Environmental Research and Public Health*, 14(5), pp. 1–12. doi: 10.3390/ijerph14050509.

Miller, L. C. *et al.* (2017) "Women's education level amplifies the effects of a livelihoods-based intervention on household wealth, child diet, and child growth in rural Nepal," *International Journal for Equity in Health*. International Journal for Equity in Health, 16(1), pp. 1–17. doi: 10.1186/s12939-017-0681-0.

Ministry of Health-Federal Democratic Republic of Ethiopia (2011) "Training of Trainers Manual for Counseling on Maternal , Infant and Young Child Nutrition," (December). Available at: http://iycn.wpengine.netdna-cdn.com/files/IYCN_MIYCN_Ethiopia_Counseling_TOT_Manual_1211.pdf.

Ministry of Health (2017) "National Guideline for Healthy Diet and Physical Activity. Goverment of Kanya. Nairobi."

Minten, B. and Fantu, B. (2020) Improving the evidence and policies for better performing livestock systems in Ethiopia. Available at: https://livestocklab.ifas.ufl.edu/media/livestocklabifasufledu/pdf-/results-summary/BRIEF-Minten_IFPRI_Evidence-and-Policy-for-better-livestock-systems-_Ethiopia_final-2020_04_11.pdf.

Miranda, J. M. *et al.* (2015) "Egg and egg-derived foods: Effects on human health and use as functional foods," *Nutrients*, 7(1), pp. 706–729. doi: 10.3390/nu7010706.

Mirmiran, P. *et al.* (2002) "Association of educational level and marital status with dietary intake and cardiovascular risk factors in Tehranian adults: Tehran Lipid and Glucose Study (TLGS)," *Nutrition Research*, 22(12), pp. 1365–1375. doi: 10.1016/S0271-5317(02)00440-2.

Misker, D. (2016) "House hold dietary diversity and associated factors in Mirab Abaya wereda Southern Ethiopia 2016; community based cross sectional study," *Diversity & Equality in Health and Care*, 13(4), pp. 293–296. doi: 10.21767/2049-5471.100065.

Mohammed, S. H. *et al.* (2019) "Food taboo among pregnant Ethiopian women: Magnitude, drivers, and association with anemia," *Nutrition Journal*. Nutrition Journal, 18(1), pp. 1–9. doi: 10.1186/s12937-019-0444-4.

Mohammed, S. H., Larijani, B. and Esmaillzadeh, A. (2019) "Concurrent anemia and stunting in young children: Prevalence, dietary and non-dietary associated factors," *Nutrition Journal*. Nutrition Journal, 18(1), pp. 1–10. doi: 10.1186/s12937-019-0436-4.

Mohanty, B. P. *et al.* (2019) "Fish in human health and nutrition," *Advances in fish research*, (January), pp. 189–218. Available at: http://www.researchgate.net/publication/329831003_FISH_IN_HUMAN_HEALTH_AND_NUTRITION%0Ahttps://www.researchgate.net/profile/Bimal_Mohanty/publication/329685486_VOLUME-VII_THEME_CONTEMPORARY_RESEARCH_IN_FISH_BIOLOGY_AND_BIOTECHNOLOGY/links/5c15334d92851c39.

Montagnese, C. *et al.* (2015) "European food-based dietary guidelines: A comparison and update," *Nutrition*, 31(7–8), pp. 908–915.

Moursi, M. M. *et al.* (2008) "Dietary Diversity Is a Good Predictor of the Micronutrient Density of the Diet of 6- to," *The journal of Nutrition*, (September), pp. 0–5. doi: 10.3945/jn.108.093971.promise.

Mtumwa, A. H., Paul, E. and Vuai, S. A. H. (2016) "Determinants of undernutrition among women of reproductive age in Tanzania mainland," *South African Journal of Clinical Nutrition*, 29(2), pp. 75–81. doi: 10.1080/16070658.2016.1216509.

Mukta, U. S. *et al.* (2015) "Identified Factors Behind Low Consumption of Animal Foods among the Children of 6 - 23 Months Old in Alive and Thrive Intervention Areas in Bangladesh," *OALib*, 02(06), pp. 1–15. doi: 10.4236/oalib.1101452.

Mulema, A. and Damtew, E. (2016) "Gender-based constraints and opportunities to agricultural intensification in Ethiopia: A systematic review," (August 2016), p. 36 pages. Available at: https://cgspace.cgiar.org/handle/10568/78212.

Mulualem, D. *et al.* (2016) "The effectiveness of nutrition education: Applying the Health Belief

Model in child-feeding practices to use pulses for complementary feeding in Southern Ethiopia," *Ecology of Food and Nutrition*, 55(3), pp. 308–323. doi: 10.1080/03670244.2016.1161617.

Muluye, S. D., Lemma, T. B. and Diddana, T. Z. (2020) "Effects of Nutrition Education on Improving Knowledge and Practice of Complementary Feeding of Mothers with 6-to 23-Month-Old Children in Daycare Centers in Hawassa Town, Southern Ethiopia: An Institution-Based Randomized Control Trial," *Journal of Nutrition and Metabolism*, 2020. doi: 10.1155/2020/6571583.

Murakami, K. *et al.* (2009) "Education, but not occupation or household income, is positively related to favorable dietary intake patterns in pregnant Japanese women: the Osaka Maternal and Child Health Study," *Nutrition Research*. Elsevier Inc., 29(3), pp. 164–172. doi: 10.1016/j.nutres.2009.02.002.

Murimi, M. W. (2013) "Healthy literacy, nutrition education, and food literacy," *Journal of Nutrition Education and Behavior*. Society for Nutrition Education and Behavior, 45(3), p. 195. doi: 10.1016/j.jneb.2013.03.014.

Murimi, M. W. *et al.* (2017) "Factors Influencing Efficacy of Nutrition Education Interventions: A Systematic Review," *Journal of Nutrition Education and Behavior*. Elsevier Inc., 49(2), pp. 142-165.e1. doi: 10.1016/j.jneb.2016.09.003.

Murimi, M. W. *et al.* (2018) "Factors that contribute to effective nutrition education interventions in children: A systematic review," *Nutrition Reviews*, 76(8), pp. 553–580. doi: 10.1093/nutrit/nuy020.

Murphy, S. P. and Allen, L. H. (2003) "Nutritional Importance of Animal Source Foods," *J. Nutr*, 133, pp. 3965–3971.

National Counsel for Nutrition (2011) "The Norwegian Dietary Guidelines."

Negash, C. *et al.* (2014) "Nutrition education and introduction of broad bean-based complementary food improves knowledge and dietary practices of caregivers and nutritional status of their young children in Hula, Ethiopia," *Food and Nutrition Bulletin*, 35(4), pp. 480–486. doi: 10.1177/156482651403500409.

Negash, C. *et al.* (2015) "Association between maternal and child nutritional status in Hula, rural Southern Ethiopia: A cross sectional study," *PLoS ONE*, 10(11), pp. 1–8. doi: 10.1371/journal.pone.0142301.

Negesse, A. *et al.* (2020) "The impact of being of the female gender for household head on the prevalence of food insecurity in Ethiopia: A systematic-review and meta-analysis," *Public Health Reviews*. Public Health Reviews, 41(1), pp. 1–14. doi: 10.1186/s40985-020-00131-8.

Neuhauser, L., Rothschild, R. and Rodríguez, F. M. (2007) "MyPyramid.gov: Assessment of Literacy, Cultural and Linguistic Factors in the USDA Food Pyramid Web Site," *Journal of Nutrition Education and Behavior*, 39(4), pp. 219–225. doi: 10.1016/j.jneb.2007.03.005.

Neumann, C. G. *et al.* (2007) "Meat Supplementation Improves Growth, Cognitive, and Behavioral Outcomes in Kenyan Children," *The Journal of Nutrition*, 137(4), pp. 1119–1123. doi: 10.1093/jn/137.4.1119.

Neumann, C., Harris, D. M. and Rogers, L. M. (2002) "Contribution of animal source foods in improving diet quality and function in children in the developing world," *Nutrition Research*.

Elsevier Science Inc., 22(1–2), pp. 193–220. doi: 10.1016/S0271-5317(01)00374-8.

Nguyen, P. H. *et al.* (2013) "Maternal and Child Dietary Diversity Are Associated in Bangladesh, Vietnam, and Ethiopia," *The Journal of Nutrition*, 143(7), pp. 1176–1183. doi: 10.3945/jn.112.172247.

Njinkoue, J. M. *et al.* (2016) "Proximate composition, mineral content and fatty acid profile of two marine fishes from Cameroonian coast: Pseudotolithus typus (Bleeker, 1863) and Pseudotolithus elongatus (Bowdich, 1825)," *NFS Journal*. Elsevier B.V., 4, pp. 27–31. doi: 10.1016/j.nfs.2016.07.002.

Nutbeam, D. (2000) "Health literacy as a public health goal: A challenge for contemporary health education and communication strategies into the 21st century," *Health Promotion International*, 15(3), pp. 259–267. doi: 10.1093/heapro/15.3.259.

Nyikahadzoi, K. *et al.* (2017) "Promoting production and marketing of root crops in Southern Africa in a changing climate using integrated agricultural research for development (IAR4D) pathway," *African Journal of Food, Agriculture, Nutrition and Development*, 17(1), pp. 11787–11802. doi: 10.18697/ajfand.77.13765.

Obiero, K. *et al.* (2019) "The contribution of fish to food and nutrition security in Eastern Africa: Emerging trends and future outlooks," *Sustainability (Switzerland)*, 11(6), pp. 1–15. doi: 10.3390/su11061636.

Olson, C. M. (2005) "Food Insecurity in Women," *Topics in Clinical Nutrition*, 20(4), pp. 321–328. doi: 10.1097/00008486-200510000-00005.

Omer, A. *et al.* (2018) "A Community Poultry Intervention to Promote Egg and Eggshell Powder Consumption by Young Children in Halaba Special Woreda, SNNPR, Ethiopia," *Journal of Agricultural Science*, 10(5), p. 1. doi: 10.5539/jas.v10n5p1.

Onyenweaku, E. O. *et al.* (2018) "Comparison of Nutritional Composition of Bird Egg Varieties Found in Southern Nigeria: A Preliminary Study," *Food and Nutrition Sciences*, 09(07), pp. 868–879. doi: 10.4236/fns.2018.97065.

Orsango, A. Z. *et al.* (2021) "Co-morbid anaemia and stunting among children 2 – 5 years old in southern Ethiopia : a community-based sectional study," *BMJ Pediatrics Open*, 2021(5), pp. 1–13. doi: 10.1136/bmjpo-2021-001039.

Osman, H., Suriah, A. . and Law, E. . (no date) "Fatty acid composition and cholesterol content of selected marine fish in Malaysian waters." Available at: https://doi.org/10.1016/S0308-8146(00)00277-6Get rights and content.

Pachón, H. *et al.* (2007) "Constraints on the delivery of animal-source foods to infants and young children: Case studies from five countries," *Food and Nutrition Bulletin*, 28(2), pp. 215–220. doi: 10.1177/156482650702800211.

Park, Y. W. (2006) Goat milk–chemistry and nutrition. Blackwell Publishing Professional, Oxford, UK/Ames, Iowa.

Pereira, P. and Vicente, A. (2013) "Meat nutritional composition and nutritive role in the human diet," *Meat Science*, 93(3), pp. 586–592.

Prendergast, A. J. and Humphrey, J. H. (2014) "The stunting syndrome in developing countries," *Paediatrics and International Child Health*, 34(4), pp. 250–265. doi: 10.1179/2046905514Y.0000000158.

Rah, J. H. *et al.* (2010) "Low dietary diversity is a predictor of child stunting in rural Bangladesh," *European Journal of Clinical Nutrition*. Nature Publishing Group, 64(12), pp. 1393–1398. doi: 10.1038/ejcn.2010.171.

Rah, J. H. *et al.* (2015) "Household sanitation and personal hygiene practices are associated with child stunting in rural India: A cross-sectional analysis of surveys," *BMJ Open*, 5(2). doi: 10.1136/bmjopen-2014-005180.

Rahman, SMR., Hashan, S., Shahjahan, MD. and Islam, S. (2001) "Ownership of livestock and land size.pdf," *Online Journal of Biological Sciences*, 1(10), pp. 960–962.

Rahman, M. *et al.* (1993) "Maternal Nutritional Status as a Determinant of Child Health," *Journal of Tropical Pediatrics*, 39(2), pp. 86–88. Available at: https://doi.org/10.1093/tropej/39.2.86.

Ramakrishnan, U. *et al.* (1999) "Role of Intergenerational Effects on Linear Growth," *The Journal of Nutrition*, 129(2), pp. 544S-549S. doi: 10.1093/jn/129.2.544s.

Rashid, A. G. *et al.* (2018) "06|Effect of Nutrition Education Intervention on Knowledge Attitude and Practice of Mothers/caregivers on Infant and Young Child Feeding in Shabelle (Gode) Zone, Somali Region, Eastern Ethiopia," *Revelation and Science*, 8(1).

Rathnayake, K. M., Madushani, P. and Silva, K. (2012) "Use of dietary diversity score as a proxy indicator of nutrient adequacy of rural elderly people in Sri Lanka," *BMC Research Notes*, 5, pp. 2–7. doi: 10.1186/1756-0500-5-469.

Read, S. (1987) "Current definitions of Literacy," *Journal of Reading*, 30(5), pp. 458–461.

Réhault-Godbert, S., Guyot, N. and Nys, Y. (2019) "The golden egg: Nutritional value, bioactivities, and emerging benefits for human health," *Nutrients*, 11(3), pp. 1–26. doi: 10.3390/nu11030684.

Reinhardt, K. and Fanzo, J. (2016) "Addressing chronic malnutrition through multi-sectoral, sustainable approaches: A review of causes and consequences," *World Review of Nutrition and Dietetics*, 114(August), pp. 120–121. doi: 10.1159/000441823.

Reta, D. (2009) "Understanding the role of indigenous chickens during the long walk to food security in Ethiopia," *Livestock Research for Rural Development*, 21(8).

Ritchie, H. and Roser, M. (2020) *Age Structure*. OurWorldInData.org. Available at: https://ourworldindata.org/age-structure.

Roberts, P. (2005) "A framework for analysing definitions of literacy," *Educational Studies*, 31(1), pp. 29–38. doi: 10.1080/0305569042000310949.

Roe, M. *et al.* (2013) "Nutrient Analysis of Eggs," *Department of Health*, pp. 1–44. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/167973/Nutrient_analysis_of_eggs_Analytical_Report.pdf.

Rubhara, T. T. *et al.* (2020) "Impacts of cash crop production on household food security for

smallholder farmers: A case of shamva district, zimbabwe," *Agriculture (Switzerland)*, 10(5). doi: 10.3390/agriculture10050188.

Rutterford, C., Copas, A. and Eldridge, S. (2015) "Methods for sample size determination in cluster randomized trials," *International Journal of Epidemiology*, 44(3), pp. 1051–1067. doi: 10.1093/ije/dyv113.

Sanders, L. M. *et al.* (2009) "Health literacy and child health promotion: Implications for research, clinical care, and public policy," *Pediatrics*, 124(SUPPL. 3). doi: 10.1542/peds.2009-1162G.

Sani, S. and Kemaw, B. (2019) "Analysis of households food insecurity and its coping mechanisms in Western Ethiopia," *Agricultural and Food Economics*. Agricultural and Food Economics, 7(1). doi: 10.1186/s40100-019-0124-x.

Savy, M. *et al.* (2006) "Dietary Diversity Scores and Nutritional Status of Women Change during the Seasonal Food Shortage in Rural Burkina Faso," *The Journal of Nutrition*, 136(10), pp. 2625–2632. doi: 10.1093/jn/136.10.2625.

Schmid, A. and Walther, B. (2013) "Natural vitamin D content in animal products," *Advances in Nutrition*, 4(4), pp. 453–462. doi: 10.3945/an.113.003780.

Schönfeldt, H. C., Pretorius, B. and Hall, N. (2013) "The impact of animal source food products on human nutrition and health," *South African Journal of Animal Sciences*, 43(3), pp. 394–412. doi: 10.4314/sajas.v43i3.11.

Schönfeldt, H. C., Pretorius, B. and Hall, N. (2015) "Bioavailability of Nutrients," *Encyclopedia of Food and Health*, (January 2019), pp. 401–406. doi: 10.1016/B978-0-12-384947-2.00068-4.

Seleshe, S., Jo, C. and Lee, M. (2014) "Meat Consumption Culture in Ethiopia," *Korean Journal of Food Science of Animal Resources*, 34(1), pp. 7–13. doi: http://dx.doi.org/10.5851/kosfa.2014.34.1.7.

Shehawy, S. M. El, Gab-Alla, A. A. and Mutwally, H. M. A. (2016) "Proximate and Elemental Composition of Important Fish Species in Makkah Central Fish Market, Saudi Arabia," *Food and Nutrition Sciences*, 07(06), pp. 429–439. doi: 10.4236/fns.2016.76044.

Silk, K. J. *et al.* (2008) "Increasing Nutrition Literacy: Testing the Effectiveness of Print, Web site, and Game Modalities," *Journal of Nutrition Education and Behavior*, 40(1), pp. 3–10. doi: 10.1016/j.jneb.2007.08.012.

Sirajuddin *et al.* (2021) "The intervention of maternal nutrition literacy has the potential to prevent childhood stunting: Randomized control trials," *Journal of Public Health Research*, 10(2), pp. 365–369. doi: 10.4081/jphr.2021.2235.

Smith, J. *et al.* (2013) "Beyond milk, meat, and eggs: Role of livestock in food and nutrition security," *Animal Frontiers*, 3(1), pp. 6–13. doi: 10.2527/af.2013-0002.

Smith, K. (2014) "What's the Difference Between Eggs From Different Poultry?" Available at: https://www.backyardchickencoops.com.au/blogs/learning-centre/whats-the-difference-between-eggs-from-different-poultry.

Soliman, G. Z. A. (2005) "Comparison Of Chemical And Mineral Content Of Milk From Human, Cow, Buffalo, Camel And Goat In Egypt.," *Egyptian Journal of Hospital Medicine*, 21(December),

pp. 116–130.

Solomon, D., Aderaw, Z. and Tegegne, T. K. (2017) "Minimum dietary diversity and associated factors among children aged 6-23 months in Addis Ababa, Ethiopia," *International Journal for Equity in Health*. International Journal for Equity in Health, 16(1), pp. 1–9. doi: 10.1186/s12939-017-0680-1.

Sørensen, K. *et al.* (2012) "Health literacy and public health: A systematic review and integration of definitions and models," *BMC Public Health*. BioMed Central Ltd, 12(1), p. 80. doi: 10.1186/1471-2458-12-80.

Spronk, I. *et al.* (2014) "Relationship between nutrition knowledge and dietary intake," *British Journal of Nutrition*, 111(10), pp. 1713–1726. doi: 10.1017/S0007114514000087.

Streeter, J. L. (2017) "Socioeconomic Factors Affecting Food Consumption and Nutrition in China: Empirical Evidence During the 1989–2009 Period," *Chinese Economy*. Taylor & Francis, 50(3), pp. 168–192. doi: 10.1080/10971475.2017.1297653.

Stuart, T. H. (1991) Problem identification and needs analysis for nutrition information, education and communication. In Valbuen. Singapore, Asian Mass Communication Research and Information Center (AMIC).

Stuart, T. H. and Achterberg, C. (2018) "Education and communication strategies for different groups and settings." Available at: http://www.fao.org/3/W3733E/w3733e04.htm.

Taddese, Z., Larson, C. P. and Hanley, J. A. (no date) "status of Oromo women of childbearing age in rural south western Ethiopia," pp. 1–8.

Tariku, B. *et al.* (2015) "Application of the Health Belief Model to Teach Complementary Feeding Messages in Ethiopia," *Ecology of Food and Nutrition*, 54(5), pp. 572–582. doi: 10.1080/03670244.2015.1049344.

Taylor, M. K. *et al.* (2019) "Nutrition literacy predicts adherence to healthy/unhealthy diet patterns in adults with a nutrition-related chronic condition," *Public Health Nutrtion*, 22(12), pp. 2157–2169. doi: 10.1017/S1368980019001289.Nutrition.

Tee, E. S. (2015) "Food-based dietary guidelines of southeast Asia: An analysis of key messages," *Journal of Nutritional Science and Vitaminology*, 61, p. S214. doi: 10.3177/jnsv.61.S214.

Tegegne, M. *et al.* (2017) "Factors associated with minimal meal frequency and dietary diversity practices among infants and young children in the predominantly agrarian society of Bale zone, Southeast Ethiopia: A community based cross sectional study," *Archives of Public Health*. Archives of Public Health, 75(1), pp. 1–11. doi: 10.1186/s13690-017-0216-6.

Temesgen, H., Yeneabat, T. and Teshome, M. (2018) "Dietary diversity and associated factors among children aged 6–23 months in Sinan Woreda, Northwest Ethiopia: a cross-sectional study," *BMC Nutrition*. BMC Nutrition, 4(1), pp. 1–8. doi: 10.1186/s40795-018-0214-2.

Teo, C. G. (2010) "Much meat, much malady: Changing perceptions of the epidemiology of hepatitis E," *Clinical Microbiology and Infection*. European Society of Clinical Infectious Diseases, 16(1), pp. 24–32. doi: 10.1111/j.1469-0691.2009.03111.x.

Teshome, G. B. *et al.* (2020) "Scaled-up nutrition education on pulse-cereal complementary food

practice in Ethiopia: A cluster-randomized trial," *BMC Public Health*. BMC Public Health, 20(1), pp. 1–12. doi: 10.1186/s12889-020-09262-8.

Tigga, P. L. and Sen, J. (2016) " Maternal Body Mass Index Is Strongly Associated with Children Z -Scores for Height and BMI ," *Journal of Anthropology*, 2016, pp. 1–10. doi: 10.1155/2016/6538235.

Tikuye, H. H. *et al.* (2019) "Prevalence and Factors Associated with Undernutrition among Exclusively Breastfeeding Women in Arba Minch Zuria District, Southern Ethiopia: A Cross-sectional Community-Based Study," *Ethiopian journal of health sciences*, 29(1), pp. 913–922. doi: 10.4314/ejhs.v29i1.13.

Tran, T. A. *et al.* (2020) "The role of education in the livelihood of households in the Northwest region, Vietnam," *Educational Research for Policy and Practice*. Springer Singapore, 19(1), pp. 63–88. doi: 10.1007/s10671-018-9242-6.

Tran, T. D. *et al.* (2019) "Co-morbid anaemia and stunting among children of pre-school age in low- and middle-income countries: A syndemic," *Public Health Nutrition*, 22(1), pp. 35–43. doi: 10.1017/S136898001800232X.

Truman, E., Bischoff, M. and Elliott, C. (2020) "Which literacy for health promotion: Health, food, nutrition or media?," *Health Promotion International*, 35(2), pp. 432–444. doi: 10.1093/HEAPRO/DAZ007.

UN (2010) "Progress in Nutriti N," *United Nations Administrative Committee on Coordination/Standing Committee on Nutrition*, pp. 1–131.

UNDP (2012) "The Nutrition Challenge in Sub-Saharan Africa," (January).

UNICEF/WHO/World Bank (2017) "Levels and Trends in Child Mannutrition." doi: 10.1042/cs0470143.

Unicef, E. union (2015) "Multi-sectoral Approaches to Nutrition :," pp. 1–4. Available at: www.who.int.

UNICEF and WHO (2018) Capture the Moment – Early initiation of breastfeeding: The best start for every newborn., *Unicef*. Available at: https://data.unicef.org/topic/nutrition/infant-and-young-child-feeding/%0Ahttps://www.unicef.org/publications/files/UNICEF_WHO_Capture_the_moment_EIBF_2018.pdf.

United Nations Children's Fund (1991) "Strategy for improved nutrition of children and women in developing countries," *Indian Journal of Pediatrics*, 58(1), pp. 13–24.

United Nations Children's Fund (UNICEF), W. H. O. & T. I. B. for R. and D. W. B. (2019) Levels and trends in child malnutrition: key findings of the 2019 Edition of the Joint Child Malnutrition Estimates. Geneva. Available at: http://www.unicef.org/media/files/JME_2015_edition_Sept_2015.pdf.

USAID (2014) "Multi-Sectoral Nutrition Strategy," Multi-Sectoral Nutrition Strategy *2014-2025*, p. 11. Available at: https://www.usaid.gov/sites/default/files/documents/1867/USAID_Nutrition_Strategy_5-09_508.pdf.

USDA (2015) “Dietary Guidelines for Americans 2015-2020.”

USDA (2018) “National Nutrient Database for Standard Reference Release 28 slightly revised May , 2016:Food Group : Dairy and Egg Products Carbohydrate_USDA. (2018). National Nutrient Database for Standard Reference Release 28 slightly revised May , 2016:Food Group : D.” Available at: http://www.ovosbrasil.com.br/site/wp-content/uploads/2016/07/composicao-quimica-ovo.pdf.

Valette, D. (2015) Invisible Workers. The Economic Contributions of Working Donkeys, Horses and Mules to Livelihoods, *The Brooke*. doi: 10.1177/001139287035003004.

Velardo, S. (2015) “The Nuances of Health Literacy, Nutrition Literacy, and Food Literacy,” *Journal of Nutrition Education and Behavior*. Elsevier Inc., 47(4), pp. 385-389.e1. doi: 10.1016/j.jneb.2015.04.328.

Vettori, V. *et al.* (2019) “Towards the implementation of a conceptual framework of food and nutrition literacy: Providing healthy eating for the population,” *International Journal of Environmental Research and Public Health*, 16(24). doi: 10.3390/ijerph16245041.

Victora, C. G. *et al.* (2010) “Worldwide timing of growth faltering: Revisiting implications for interventions,” *Pediatrics*, 125(3). doi: 10.1542/peds.2009-1519.

Vidgen, H. A. and Gallegos, D. (2014) “Defining food literacy and its components,” *Appetite*. Elsevier Ltd, 76, pp. 50–59. doi: 10.1016/j.appet.2014.01.010.

Vieira, S. L. (2007) “Chicken embryo utilization of egg micronutrients,” *Revista Brasileira de Ciencia Avicola*, 9(1), pp. 1–8. doi: 10.1590/S1516-635X2007000100001.

Vijverberg, J. *et al.* (2012) “The composition of fish communities of nine Ethiopian lakes along a north-south gradient: Threats and possible solutions,” *Animal Biology*, 62(3), pp. 315–335. doi: 10.1163/157075611X618246.

Visioli, F. and Strata, A. (2014) “Milk, Dairy Products, and Their Functional Effects in Humans: A Narrative Review of Recent Evidence,” *Advances in Nutrition*, 5(2), pp. 131–143. doi: 10.3945/an.113.005025.

Wang, J. *et al.* (2017) “Nutritional modulation of health, egg quality and environmental pollution of the layers,” *Animal Nutrition*. Elsevier Ltd, 3(2), pp. 91–96. doi: 10.1016/j.aninu.2017.03.001.

Watson, W. L. *et al.* (2013) “How well do Australian shoppers understand energy terms on food labels?,” *Public Health Nutrition*, 16(3), pp. 409–417. doi: 10.1017/S1368980012000900.

Weldehaweria, N. B. *et al.* (2016) “Dietary diversity and related factors among lactating women visiting public health facilities in Aksum town, Tigray, Northern Ethiopia,” *BMC Nutrition*. BMC Nutrition, 2(1), pp. 1–9. doi: 10.1186/s40795-016-0077-3.

Whaley, S. E. *et al.* (2003a) “Animal Source Foods and Human Health during Evolution,” *J. Nutr*, 133, pp. 3965–3971.

Whaley, S. E. *et al.* (2003b) “Providing Micronutrients through Food-Based Solutions: A Key to Human and National Development,” *J. Nutr*, 133, pp. 3965–3971.

Who (2007) “Indicators for assessing infant and young child feeding practices,” *World Health*

Organization, 2007(November), pp. 1–19. doi: ISBN 978 92 4 159975 7.

WHO (2003) "Food based dietary guidelines in the WHO European Region Nutrition and Food Security Programme WHO Regional Office for Europe Scherfigsvej 8, 2100 Copenhagen Denmark." Available at: http://apps.who.int/iris/bitstream/10665/107490/1/E79832.pdf.

Wikipedia (no date a) "Arsi Negele (woreda)."

Wikipedia (no date b) "Dale (woreda)." Available at: https://en.wikipedia.org/wiki/Dale_(woreda).

Wikipedia (no date c) "Irgalem." Available at: https://en.wikipedia.org/wiki/Irgalem.

Wikipedia (no date d) "Wondo Genet." Available at: https://en.wikipedia.org/wiki/Wondo_Genet.

Wikipedia (no date e) "Wondo Genet (woreda)." Available at: https://en.wikipedia.org/wiki/Negele_Arsi.

Włodarski, K. H., Brodzikowska, A. and Kuzaka, B. (2014) "Characteristics of Egg Parts, Chemical Composition and Nutritive Value of Japanese Quail Eggs – a Review," *Folia Biologica (Kraków)*, 62(2), pp. 135–142. doi: 10.3409/fb62.

Wodajo, H. D. *et al.* (2020) "Contribution of small ruminants to food security for Ethiopian smallholder farmers," *Small Ruminant Research*. Elsevier, 184(February), p. 106064. doi: 10.1016/j.smallrumres.2020.106064.

Wordofa, M. G. and Sassi, M. (2020) "Impact of agricultural interventions on food and nutrition security in Ethiopia: Uncovering pathways linking agriculture to improved nutrition," *Cogent Food & Agriculture*. Cogent, 6(1), p. 1724386. doi: 10.1080/23311932.2020.1724386.

Workicho, A. *et al.* (2016) "Household dietary diversity and Animal Source Food consumption in Ethiopia: Evidence from the 2011 Welfare Monitoring Survey," *BMC Public Health*. BMC Public Health, 16(1), pp. 1–11. doi: 10.1186/s12889-016-3861-8.

World Health (2012) "Interpretation Guide," *Nutrition Landacape Information System (NLIS)*, pp. 1–51. doi: 10.1159/000362780.Interpretation.

World Health Organization. Nutrition Unit, Food and Agriculture Organization of the United Nations and International Conference on Nutrition (1992) "Nutrition and development : a global assessment." Rome, Italy: World Health Organization.

World Health Organization (2003) "Infant and Young Child Feeding A tool for assessing national practices ," p. 158.

World Health Organization (2012) Regional Consultation on Food-Based Dietary Guidelines for countries in the Asia Region. Available at: https://apps.who.int/iris/handle/10665/205756.

World Health Organization (2013a) "Essential Nutrition Actions: Improving Maternal, Newborn, Infant and Young Child Health and Nutrition." Geneva 27, Switzerland. Available at: https://apps.who.int/iris/bitstream/handle/10665/84409/9789241505550_eng.pdf?sequence=1&isAllowed=y.

World Health Organization (2013b) Infant and Young Child Feeding, IAP Textbook of Pediatrics. doi: 10.5005/jp/books/11894_132.

World Health Organization (2015) “Improving nutrition outcomes with better water, sanitation and hygiene: Practical Solutions for Policies and Programs.”

World Health Organization (2019) “Children: reducing mortality.” Available at: https://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality#_ftnref1.

Wuneh, A. G. *et al.* (2019) “Dietary Diversity and Meal Frequency Practices among Children Aged 6-23 Months in Agro Pastoral Communities in Afar Region, Ethiopia: A Cross-sectional Study,” *Ecology of Food and Nutrition*. Routledge, 58(6), pp. 575–596. doi: 10.1080/03670244.2019.1644328.

Yadgary, L. *et al.* (2010) “Yolk sac nutrient composition and fat uptake in late-term embryos in eggs from young and old broiler breeder hens,” *Poultry Science*, 89(11), pp. 2441–2452. doi: 10.3382/ps.2010-00681.

Yalçin, S and Yalçin, Suzan (2013) “Poultry eggs and child health–a review,” *Lohmann Information*, 48(1), pp. 3–14.

Yibrah, T. and Esheti, A. (2017) “Assessment of Meat Consumption Pattern in Mirab Abaya Woreda, Southern Ethiopia,” *Archives on Veterinary Science and Technology*, AVST-128.

Yoganandi, J. *et al.* (2014) “Evaluation and comparison of camel milk with cow milk and buffalo milk for gross composition,” *Journal of Camel Practice and Research*, 21(2), pp. 259–265. doi: 10.5958/2277-8934.2014.00046.0.

Zahraddeen *et al.* (2007) “Evaluation of some factors affecting milk composition of indigenous goats in Nigeria,” *Livestock Research for Rural Development*, 19(11). Available at: http://www.lrrd.org/lrrd19/11/zahr19166.htm.

Zakaria, H. (2017) “The drivers of women farmers’ participation in cash crop production: the case of women smallholder farmers in Northern Ghana,” *Journal of Agricultural Education and Extension*. Taylor & Francis, 23(2), pp. 141–158. doi: 10.1080/1389224X.2016.1259115.

Zelalem, A. *et al.* (2019) “The prevalence and antimicrobial resistance profiles of bacterial isolates from meat and meat products in Ethiopia : a systematic review and meta-analysis.” International Journal of Food Contamination, pp. 1–14.

Zerfu, T. A., Umeta, M. and Baye, K. (2016) “Dietary diversity during pregnancy is associated with reduced risk of maternal anemia, preterm delivery, and low birth weight in a prospective cohort study in rural Ethiopia,” *American Journal of Clinical Nutrition*, 103(6), pp. 1482–1488. doi: 10.3945/ajcn.115.116798.

Zhang, J. and Kang, H. (2016) “A Prevalence Analysis to Assess the Relationship between Maternal and Children’s Nutritional Status in North-Western Rural China,” *Clinics in Mother and Child Health*, 13(2). doi: 10.4172/2090-7214.1000242.

Zongrone, A. A. *et al.* (2018) “The pathways from a behavior change communication intervention to infant and young child feeding in Bangladesh are mediated and potentiated by maternal self-efficacy,” *Journal of Nutrition*, 148(2), pp. 259–266. doi: 10.1093/JN/NXX048.

ID:_____

Annex

Annex-I: POLICY BRIEF

Animal Source Foods: Consumption Patterns and its Drivers in Rural Districts of Ethiopia, and Ways Forward

This policy brief describes drivers of dietary quality in view of the inclusion of animal source foods (ASF) in diets consumed by lactating mothers and infant and young children. It has also considered results from household level animal source foods consumption frequency assessment.

Key Message

- Undernutrition as measured by BMI and MUAC for mothers and by height for age and weight for age for 6-23 months old children is a medium level public health significant problem of lactating mothers and infant and young children in rural districts of Ethiopia.
- The majority of lactating mothers and infant and young children did not meet the minimum dietary diversity
- Households did not consume animal source foods on a regular bases
- Animal source foods were not included in the diet of majority of the lactating mothers and infant and young children
- Animal source foods' unavailability, unaffordability, high price as compared to plant based food products and limited consumption tradition are the constraints to the consumption of ASF.
- Religion and related fasting does not affect the consumption of ASF.
- Land size, household food insecurity, livestock ownership, crop production, less income, family size, maternal educational status and maternal occupation are also derivers of ASF consumption at household level, by lactating mothers and by infant and young children.
- A low health literacy approach nutrition education intervention improved dietary diversity and the consumption of ASF by lactating mother and infant and young children. Weight for height and weight for age of children also improved after the nutrition education intervention. Nutritional status of the children also improved
- Policy should aim on nutrition education interventions focused on the need for inclusion of ASF in diversified diets integrated with multispectral activities to improve livelihoods communities in rural settings of Ethiopia.

Introduction

Women and children are vulnerable to undernutrition as compared to the general population. Following the first day of pregnancy, the first 1000days are critical both for the women later to be a mother and to the conceptus later to be a child. The period ranges from the first day of pregnancy to the second birth day of a child. Out of the critical 1000days, the last 550 days are the third longest season next to period for pregnancy (270 days) and period for exclusive breast feeding (180 days). It is also considered as a window of opportunity during which nutrition failures happened before can be corrected. This is a period during which lactating mothers has to get additional diversified meals including animal source foods (ASF), keep a healthy nutritional status and continue breastfeeding their babies. It is also a period in which infant and young children have to start and continue consumption of diversified complementary food including ASF so that they grow and develop to their full potential. Animal source foods are important segments of a diversified diet. They are good sources of quality macro- and micro-nutrients. They provide complete protein that contains all of the essential amino acids, zinc, iron, calcium, selenium, vitamin A, vitamin B_{12} and vitamin D, which are important for bone health and growth, healthy blood cell production, immunity, neurological function and behavioral outcomes. Moreover, addition of small quantities of ASF in a diet can improve the nutritional performance of plant-based diets and nutritional status of the consumers. Despite the evidence on the dietary diversity of women and children, understandings about ASF consumption patterns by households, infant and young children and lactating mothers and its drivers are limited. Based on information of a research result from Dale and Wondo Genet (Sidama Region) and Arsinegelle (Oromia Region) districts (Woreda) of Ethiopia, this policy brief looks at consumption of ASF by households (n=422), by infant and young children (n=605) and by lactating mothers (n=606) and its drivers.

Consumption of ASFs by Households, Lactating Mothers and Infant and Young Children

Almost all mothers consumed ≤4 meals/day (92.1%) and from ≤4 food groups (90%). Dairy was consumed by 28%, eggs by 5% and meat, poultry and fish by 5% of the lactating mothers (**Figure 10**). Only 16% of infant and young children met MDD. Dairy was consumed by 41.2%, eggs by 16% and meat by about 2% of the infant and young children (**Figure 11**).

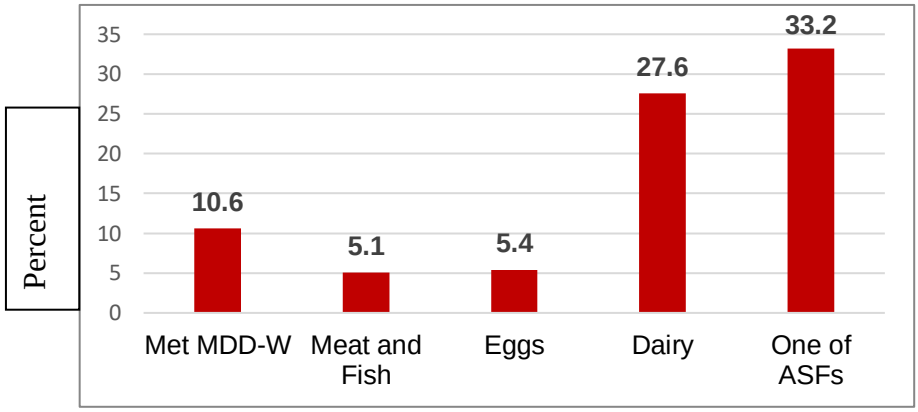

Figure 10 Proportion of lactating mothers who met minimum dietary diversity of women (MDD-w) and consumed ASFs based on 24 hours consumption recall (n=606)

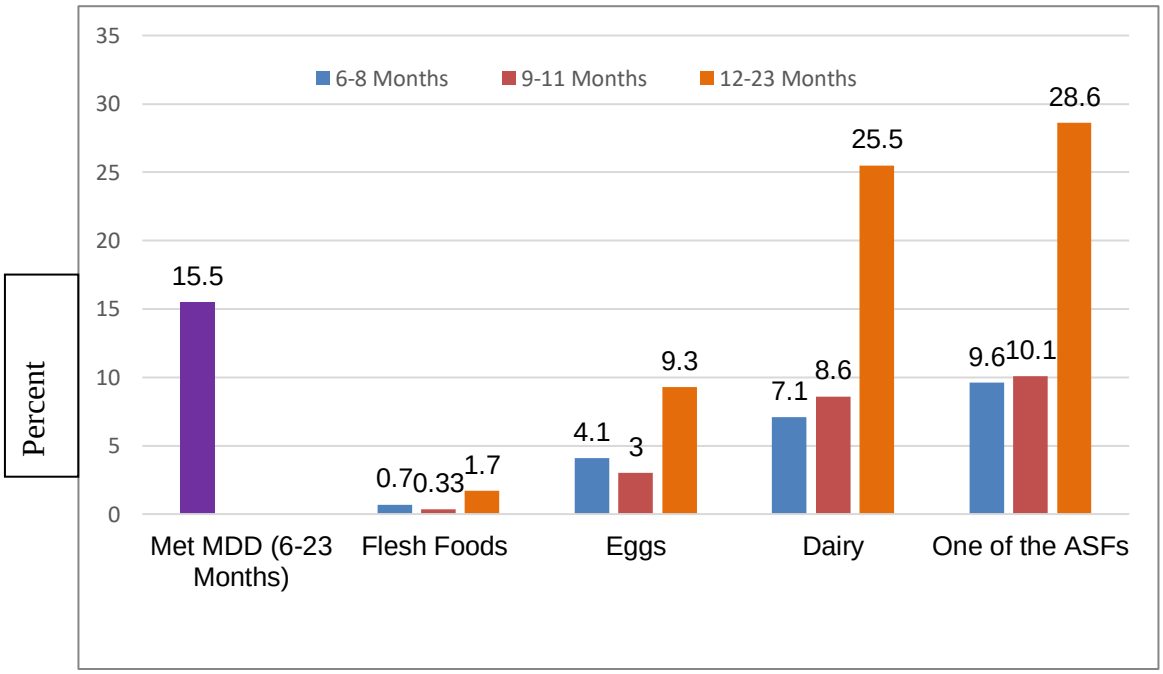

Figure 11 Proportion of infant and young children who met minimum dietary diversity (MDD) and consumed ASFs based on 24 hours consumption recall (n=605)

Meat from sheep or lamb, goat, beef or cattle and other large animals was consumed 1-2 times in a month by 26% of the households. Milk was consumed by less than one quarter of the households once in a day (21%) and by a quarter (26%) 1-2 times in a week. Milk products like yogurt, cheese, whey and others were consumed 1-2 times in a month by 15% of the households. Eggs were consumed 1-2 times in a week and 1-2 times in a month by 20% and 19% of households, respectively (**Figure 12**).

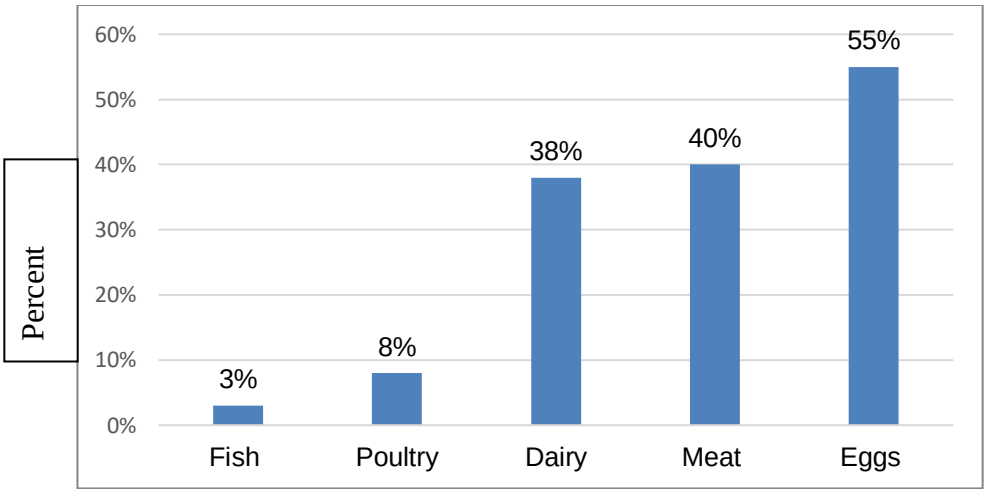

Figure 12 Proportion of Households ASFs (Eggs, Meat, Milk, Poultry and Fish) in a Month Period, Ethiopia (n=422)

Drivers of Consumption of Animal Source Foods

Animal source foods' unavailability, unaffordability, limited consumption tradition, income generation priority from livestock rearing and high price of ASF as compared to plant-based foods were constraints identified to the consumption of ASF. Meat and fish were reported of being unavailable where the respondents usually shop their food commodities. Price for all types of the studied (dairy, eggs, meat and fish) ASF was reported of being higher than pant-based food.

On the other hand, religion and related fasting practices were not reported to constrain the consumption of ASF. Perception about nutritional quality and health benefit of ASF were among the facilitators. Lack of storage facility and cooking difficulties were not also reported to constrain ASF consumption. In the area, consumption of ASF was reported to be common during holidays and whenever there are ceremonies.

Household food insecurity negatively affected consumption of all types of ASF (dairy, eggs and meat) at household level, by the lactating mothers and by infant and young children. All forms of ASF we less likely to be frequently consumed by food insecure households. Lactating mothers and infant and young children lived in food insecure households were less likely to consume ASF than mothers and children lived in food secure households.

Household income was another factor that determined consumption of ASF by households, mothers and children. Households with lower category income, less than 5000 Ethiopian Birr (ETB) estimated annual income, were found to consume meat less frequently than households with higher category income, above 30,000ETB. Children lived in households with lower category income were less likely to consume dairy, and mother were less likely to consume at least one of the ASF than children and mothers lived in households with higher category estimated annual income.

Family size contributed to household level ASFs consumption frequency. Household with more family size were likely to have poultry and meat less frequently than households with less family size. Land size owned by households determined dairy consumption frequency. Households those owned more land size were more likely to consume dairy frequently.

Livestock contributes to the consumption of ASF directly by providing ASF or indirectly increasing income. Similarly, cow ownership increased dairy consumption at household level, by lactating mothers and by children. Donkey ownership amplified dairy consumption by children and household level poultry, meat and egg consumption frequency. Children lived in households that owned chicken were more likely to consumed eggs than children lived in households that did not own chicken.

Consumption of ASF was also determined by maternal educational status and occupation. Eggs were less frequently consumed by households with mother who never attended formal education. The chance to consume at least one of the ASF was lower for children from mother who never attended school and too for the mothers themselves. Merchant mothers were with more chance of ASF consumption than housemakers.

In addition, crop production practices were observed to have connection with the consumption of ASF. Cash crop producing households and mothers lived in cash crop producing households had more chance of meat consumption than their counter parts. Mother and children lived in root crop producing households consumed eggs more than mothers and children lived in households that did not produce root crops.

Nutritional Status of Infant and Young Children and Lactating Mothers

The prevalence of stunting, underweight and wasting among infant and young children in the districts were 25.8%, 13.6% and 5.6%, respectively. Also, significant proportion of lactating mother in the districts suffered from undernutrition. About 13% as identified by-BMI and 11% as identified by-MUAC mothers were undernourished.

Policy Recommendations

It is figured out that households do not consume animal source foods regularly. Animal source foods are not also included in the diets of the majority of lactating mothers and infant and young children. In addition, the less inclusion of ASF in the diets of lactating mothers and children limited them from achieving recommended minimum dietary diversity. This in turn decreases the overall nutritional contribution of diets to communities in rural settings of Ethiopian in general and to lactating mothers and infant and young children in particular. Animal source foods' unavailability, unaffordability and higher price as compared to plant based food products constrained its consumption. Livestock ownership, food security, income, land size, crop production, family size and maternal occupation and education were drivers identified to the consumption of ASF. In general, the consumption of animal source foods was hampered by poverty and lower sociodemographic condition of the community. Thus, policy shall focus on nutrition education on the need for the inclusion of ASF in a diversified diet integrated with activities to (1) boost healthy agricultural productivity-especially livestock productivity, (2) revise active nutrition and food security interventions, (3) create jobs in rural settings for income generation (4) to empower women through education and engagement in small scale businesses like small livestock husbandry, feed production and others, and (5) provide reproductive health services including family planning. Looking for strategies to avail ASF in the local markets of rural setting of Ethiopia on program basis may also benefit, especially for flesh foods.

Annex-II: Data Collection Tool English Version

Information Sheet and Consent Form

My name is (Data Collector's Name). I am working as data collector of study being conducted by Mr Alemneh Kabeta from Hawassa University.

Introduction: This interview and some anthropometric measurements are being conducted to get your input about your household's, yours and your child's dietary diversity and animal food consumption behavior in Hawassa Milk Shades, where you and other study participants are reside. You and Your child are selected randomly as a pair participant of the study.

Purpose: The purpose of this study is to assess the current dietary behaviours related to the consumption of animal source food as well as barriers (if any) to the adequate intake of animal source food at your household. This information will allow us to understand the factors that affect your household consumption of animal source food as well as to develop appropriate nutrition interventions to overcome the barriers to animal source food consumption

Risks: The interview and anthropometric measurement will cause you no harm.

Benefit: After this survey, we will have at least continuous and frequent dietary diversification and animal source foods consumption promotion session which you will attend for free. By the anthropometric measurements we can easily identify yous and your child's nutritional status and if there is an urgent problem we will tell you what to do and where to go, link with health facility. In the promotion session also you can raise issue specific to your and your child's nutritional status and experts will discuss on it. On top of the mentioned for free personal benefits, it will help you play roles and contribute for the advancement of science. In turn, the expected positive outcome of the study will potentially benefit the larger community beyond study participants like you!

Data communication concern: As much as possible, the to be collected information, from you, will be kept confidential. We will provide a code which is different from other participants and not matching with your personal identity. In case, if a need arises it will be anonymous. Hence in this respect you should have no worry.

Participation: You and your child participation in this study is based on voluntary will, any time you can quit and withdraw from the study. You may refuse to answer specific question during the interview. When further discussion is needed I may probe you for more information. The expected duration that this discussion will take may vary but expected to be 90 minutes. In some cases based on the situation we can arrange more time based on your will.

Contact address: Alemneh Kabeta
+251910101982
alemnehk@hu.edu.et/alemneh33@gmail.com/alemnehk@yahoo.com
Skype: alemneh.kabeta2

Are you willing to participate? Yes[ ] No[ ]

Dear participant, In order to achieve our objectives, we need your collaboration to complete this questionnaire. Please try to answer questions as honest as you can and according to your opinion. Do not worry about right or wrong answers, as your opinion and perspective is the right answer.

The questionnaire you are about to answer consists of 7 sections:

Section 1: Household food security

Section 2: Dietary diversity/24-hr dietary recall

Section 3: Animal source and alternative protein food frequency

Section 4: Barriers to and facilitators of animal food consumption

Section 5: Water, sanitation, and hygiene (WASH)

Section 6: Maternal and Child Sickness History

Section 7: Demographic and Anthropometric characteristics

The questionnaire will take you approximately 90 minutes to answer it. In case you have any doubts, please ask one of the research team members.

Remember that all information you put in this questionnaire is confidential.

Section 1: Household Food Security

Please select which answer is true for the last 30 days. ***Remember members of your household including children***

No	Question	Response Options	Code
1	During the last 30 days, did you **worry** that your household would not have enough food?	0 = No (skip to Q2) 1 = Yes	
1a	How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
2	During the last 30 days, were you or any household member **not able to eat** the kinds of **foods** you **preferred** because of a lack of resources?	0 = No (skip to Q3) 1 = Yes	
2a	How often did this happen?	1 = Rarely (Once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
3	During the last 30 days, did you or any household member have to **eat a limited variety of foods** due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	
3a	How often did this happen?	1 = Rarely (once to twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
4	During the last 30 days, did you or any household member have to **eat some foods that you really did not want to eat** because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	
4a	How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
5	During the last 30 days, did you or any household member have **to eat a smaller meal than you felt you needed** because there was not enough food?	0 = No (skip to Q6) 1 = Yes	

5a	How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
6	During the last 30 days, did you or any other household member have to **eat fewer meals in a day** because there was not enough food?	0 = No (skip to Q7) 1 = Yes	
6a	How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
7	During the last 30 days, was there **ever no food** to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q7) 1 = Yes	
7a	How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
8	During the last 30 days, did you or any household member **go to sleep at night hungry** because there was not enough food?	0 = No (skip to Q7) 1 = Yes	
8a	How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	
9	During the last month, did you or any household member **go a whole day and night without eating anything** because there was not enough food?	0 = No (skip to Q7) 1 = Yes	
9a	How often did this happen?	1 = Rarely (once or twice) 2 = Sometimes (three to ten times) 3 = Often (more than ten times)	

Section 2: Dietary Diversity/24-hr Dietary Recall

Now I would like to ask you about the types of foods you ate **yesterday during the day and at night**.*Read the list of foods, write 1 if the **mother** ate the food in question, place a 0 in the box if none of the mentioned foods were eaten.*

No.	Did you eat any of the following foods yesterday during the day or night?	Yes = 1 No = 0
1	Bread, Enjera or any food made from cereal grains (e.g. made with maize, sorghum, millet, wheat, barley, teff?)	
2	**Vitamin A rich vegetables and roots** such as pumpkin, carrot, yellow flesh sweet potato?	
3	Any foods made from **Roots and Tubers**: potato, sweet potato, white yam and other foods made from and Enset foods (kocho and bulla)?	
4	Any foods made from kale, spinach, moringa or from any other **dark green leafy vegetables**.	
5	Any food made from **other vegetables** like tomato, onion, mushroom, etc.	
6	Any **vitamin A rich fruit** such as ripe mango, papaya, guava	
7	**Other fruits**- like banana, avocado, etc	
9	Flesh/Meat	
9.1	Beef and other cattle Meat	
9.2	Goat Meat	
9.3	Sheep/Lamb Meat	
9.4	Meat from Pig and other Wild Animals	
9.5	Poultry Meat (Chicken, Turkey and any other wild bird)	
10	Organ meats (liver, heart, kidney and Offal)?	
10	Eggs	
11	Any fresh or dried **fish**?	
12	Any foods made from beans (Kidney/haricot and broad beans; field, cow, chick-peas or others?)	
13	Any food made from nuts (Peanut, Sesame, Mustard, Sunflower Seeds and others)	
14	**Dairy and Dairy Products**	
14.1	Whole Milk alone and added to any other food?	
14.2	Yogurt	
14.3	Skimmed Milk-milk after butter production	
14.4	Cheese	
14.5	Whey- the fluid after cheese production	
14	Any food with oil, fat, or butter?	
15	**Sweets**: Any Sugar or honey, sweet /soft drinks, chocolates, candies, cookies and cakes	
16	**Spices** (black pepper, salt,	
17	**Hot Drinks [**Coffee, Tea and Others mention other locally available**)]**	
18	**Alcoholic beverage (** Local (mention) and Industry processed**)**	

Infant and Young Children Dietary Diversity

Now I would like to ask you about the types of **foods your child ate yesterday during the day and at night**.

Read the list of foods, write 1 if the child ate the food in question, place 0 in the box if none of the mentioned foods were eaten.

	Yesterday during the day or night, which food did you give to your child (_____) to eat?	**No = 0 Yes = 1**
1	**Cereal foods: maize and the like….**	
2	**Legumes and nuts foods**	
3	**Dairy products**	
3.1	Whole Milk	
3.2	Yogurt	
3.3	Skimmed Milk-milk after butter production	
3.4	Cheese	
3.5	Whey-milk after cheese production	
4	Flesh foods	
4.1	Beef and other cattle Meat	
4.2	Goat Meat	
4.3	Sheep/Lamb Meat	
4.4	Meat from Pig and other Wild Animals	
4.5	Poultry Meat (Chicken, Turkey and any other wild bird)	
4.6	Organ meats (liver, heart, kidney and Offal)?	
5	**Eggs**	
6	**Vitamin A-rich** vegetables (yellow, green and red colored) and fruits	
7	**Other fruits and vegetables**	
8	Roots and Tubers (kocho, potato, etc.)	

24-Hour Dietary Recall

1. ID#:	2. Date Taken:
3. Participant Name:	
4. Pregnant Yes [ ] No [ ] 5. Breast Feeding Yes [ ] No [ ]	
6. How was your food yesterday?	
About usual [ ] Social occasion/holiday [ ] Sickness [ ]	
Fasting [ ] No appetite [ ] Other (Please specify)_____	
7. Are you vegetarian/fasting Animal Source Foods? Yes [ ] No [ ]	

8. What did Participant eat and drink in the last 24 hours?			11. Number of serving to be calculated by staff. (List whole or half servings in each cell, then sum at bottom.)					
FOOD ITEMS AND DESCRIPTION (List all foods and beverages consumed as meals or snacks. List separately main ingredients in mixed dishes.)		AMOUNT EATEN	BREADS & CEREAL	FRUITS	VEGETABLES	MEATS	MILK	OTHER
Food Quick list		Place of Consumption						
	Breakfast:							
	Snack:							

	Lunch:								
	Snack:								
	Dinner								
	Snack:								
9. Total Number of Different Meals/Snacks:			Total						
10. How many cups of water did you have yesterday?									

Section 3: Animal Source and Alternative Protein Food Frequency Questionnaire: *How often did you ate each of the following in your household in the **last month/30 days**? Please place a tick in the appropriate box or write the self-reported response!*

	Once per day	More than once a day	1-2 times a week	3-6 times a week	1-2 times/ fortnight	1-2 times a month	Never	If Never, ask for self-reported: 1. Occasionally/Holiday/Ceremony 2. Self- reported Consumption Frequencies-write the frequency
White meat (e.g. chicken, turke)	☐	☐	☐	☐	☐	☐	☐	
Red meat (e.g. beef, lamb, goat, pork)	☐	☐	☐	☐	☐	☐	☐	
Processed meats (e.g. dried meat/Kuwanta, ham, bacon, sausages,)	☐	☐	☐	☐	☐	☐	☐	
White fish (e.g. cod, haddock)	☐	☐	☐	☐	☐	☐	☐	
Oily fish (e.g. sardines, salmon)	☐	☐	☐	☐	☐	☐	☐	
Seafood (e.g. prawns, mussels, crab)	☐	☐	☐	☐	☐	☐	☐	
Eggs	☐	☐	☐	☐	☐	☐	☐	
Whole Milk	☐	☐	☐	☐	☐	☐	☐	
Milk products, Yoghurt, Skimmed milk, cheeses, Whey.	☐	☐	☐	☐	☐	☐	☐	
Meat alternatives:								
Nuts	☐	☐	☐	☐	☐	☐	☐	
Mushrooms	☐	☐	☐	☐	☐	☐	☐	
Beans	☐	☐	☐	☐	☐	☐	☐	
Pulses (e.g. lentils, Dahl)	☐	☐	☐	☐	☐	☐	☐	
Soy and soy products	☐	☐	☐	☐	☐	☐	☐	

Section 4: Barriers to and Facilitators of Animal Food Consumption

4.1. Meat—white meat, red meat and processed meats

*Please answer this question **only if you eat meat**. Please think about the meat you eat most often, and tell us whether you strongly agree, slightly agree, neither agree nor disagree, slightly disagree or strongly disagree with the following statements. Please place **a tick** in the appropriate box.*

		Strongly disagree	**Slightly disagree**	**Neither agree nor disagree**	**Slightly agree**	**Strongly agree**
		-2	-1	0	+1	+2
Quality	The quality of meat is **important** to me					
Availability	It is **difficult to find** meat that I like or want to eat where I usually shop					
Cost	I am **able to afford** meat					
Effort involved	It takes **a lot of effort to prepare and cook** meat					
Storage	**Lack** of proper meat **storage** prevents me from eating meat as often as I would like to eat					
Health beliefs	I think eating meat is **good for my health**					
Medical concerns	My health **does not allow me** to eat meat					
Tradition	Meat was **a regular component** of my diet while growing up					
	Growing up, we only ate meat **on special occasions**					
Religion	My religion **does not prohibit** eating of meat					
	I **don't eat some kinds of meat** because of my religion					
	I **don't eat meat** when I am **fasting**					
Income	Although we rear chicken, we sell them for income					
	Eating plant-based foods is more affordable to us than eating of meat					

4.2. Fish—white fish, oily fish and seafood

Please answer this question **only if you eat fish**. Please think about the fish you eat most often, and tell us whether you strongly agree, slightly agree, neither agree nor disagree, slightly disagree or strongly disagree with the following statements. Please place **a tick** in the appropriate box.

A. Do you have fish pond? NO [ ] Yes [ ]
B. If yes, Is it productive? No [ ] Yes [ ]
C. If productive, use? 1. Consumption 2. Sale 3. Both consumption

		Strongly disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Strongly agree
		-2	-1	0	+1	+2
Quality	The **quality** of fish is **important** to me					
Availability	The **fish that I like or want to eat** are **available where I usually shop**					
Cost	I am **able to afford** fish					
Effort involved	It takes **a lot of effort to prepare and cook** fish					
Storage	**Lack of proper fish storage prevents** me from **eating** fish as often as I would like to eat					
Health beliefs	I think eating fish is **good for my health**					
Medical concerns	My health **does not allow** me to eat fish					
Tradition	Fish was **a regular component** of my diet while **growing up**					
	Growing up, we **only ate fish on special occasions**					
Religion	My religion **does not prohibit eating** of fish					
	I **don't eat fish** when I am **fasting**					
Income	Although we **rear fish**, we **sell them for income**					
	Eating **plant-based foods** is **more affordable** to us than eating of fish					

4.3. Eggs

Please answer this question **only if you eat eggs**. Please think about the meat you eat most often, and tell us whether you strongly agree, slightly agree, neither agree nor disagree, slightly disagree or strongly disagree with the following statements. Please place **a tick** in the appropriate box.

		Strongly disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Strongly agree
		-2	-1	0	+1	+2
Quality	The **quality** of egg is **important** to me					
Availability	Eggs are **available** where **I usually shop**					
Cost	I am **able to afford** eggs					
Effort involved	It takes **a lot of effort** to prepare and cook eggs					
Storage	**Lack of proper egg storage prevents me from eating** eggs as often as I would like to eat					
Health beliefs	I think eating egg is **good for my health**					
Medical concerns	My health **does not allow** me to eat eggs					
Tradition	Eggs were a **regular component** of my diet while **growing up**					
	Growing up, we only ate eggs on **special occasions**					
Religion	My religion **does not prohibit** eating of eggs					
	I don't eat eggs when I am fasting					
Income	Although we **rear chicken for eggs**, we **sell them for income**					
	Eating **plant-based foods** is more **affordable** to us than eating of eggs					

4.4. Dairy products—milk, yoghurt, custards and blancmanges, soft cheeses and hard cheesesPlease answer this question **only if you consume milk and milk products.** Please think about the dairy products you eat most often, and tell us whether you strongly agree, slightly agree, neither agree nor disagree, slightly disagree or strongly disagree with the following statements.

What is the usual source of milk or milk products in your household?

a) Family milk cows b) Family milk goats c) Family milk camels d) Shop/market e) Others (specify)_____

		Strongly disagree	**Slightly disagree**	**Neither agree nor disagree**	**Slightly agree**	**Strongly agree**
		-2	-1	0	+1	+2
Quality	The **quality** of milk and milk products is **important** in my decision to use or not use the product					
Availability	The milk and milk products I can use **are available where I usually shop**					
Cost	I am **able to afford** milk and milk products					
Effort involved	The amount of effort needed to prepare milk based meals prevents me from using it often					
Storage	Lack of proper storage facility prevents me from eating milk and milk products often					
Health beliefs	I think consuming milk and milk products is good for my health					
Medical reasons	My health **does not allow** me to use milk and milk products					
Tradition	Milk and milk products was a **regular component** of my diet while **growing up**					
	Growing up, we only consumed milk and milk products **on special occasions**					
Religion	My religion **does not prohibit** me from consuming milk and milk products					
	I **don't consume** dairy products when I am **fasting**					
Income	Although we **rear cows/goats/camel for milk and milk** products, we **sell them for income**					
	Consuming **plant-based foods is more affordable** to us than consuming milk and milk products					

Section 5: WASH Questions

1. What is the main source of drinking water for members of your household at this time?

   A) Tap/public
   B) Borehole
   C) Protected well/spring
   D) Unprotected well/spring
   E) River/stream/lake/dam
   F) Dwelling piped supply

2. How long does it take to collect household water (including travel to and from and waiting)?

   _____Hour/s and _____Minute/s

3. How many liters of water did the household use yesterday in total? (calculate from number of liters of container and multiply by number of trips to water source)

   Please specify ……..

4. How do you prepare water for drinking (all that apply)

   A) Nothing
   B) Boiling
   C) Filtering with a cloth
   D) Letting it settle
   E) Chlorination
   F) Wuha Agar
   G) Other, please specify ……

5. When do you usually wash your hands during the day (list all options mentioned)?

   A) Never
   B) After defecating
   C) After cleaning child feces
   D) Before cooking
   E) Before breast-feeding
   F) Before Every meal
   G) After Every Meal
   H) Other, please specify ……

6. What do you use to wash hands?

   A) Nothing
   B) Water only
   C) Water and soap
   D) Water and ash
   E) Other, please specify …….

7. How do you dispose **Solid** waste?

   A) Composting/fertilizer
   B) Burn
   C) Disposing on farm
   D) Throw it on roadside
   E) Other, please specify ……..

8. How do you dispose **Liquid** waste?

   A) Flush in the compound

   B) Drain in bore whole

   C) Drain on road

   D) Other Specify_____

9. What type of toilet facility does your household use?

   A) No toilet

   B) Traditional pit latrine

   C) Latrine with shade

   D) Ventilated improved pit latrine

   E) Flush to sewage/septic tank- Water carriage

Section 6: Demographic Characteristics and Anthropometric Measurements

6.1. Demographic characteristics

The following questions ask general information about you. Please read each question carefully and answer to the best of your ability:

No.	Question	Option
1	What is your highest level of education? **NB: Circle the award for "D" and "E"**	A) No education B) Elementary school, Grade_____ C) High school, Grade_____ D) Technical /vocational training, Award: Certificate, Diploma, BSC E) College and over, Award: Certificate, Diploma, BSC, MSc, PhD F) Other forms of studies _____
2	What is your marital status?	A) Never married B) Married C) Separated D) Divorced E) Widowed
3	What is your age?	• _____Yrs • If Adolescent (10-24 Yrs), _____Yrs & _____Months
4	A. What is your mother Tongue?	_____
	B. If 'A" d/t from Amharic, do you speak Amharic?	A) Yes B) No
5	How many people living in your household are ages 0-5 years? (If none, write 0)	• <2Yrs_____ • 2 – 5yrs_____
6	How many people living in your household are ages 6-17 years? (If none, write 0)	_____
7	How many people living in your household, including yourself, are ages 18 and above? (If none, write 0)	• 18 - 60 Yrs_____ • > 60 Yrs_____
7.1	People in the Household	• Male_____ Female_____

No.	Question	Option
8	What is your religious preference?	A) Protestant B) Muslim C) Orthodox D) Catholic E) Waqifata F) Other, specify _____
9	What is the major source of health care for you?	A) Modern medical care B) Traditional doctor C) Spiritual healer D) Other, specify _____
10	What is your current employment status? Select one that best describes you:	A) Employed for wages B) Self-employed C) Out of work D) A homemaker E) A student F) Retired G) Unable to work H) House wife I) Merchant J) Farmer K) Other, explain _____
11	If employed, what is your usual occupation?	A) Civil servant B) Farmer C) Petty trader D) Other, specify _____
12	What is your total income during the past 12 months?	_____ _____
13	Who is the head of the household?	A) Wife/woman B) Husband/man C) Grandparent D) Other, specify _____
14	Who usually makes decisions about making **major household purchases**?	A) Wife/woman B) Husband/man C) Both husband and wife D) Other, specify _____
15	Who usually makes decisions about making purchases for **daily household needs**?	A) Wife/woman B) Husband/man C) Both husband and wife D) Other, specify _____

No.	Question	Option
16	Who decides how the **household income** will be **used**?	A) Wife/woman B) Husband/man C) Both husband and wife D) Other, specify _____
17	Does your household have **agricultural land**?	A) Yes, ✓ _____Hectare ✓ 1) Own 2) Rental 3) Other _____ B) No
18	Does your household own any animals? ☐ Yes ☐ No	

Animals:		Yes	No	Number
Ox		☐	☐	_____
Cow		☐	☐	_____
Goat		☐	☐	_____
Sheep		☐	☐	_____
Donkey		☐	☐	_____
Horse/Mule		☐	☐	_____
Chicken		☐	☐	_____

19

Do you grow any Crop? No [ ] Yes [ ]		
If Yes, which of the following crops do you grow?	Yes	No
• **Cereals**: maize, teff, sorghum, millet, etc.	☐	☐
• **Roots**: cassava, potato, yam, sweet potato	☐	☐
• **Legumes**: broad bean, peas, haricot bean, kidney bean, etc.	☐	☐
• **Oil seeds**: peanut, sesame, sunflower, etc.	☐	☐
• **Vegetables:** cabbage, carrot, pumpkin, tomato, beet root, etc.	☐	☐
Fruits: mango, orange, papaya, banana, avocado, guava, lemon, etc.	☐	☐
• **Cash Crops**: Coffee, tea, Khat and others	☐	☐

20	Do you have **Enset** plants?	A) No B) Yes
21	How many **mature enset** plants do you have? (use 0 for none)	_____

Child and Mother sickness Status in The Past Two Weeks

A. Mother's

1. Did you (**the mother)** get sick with in the last two weeks? NO [ ] Yes []

1.1. Did you seek for Modern Health Care? NO [ ] Yes []

1.2. If Modern Medical Care sought, what was the diagnosis?

_____
_____
_____

1.2 What were the symptoms you felt?

_____
_____
_____
_____
_____

B. Child's

2. Did the **child get** sick with in the last two weeks? NO [ ] Yes [ ]

2.1. Was Modern Medical Care sought? NO [ ] Yes [ ]

2.2. How he/she manifested (**Only Child**)?

A) Diarrhea B) Cough C) Fever D) Skin rush and others

E) Other/s

_____
_____
_____

6.2. Anthropometric Measurements

1. Woman's measurement:
   - Name: ……
   - Height/Length (in cm): ……..
   - Weight (in kg): ……..
   - MUAC_____

2. Child's measurement:
   - Child's name: ……
   - Date of birth: DD_____MM_____YY_____
   - Age of the child in months:_____
   - Sex: 1) Female
     2) Male
   - Combined weight (woman and child) in kg: 1) No
     2) Yes
   - Weight (in kg): _____
   - Length (in cm): _____
   - Edema (**only child**): 1) No
     2) Yes, Grade (Circle One) **+** **++** **+++**
   - Child MUAC (in cm): _____

Data Collector

- ✓ **Name: _____**
- ✓ **Date_____**
- ✓ **Signature _____**

Annex –IV: Support Request, Ethical Clearance and Trial Registration Letter

Letter of Ethical Clearance

ሀዋሳ ዩኒቨርሲቲ
ህክምናና ጤና ሳይንስ ኮሌጅ
የምርምር ስነ-ምግባር ግምጋሚ ቦርድ

HAWASSA UNIVERSITY
COLLEGE OF MEDICINE AND HEALTH SCIENCES
Institutional Review Board

Ref. No: IRB/027/10

Date: 27/12/2017

Name of Researcher(s): ***Alemneh Kabeta Daba, Marry Murimi, Kebede Abegaz, Dejene Hailu***

Topic of Proposal: ***Improving the consumption of animal source foods for the betterment of women's and children's nutritional status.***

Dear researcher(s),

The Institutional Review Board (IRB) at the College of Medicine and Health Sciences of Hawassa University has reviewed the aforementioned research protocol with special emphasis on the following points:

1. Are all principles considered?
   - 1.1. Respect for persons: Yes ☑ No ☐
   - 1.2. Beneficence: Yes ☑ No ☐
   - 1.3. Justice: Yes ☑ No ☐
2. Are the objectives of the study ethically achievable? Yes ☑ No ☐
3. Are the proposed research methods ethically sound? Yes ☑ No ☐

Based on the aforementioned ethical assessment, the IRB has:

- A. Approved the proposal for implementation ☑
- B. Conditionally Approved ☐
- C. Not Approved ☐

Yours faithfully,

Ayalew Astatkie (PhD),
Institutional Review Board Chairperson.

☎ +046 820 92 90
Fax + 046 2208755
✉ 1560 Hawassa

Letter of Request for Cooperation to Study Districts from School of Nutrition, Food Science and Technology of Hawassa University

ሀዋሳ ዩኒቨርሲቲ
የሥነ-ምግብ፣ ምግብ ሣይንስና
ቴክኖሎጂ ት/ቤት
የስነ-ምግብ ትምህርት የልህቀት
ማዕከል

Hawassa University
School of Nutrition, Food
Science and Technology
Academic Center of Excellence in Human
Nutrition

ቁጥር ስነ/ም/ም/ሳ/ቴ/ት/130251/2010
Ref No.
ቀን 15/09/2010
Date

ለ አርሲ ገጠራማ ዓሌ እና ወይዶ ገነት ወረዳ ጤና ጽ/ቤት

ጉዳዩ፡- ትብብር እንዲደረግ ስለመጠየቅ

የት/ት ቤታችን የሶስተኛ ድግሪ ተማሪ የሆኑት አቶ ዓለምነህ ቃበታ የመመረቅያ ጥናታቸውን ለመስራት የጥናት ስፍራ ልየታ ሥራ ለመስራት ከተለያዩ መስሪያቤቶች እና ድርጅቶች መረጃ በማሰባሰብ ላይ ስለሚገኙ ለሚደረግላቸዉ ትብብር ከወዲሁ እያመሰገንን የእናንተም መስሪያ ቤት አስፈላጊውን ትብብር እንድያደርግላቸዉ በትህትና እንጠይቃለን፡፡

ሀዋሳ ዩኒቨርሲቲ
የሥነ-ምግብ፣ ምግብ ሳይንስና ቴክኖሎጂ ት/ቤት
School of Nutrition, Food Science and Technology
Hawassa University

ከሠላምታ ጋር
ፍቃዱ ረታ
የስ/ም/ም/ሳ/ቴ/ት/ቤት ኃላፊ

☎+ 046-221-00-60
☎+ 046220 -53-24

✉+ P.O.Box. 05
Fax+ 046-220 -67-11
Hawassa Ethiopia

Letter of Clinical Trial Registration

29 November 2019

To Whom It May Concern:

RE: Improving the Consumption of Animal Source Foods for the Betterment of Women's and Children's Nutritional Status

As project manager for the Pan African Clinical Trial Registry (www.pactr.org) database, it is my pleasure to inform you that your application to our registry has been accepted. Your unique identification number for the registry is **PACTR201911690619601**.

Please be advised that you are responsible for updating your trial, or for informing us of changes to your trial.

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

Additionally, please provide us with copies of your ethical clearance letters as we must have these on file (via email or post or by uploading online) at your earliest convenience if you have not already done so.

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

Yours faithfully,

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

The South African Medical Research Council
Cochrane South Africa | PO Box 19070, Tygerberg, 7505
Tel: +27 (0)21 938 0438 | Email: cochrane@mrc.co.za | Web: www.southafrica.cochrane.org

Annex-VII: Household Sampling Frame Format for the Cross-sectional Study

S#	Name of Head of the Household	Kebele	Gotti/Zone	District

Annex-VIII: Mother-Child Pair Sampling Frame Format for the Cross-sectional Study

S#	Name of the Mother	Name of the Child	Kebele	Gotti/Zone	District

Annex-IX: Mother-Child Pair Sampling Frame Format for the Randomized Controlled Trial

S#	Mother's Information					Child's Information					General Information
	Full Name	Age Mnths	Occupation and Education	Pregnancy(Yes/No)	Lactation (Yes/No)	Full Name	Date of Birth	Age in Mnths	Sex F/M	Father's Full Name	Gott

Annex-X: Sample Size Calculated for Randomized Controlled trial using a 5% Increment rate on proportion for ASF Consumption

			Hypothesized Changes in Percentage or Proportion and Sample Size, Percentage Changes are what I assumed to Calculate the Sample Sizes (SS)															
Study Participants	Animal Source Foods	Baseline Proportion, used as Proportion in Control Group	5%	SS	10%	SS	15%	SS	20%	SS	25%	SS	30%	SS	35%	SS	40%	SS
Mothers	Meat/Flesh and Fish [1]	5.1	10.1	874	15.1	273	20.1	146	25.1	93	30.1	65	35.1	49	40.1	37	45.1	30
	Egg [2]	5.2	10.2	884	15.2	280	20.2	147	25.2	94	30.2	66	35.2	49	40.2	38	45.2	30
	Milk and Milk Products [3]	27.7	32.7	2637	37.7	683	47.7	177	47.7	177	52.7	113	57.7	78	63.7	53	68.7	39
IYC	Dairy products (milk, yogurt, cheese) [1]	41.4	46.4	3081	51.4	773	56.4	341	61.4	**189**	66.4	117	71.4	78	76.4	55	81.4	37
	Flesh foods (meat, fish, poultry, liver/organ meats) [2]	1.7	6.7	497	11.7	189	16.7	109	21.7	74	26.7	54	31.7	41	36.7	32	41.7	26
	Eggs [3]	15.9	20.9	1875	25.9	511	30.9	241	45.9	67	50.9	50	55.9	38	60.9	29	65.9	23

Biography of the PhD Candidate

Alemneh Kabeta Daba was born from his mother *Wube Siyum Teklehayimanot* and his father "*Hamisa Aleqa*/*Sajin*" Kabeta Dhaba Mengesha in *Metu* town, the then administrative center of *Illubabor Kiflehager* in 1987 G.C (1979 E.C.). Because of his father's relocation (*Ziwuwur*) for job, he went, with the whole family, to *Masha* town in *Mocha Awuraja* of *Illubabor Kiflehager* in 1982. He had attended kindergarten in *Masha* town for two years. By age 6 he joined *Masha* primary school and attended his grade 1-8 education at *Masha* primary school. As he assured successful completion of his primary education by the result of regional exam (*ministry*) he wrote, he joined *Masha* secondary and preparatory school for his grade 9-12 education. He successfully passed the exam he wrote for grade 10 national exam and he continued to study his preparatory school, grade 11 and 12, in the same school. He had also accomplished his grade 12 with a very good result for the university entrance exam he wrote in 2005. While he was waiting his university assignment in 2005, his father passed away in the same year on October 31. In the week he was in a deep grief for that he lost his father, assignment for new university entrants was started to be broadcasted through plasma, a screen in high school though which electronic education had been delivered. Luckily, he was assigned at Hawassa University for his undergraduate study, where his elder brother Dr. *Azimeraw Kabeta Daba* had been studying doctor of medicine. Exactly after a month his father passed, he went to Hawassa University, and Alemneh was assigned at School of Nursing and Midwifery in Hawassa University to study BSc. Nursing. By the strong commitment of his mother *Wube Siyum*, who is a housemaker and by the good support of community in *Masha*, he studied Nursing from 2006 to 2009 G.C. and successfully graduated on July 15, 2009 G.C. Overcoming most of the challenges he faced during the undergraduate study, he became one of the top scorers of the school from the cohort, and Ministry of Education of Ethiopia assigned him to serve as a graduate assistant-I in the school where he studied Nursing as of September 15, 2009 G.C. After serving for two and half years as graduate assistant I and II at Hawassa University, from 2009 to 2011 G.C., he joined School of Nutrition, Food Science and Technology of Hawassa University in 2012 G.C. and he successfully completed his graduate study in Applied Human Nutrition on March 14, 2014 G.C. Then, he went back to School of Nursing and Midwifery of Hawassa University and served with an academic rank of lecturer until April, 2017. His deep-rooted interest for teaching-learning, in doing research and on working for research publication rewarded him with an academic rank of Assistant Professor in April, 2017. In January/2018, he joined the same school where he studied his MSc to study his terminal degree -PhD in Human Nutrition under the supervision of Professor *Mary Murimi* from Texas Tech University of USA, and Dr. *Kebede Abegazi Ali* and Dr. *Dejene Hailu Kassa* from Hawassa University.

Today, on October 08/2021, *Alemneh* is here to be a loin of the stage at which he will be presenting his PhD Dissertation to share findings from his PhD Research Project to you esteemed members of The Board of Examiners and distinguished guests and audiences.