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Understanding child malnutrition in Ethiopia: Determinants of child caring practices, multiple anthropometric failures and seasonality of growth

Netsanet Fentahun Babbel

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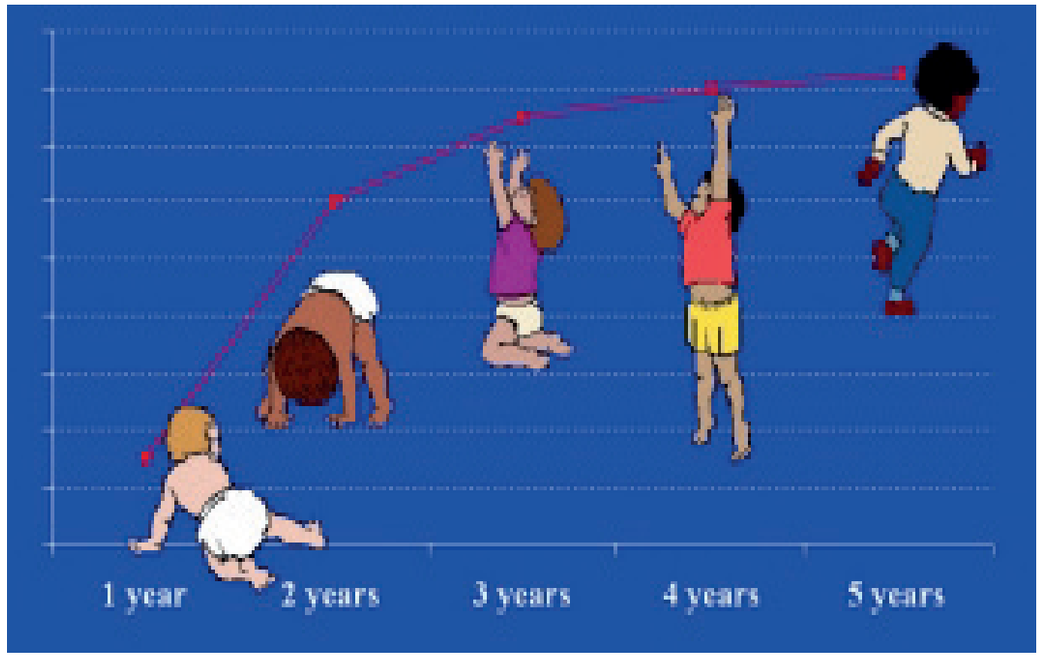

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Netsanet Fentahun Babbel

Dissertation submitted in fulfillment of the requirements for the Degree of Doctor in Human Nutrition at Jimma University and Degree of Doctor in the Applied Biological Sciences: Food Science and Nutrition at Ghent University

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Abbreviations

ACC-SCN	Administrative Committee on Coordination/Sub- Committee on Nutrition
AOR	Adjusted Odd Ratio
A4NH	Agriculture for Nutrition and Health
CDDS	Child Dietary Diversity Score
CI	Confidence Interval
CIAF	Composite Index of Anthropometric Failure
CSA	Central Statistical Agency
DAs	Development Agents
DHS	Demographics Health Survey
EDHS	Ethiopian Demographic Health Survey
ENGINE	Empowering New Generations to Improve Nutrition and Economic Opportunities
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization of the United Nations
HAZ	Height-for-Age Z-score
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
MoANR	Ministry of Agriculture and Natural Resource
OR	Odds Ratio
PhD	Doctor of Philosophy

Ref	Reference Category
SD	Standard Deviation
SDG	Sustainable Development Goals
SDSN	Sustainable Development Solutions Network
SE	Standard Error
SNNPR	Southern Nations, Nationality and People's Region
SPSS	Statistical Package for Social Sciences
SUN	Scaling Up Nutrition
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Fund for Population Activities
UNICEF	United Nations Children`s Fund
USA	United States of America
USAID	United States of Agency for International Development
USD	United States Dollar
WAZ	Weight-for-Age Z-score
WHZ	Weight-for-Height Z-score
WHO	World Health Organization

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Annex

Summary

Persistently high prevalence malnutrition rates have been a major challenge for Ethiopia over the last several years. Although the Ethiopian government recognizes the high prevalence of malnutrition and made progress to reducing malnutrition, food and nutrition insecurity remain a national concern. The Ethiopian government is committed to reduce nutrition and developed a national plan in this regard. Research plays an important role in the understanding of determinants of nutrition issues. Research finding can particularly guide policy makers towards efforts to address malnutrition and scale-up effective actions.

The PhD project was conducted to address and fill gaps in knowledge on the causes of nutrition in Ethiopia. Addressing the existing gaps contributes to the formulation of policy and nutrition program planning of the country and the development of integrated multisectoral nutrition interventions. The main aim of PhD project was to improve understanding of child malnutrition in Ethiopia through a comprehensive analysis of child caring practices, seasons and nutrition, and their determinants.

We used data generated from the 2-year longitudinal agriculture–nutrition panel surveys to address concordance of poor child feeding and preventive behavior and its predictors. Six hundred twenty-three children under the age of five years and their respective caregivers were included in the analyses. Concordance of poor child feeding and preventive behavior was observed in 45.1% of the children. Concordance of poor child feeding and preventive behavior was significantly associated with age of the caretaker of ≥ 40 years ($p<0.05$), low household dietary diversity ($p<0.001$), medium household dietary diversity ($p<0.05$), severe household food insecurity ($p<0.05$) and child age ($p<0.001$). These findings provide useful entry points for comprehensive interventions to address child feeding and caring in the area.

Three rounds of a longitudinal agriculture–nutrition panel surveys were conducted to assess determinants and morbidities of multiple anthropometric deficits. We estimated undernutrition using conventional indices and a composite index of anthropometrical failures. Five hundred seventy-nine, 674, and 674 children under-age of five of round one, two and three respectively were included in the analysis. A composite index of anthropological failure, estimated 45.1%, 42.4% and 46.4% undernourished at round one, two and three respectively. The conventional indices estimated 24.4%, 24.2% and 30.4% underweight at round one, two and three respectively.

Mixed-effects logistic regression model showed that being female ($p<0.001$), low dietary diversity ($p<0.001$), medium dietary diversity ($p<0.05$) and receiving no special foods during illness ($p<0.05$) were determinants of multiple anthropometrical failures. Children with multiple anthropometric failures were three times more likely to report child morbidities ($p<0.05$). However, none of the conventional indices were associated with any of the reported child morbidities ($p>0.05$). This finding indicates that conventional indices underestimated undernutrition and children with multiple anthropometric failures are at high risk of developing childhood morbidities and should benefit from nutrition intervention to reduce child morbidities.

Data obtained from four rounds of a longitudinal agriculture–nutrition panel surveys were used to assess seasonality and determinants of child growth velocity and growth deficit. Five hundred seventy-nine, 674, 674 and 680 children under the age of five years and their respective caregivers of round one, two, three and four respectively were included in the analyses. Higher length and weight velocity were observed in pre-harvest season compared with post-harvest season (length velocity=6. 4 cm/year and weight velocit =0. 6 kg/year).

The mean height of children increased an additional 3.3 cm ($p<0.001$) per year in the pre-harvest season compared with the post-harvest season. Similarly, the mean weight of children increased 1.0 kg ($p<0.001$) per year more in the pre-harvest season compared with the post - harvest season. Children who had a low dietary diversity ($p<0.001$) and were born during the lean season in both seasons had a higher linear growth deficit ($p<0.05$). Being member of a highly food insecure household was negatively associated with higher weight gain ($p<0.05$). Having experienced no illness during the previous two weeks was positively associated with linear growth and weight gain ($p<0.05$). This finding indicates that household income generating options should be designed to solve seasonality of child growth velocity and deficits.

In general, the majority of children suffered from a poor child caring practice, multiple anthropometric failures, morbidities, and linear growth deficits. Children with multiple anthropometric failures experienced from frequent morbidity episodes. Season was a major influencing factor for child linear growth and weight gain. Therefore, evidence-based nutrition education and promotion and social and behavior change communication strategies with clear goals, objective, and task should be designed to reduce malnutrition.

Samenvatting

Ernstige en aanhoudende ondervoeding bij kinderen vormt een blijvende uitdaging voor Ethiopië. Hoewel de Ethiopische regering het probleem erkent en er reeds verscheidene positieve resultaten geboekt zijn, blijven ondervoeding en voedselzekerheid een nationaal probleem. De Ethiopische regering heeft zich geëngageerd om ondervoeding terug te dringen en ontwikkelde een nationaal actieplan. Onderzoek naar de determinanten van voeding kan helpen om doeltreffende programma's uit te werken.

Dit doctoraat onderzocht de lacunes in kennis rond de oorzaken van ondervoeding in Ethiopië en ondersteund het beleid en uitwerking van multisectoriële interventies. De belangrijkste doelstelling van dit onderzoek was om de oorzaken van ondervoeding beter te begrijpen door middel van een analyse van kinderzorg en voeding, seizoensgebonden factoren en andere determinanten.

Dit onderzoek gebruikt data van een twee jaar durende opvolgstudie, met landbouw- en voedingsenquêtes, om gemeenschappelijke kenmerken van kindervoeding en gedragingen van moeders te bestuderen. Zeshonderd drieëntwintig kinderen jonger dan 5 jaar en hun zorgverleners namen deel aan de studie. Ontoereikende voeding en zorg van kinderen werd samen vastgesteld in 45.1% van de kinderen en was geassocieerd met de leeftijd van de zorgverlener (meer of minder dan 40 jaar, $p<0.05$), lagere en gemiddelde diversiteit in het dieet ($p<0.05$), en sterke voedselonzekerheid ($p<0.05$) en leeftijd van het kind ($p<0.001$). Deze bevindingen vormen aanknopingspunten om interventies uit te werken die voeding en zorg verbeteren in kinderen.

De determinanten en morbiditeit van groeiparameters werden bestudeerd door middel van drie enquête rondes. Ondervoeding werd gemeten doormiddel van conventionele indices voor groeiachterstand (*stunting*) en gewichtsverlies (*wasting*) en een samengestelde index van ondervoeding. Vijfhonderd negenzeventig, 674, en 674 kinderen onder de leeftijd van 5 jaar in respectievelijk ronde 1, 2 en 3 werden gemeten. Een samengestelde index van groeiachterstand schatte de prevalentie van ondervoeding op 45.1%, 42.4% en 46.4% in ronde 1, 2 en 3 respectievelijk. De conventionele indices langs de andere kant schatten de prevalenties van ondervoeding op 24.4%, 24.2% en 30.4% bij ronde1, 2 en 3 respectievelijk.

Een mixed-effects logistisch regressie model toonde aan dat meisjes ($p<0.001$), lage en gemiddelde diversiteit in het dieet ($p<0.05$), ontberen van specifieke voeding tijdens ziekte ($p<0.05$) determinanten waren van groeiachterstand zoals gemeten met een samengestelde index. Kinderen met een gecombineerde groeiachterstand hadden driemaal meer kans om een vorm van morbiditeit te vertonen ($p<0.05$). Geen enkele van de conventionele indicatoren was echter geassocieerd met deze morbiditeit ($p>0.05$). Deze resultaten tonen aan dat de conventionele indices het probleem van ondervoeding onderschatten en dat kinderen met een gecombineerde groeiachterstand een specifiek risico hebben om ziektes te ontwikkelen. Een specifieke aanpak hiervoor dringt zich op.

Data uit vier rondes van een longitudinale studie met enquêtes rond landbouw en voedingstoestand werden gebruikt om seizoen variatie in determinanten van groeisnelheid en achterstand te bepalen. Vijf honderd negenzeventig 674, 674 en 680 kinderen jonger dan 5 jaar en hun respectievelijke zorgverleners werden bevraagd. Kinderen vertoonden een hogere groei en gewichtstoename in het seizoen voor de oogst in vergelijking met het oogstseizoen (toename in lengte = 6.4 cm/jaar en toename in gewicht = 0.6 kg/jaar).

De gemiddelde lengte van kinderen nam 3.3 cm ($p<0.001$) toe per jaar in het seizoen voor de oogst in vergelijking met de periode tijdens de oogst. Ook het gewicht van de kinderen nam toe met gemiddeld 1.0 kg ($p<0.001$) per jaar in de maanden voor de oogst. Kinderen met een lage diversiteit in het dieet ($p<0.001$) en deze die geboren werden tijdens de moeilijke maanden hadden een grotere lineaire groeiachterstand ($p<0.05$). Ook het behoren tot een gezin met voedselonzekerheid was negatief geassocieerd met toenemend in gewicht ($p<0.05$). Afwezigheid van ziekte tijdens de voorbije twee weken was dan weer geassocieerd met een betere lineaire groei en gewichtstoename ($p<0.05$). Deze resultaten tonen aan dat interventies die het familiaal inkomen verbeteren nodig zijn om seizoen verschillen in groeiachterstand en snelheid aan te pakken.

De meeste van de kinderen in de studie ontbraken aan goeie zorg en kenden verschillende groei tekorten, hogere morbiditeit en een lineaire groeiachterstand. Kinderen met een gecombineerde groeiachterstand hadden daarenboven ook frequentere episodes van morbiditeit. Seizoensgebonden factoren waren een bepalend voor lineaire groei en gewichtstoename. Om deze problematiek aan te pakken is er nood aan voorlichting en gedragsverandering. Wetenschappelijk gebaseerde interventies met duidelijke doelen en taken zijn noodzakelijk ondervoeding terug te dringen.

1

Chapter 1

General introduction

1.1. Scope of malnutrition

Malnutrition develops when the body receives an inadequate amount of nutrients required to keep the organs and tissues healthy and functioning well (1). Malnutrition can affect all members of the community spanning the whole life cycle (Figure 1.1) (2). Due to their high nutritional requirements for growth and development however, infants and young children are the most vulnerable segments of the population (3).

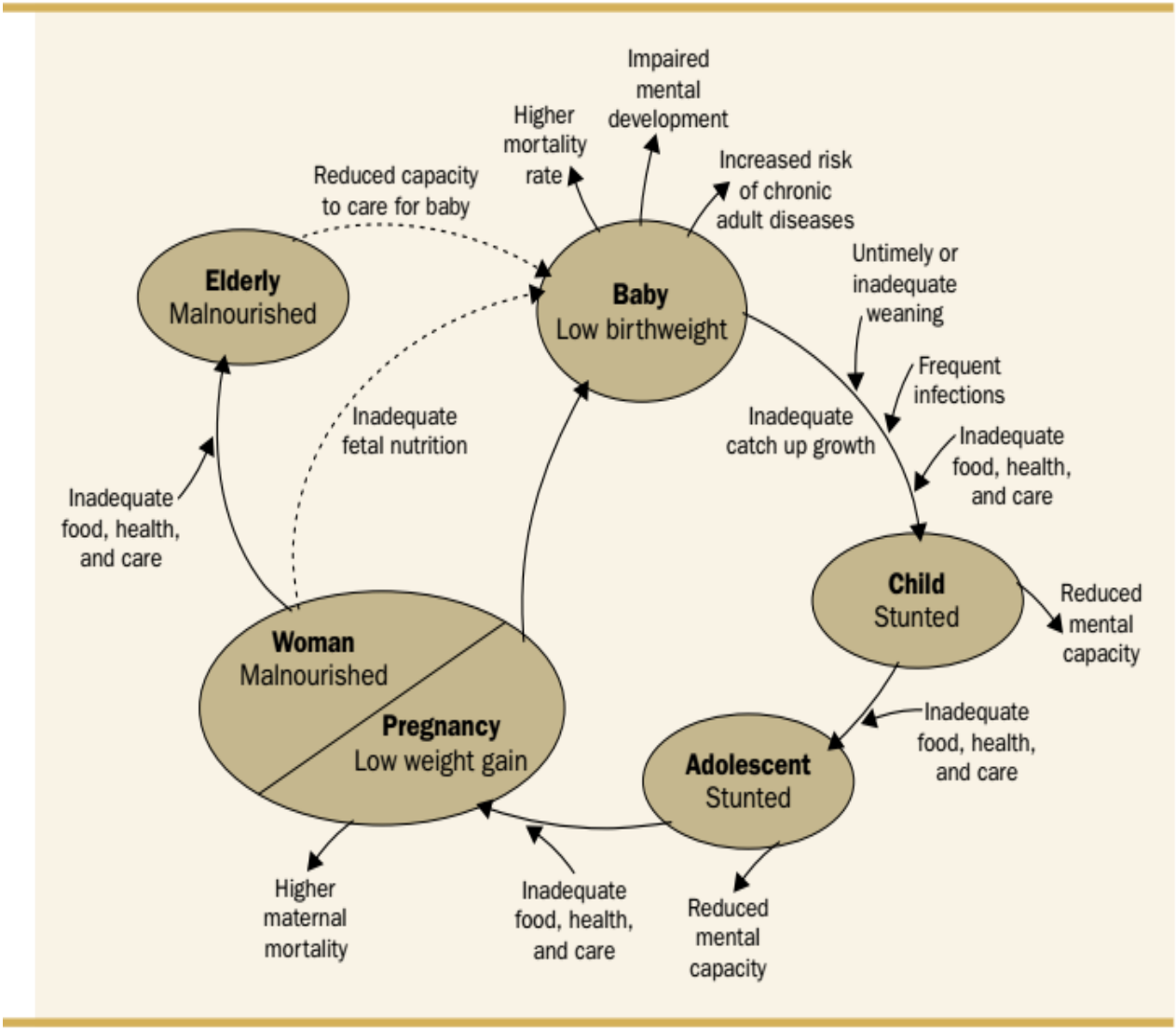

Figure 1.1. Intergenerational cycle of malnutrition (ACC-SCN/ IFPRI 2000)

1.2. Global prevalence of malnutrition

Out of 667 million children worldwide, 156 million are stunted, 50 million wasted and 42 million overweight. Figure1.2 illustrates the global trend of malnutrition from 1990-2015. Compared with two decades ago, today there are 54% overweight children globally and 35% stunted children (4). By 2025, an estimated 127 million children will be stunted (5,6). Therefore, further investment and actions are necessary to reduce stunting effectively by 2025 (7).

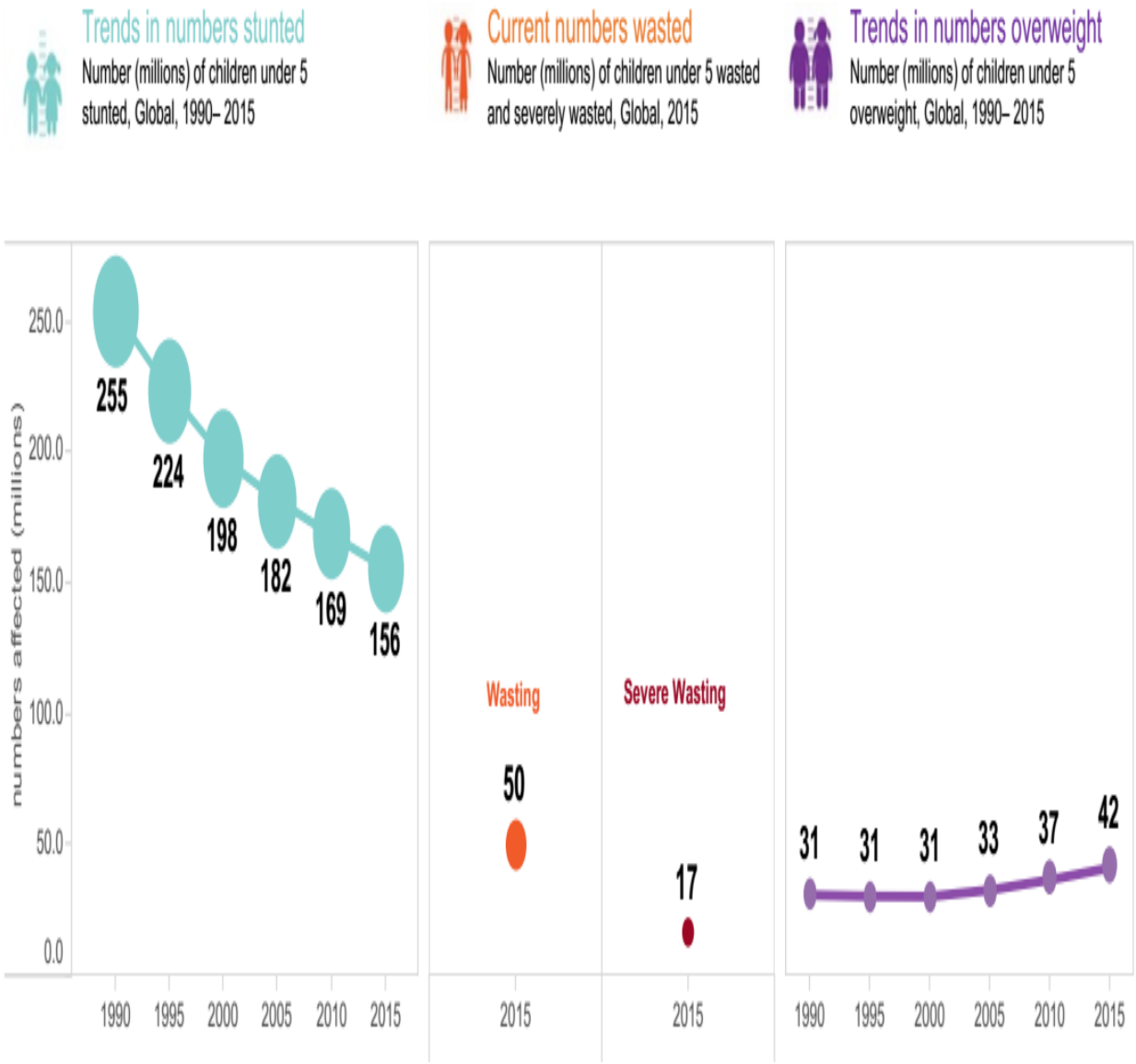

Figure 1.2. Global child malnutrition trend from 1990-2015(UNICEF/WHO/World Bank, 2016)

Figure 1.3 shows the global infant and young child feeding practices. Globally, only 43%, 29% and 16% of children are exclusively breastfed, minimum diet diversity and minimum acceptable diet.

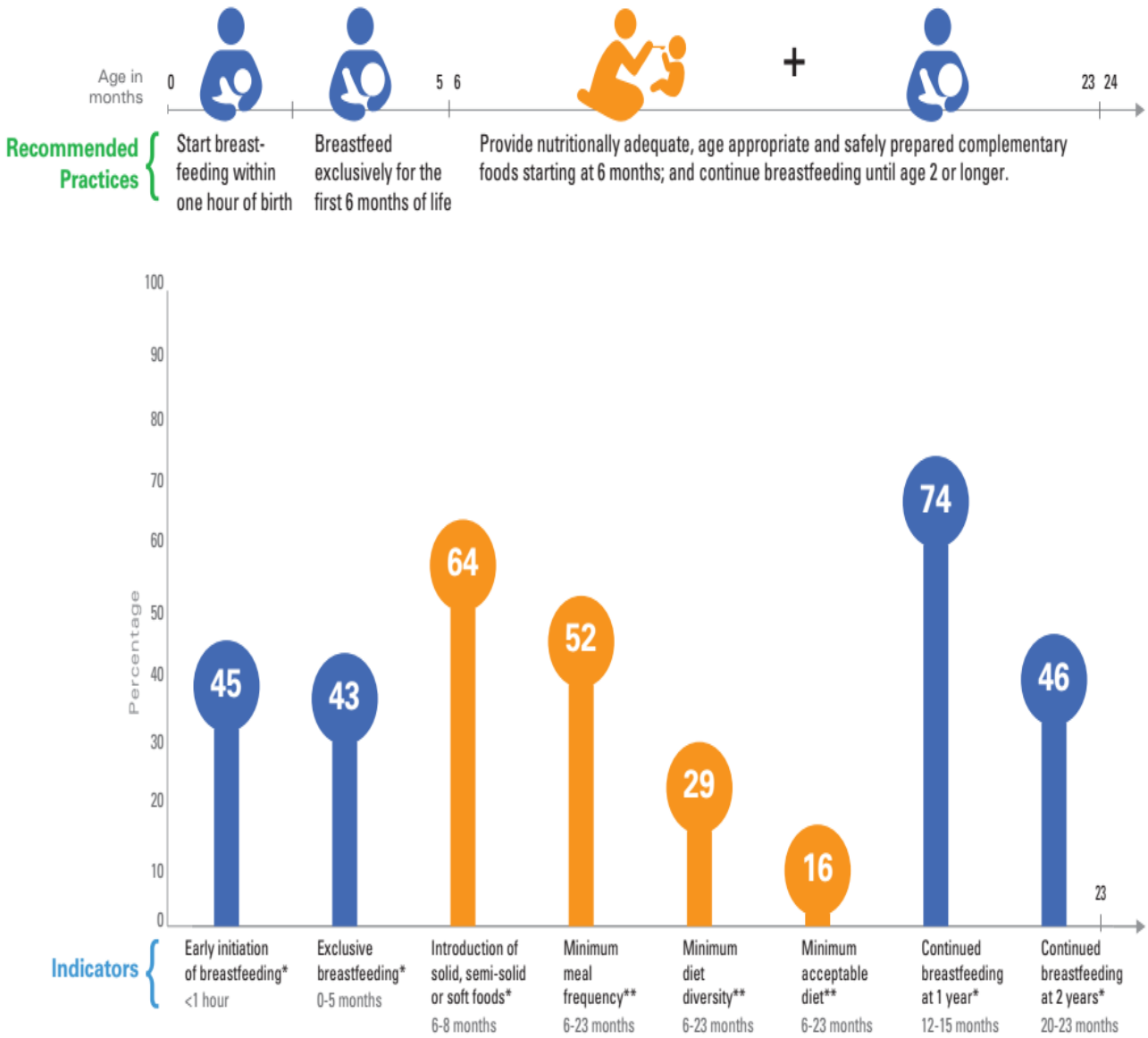

Figure 1.3. Global prevalence of child feeding from 0-23 months, 2015 (UNICEF global databases, 2016)

*Aggregates for these indicators use China, 2008; **Aggregates for these indicators do not include China due to lack of data

1.3. Regional prevalence of malnutrition

Ninety percent of chronically undernourished children live in Asia and Africa. Twenty-four countries account for more than 80 percent of the global burden of chronic under nutrition (8). Despite clear evidence of the consequences of nutritional deprivation in the short and long term, many developing countries put nutrition as a low priority on the national development agendas (8–10).

Currently, the co-existence of under and over nutrition brings programmatic challenge in countries where relatively high rates of both under and over nutrition persist among the under-fives. Therefore, promotion of good infant and young child feeding practices is key to address the co-existence of under and over nutrition (4). Figures 1.4, 1.5 and 1.6 show the regional prevalence of child malnutrition trend from 1990-2010.

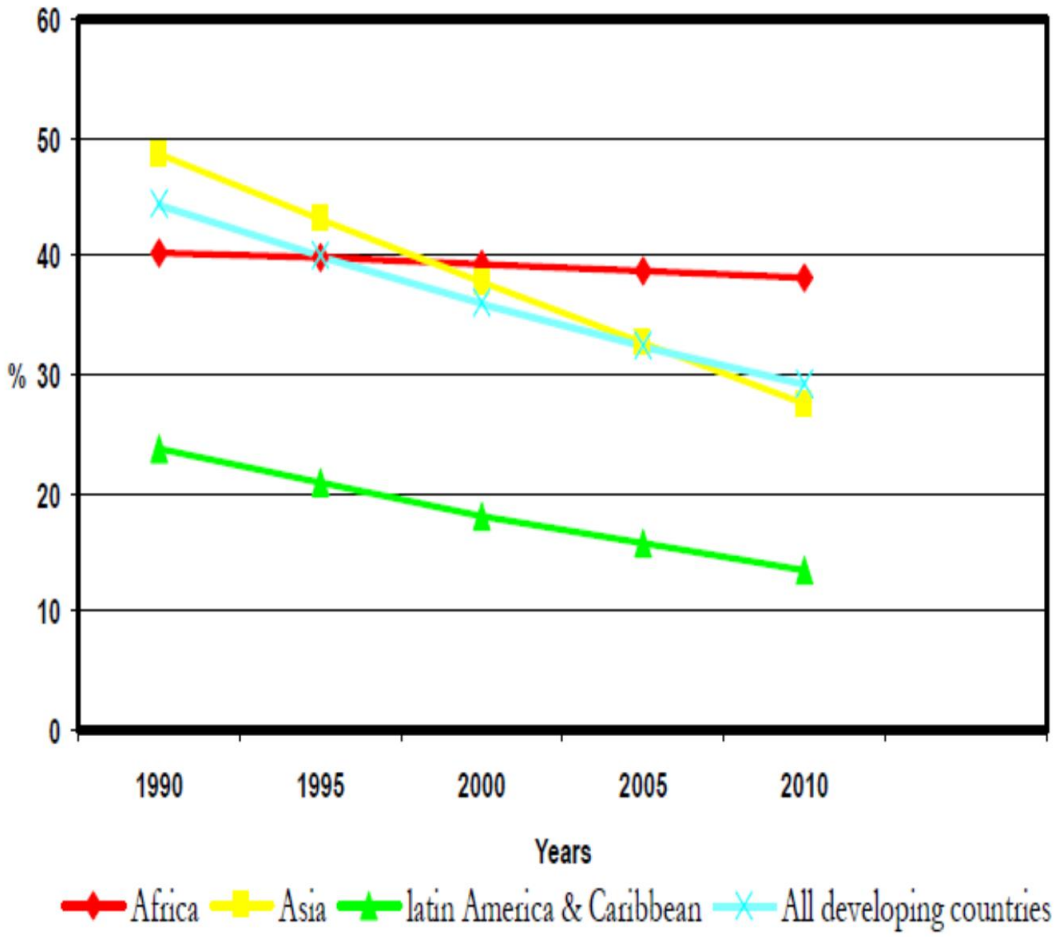

Figure 1.4. Trend in stunting from 1990-2010 (Review of Nutrition Policy, 2010)

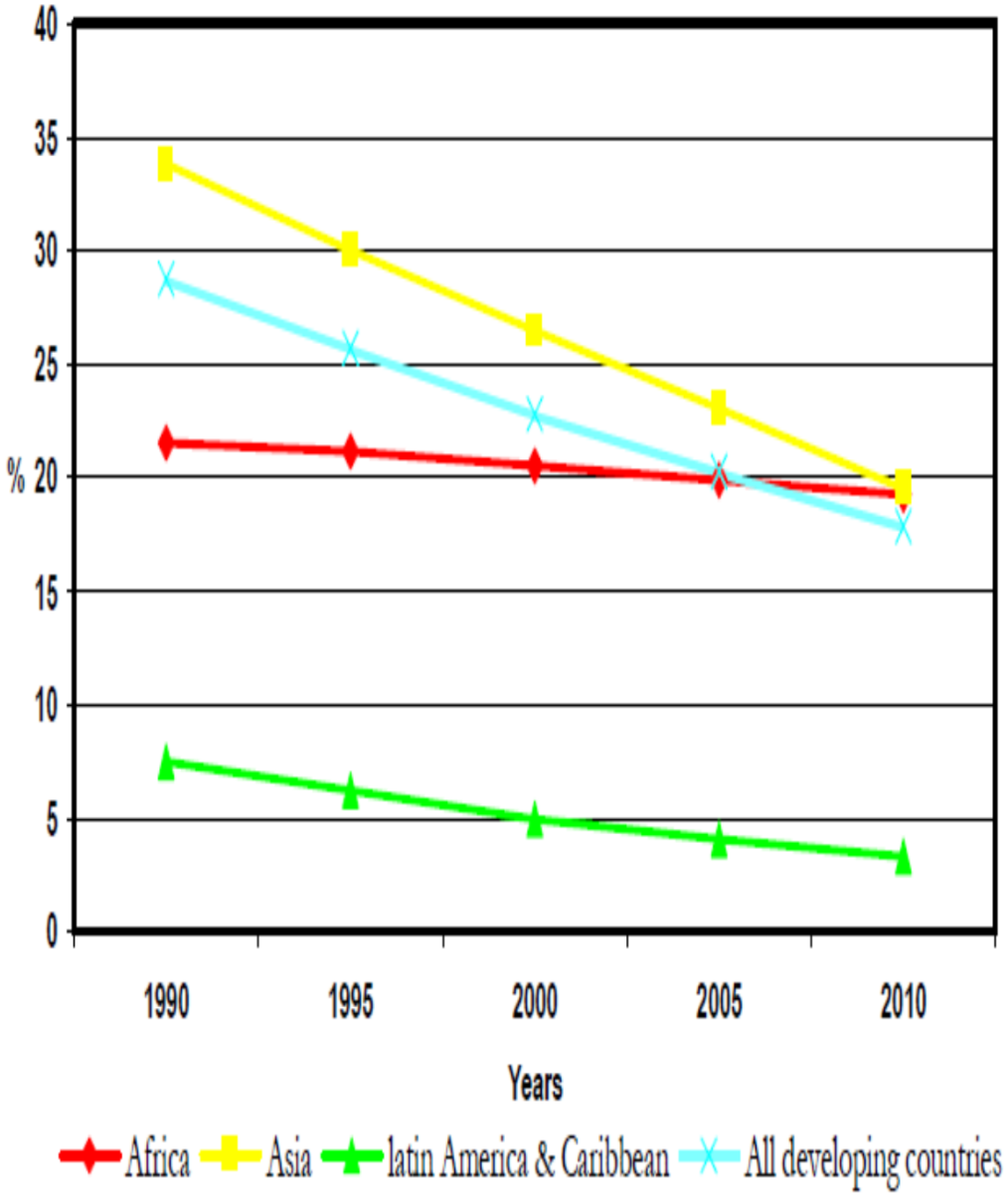

Figure 1.5. Trend in underweight from 1990-2010(Review of Nutrition Policy, 2010)

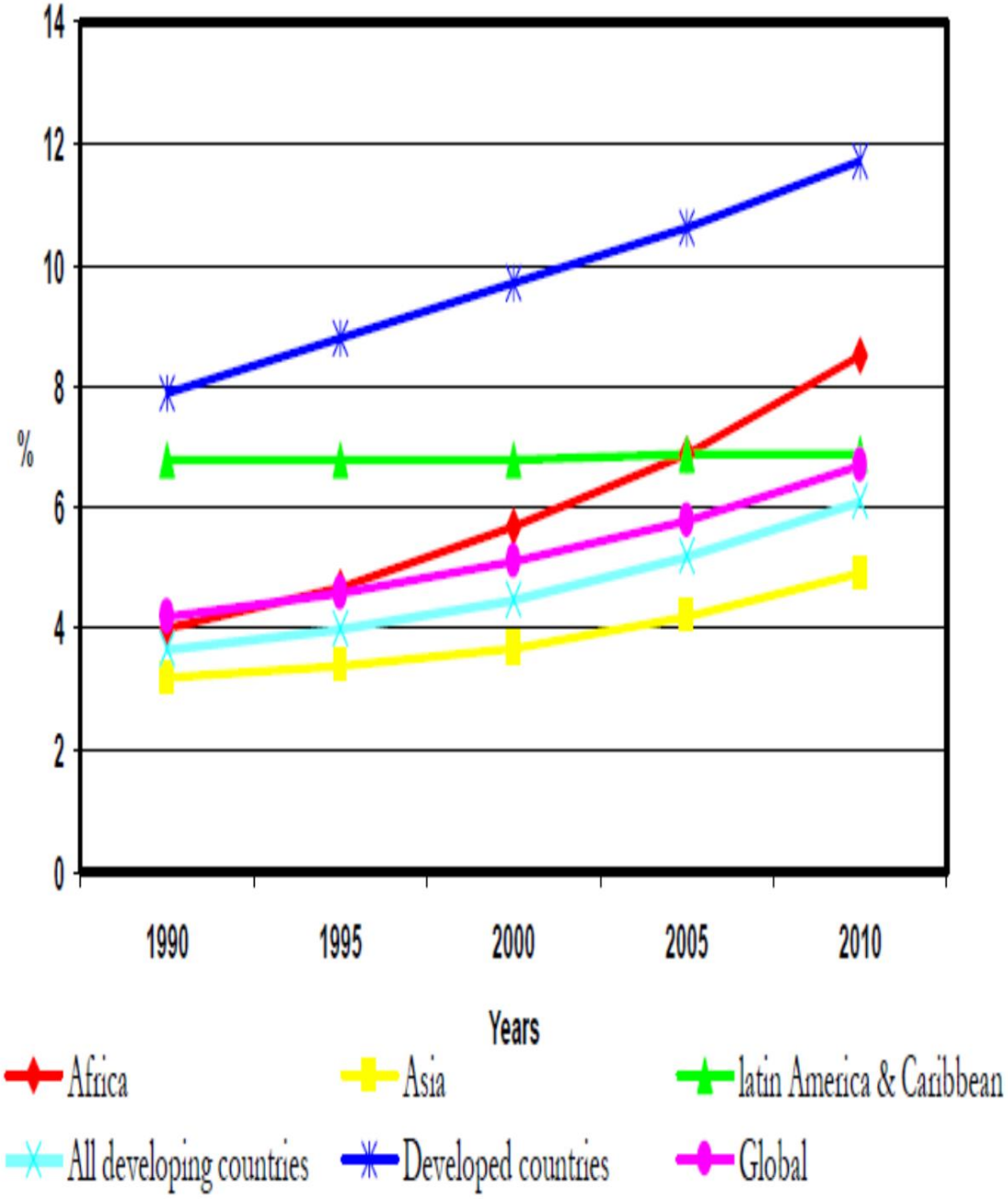

Figure 1.6. Trend in overweight from 1990-2010 (Review of Nutrition Policy, 2010)

In developing countries, 47–57% of infants younger than 2 months are exclusively breast-fed. Similarly, 20% of children in low-income and middle-income countries are underweight. The large shared was in south-central Asia and eastern Africa (33% and 28%) respectively (11). Less than half of infants are put to the breast within 1 hour of birth and 36% of infants younger than 6 months are exclusively breastfed. Less than one-third of children alone met the minimum criteria for dietary diversity and 50% receives the minimum number of meals (12). Very few children in the developing world benefit from optimal breastfeeding and complementary feeding practices. Extremely poor breastfeeding and complementary feeding practices and lack of comprehensive data on intervention coverage require urgent action to improve child nutrition (12–15). Figure 1.7 shows the regional infant and young child feeding practices.

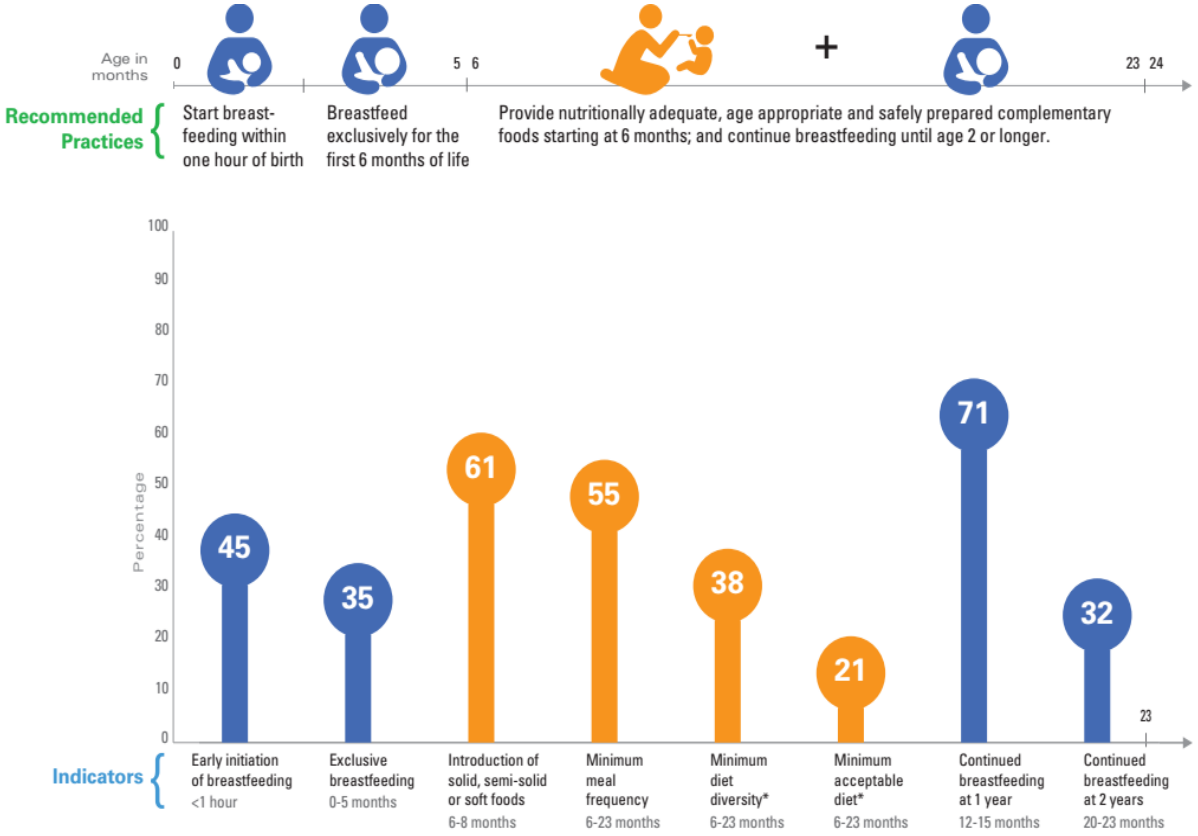

Figure 1.7. Middle-East and North-Africa prevalence of child feeding from 0-23 months, 2015 (UNICEF global databases, 2016)

*: population coverage is only 45% for these indicators for this region

1.4. Malnutrition in Ethiopia

In the last two decades, a substantial decline in the proportion of stunted and underweight children was observed in Ethiopia. The reduction in prevalence of wasting was lower. In 2014, the prevalence of stunting, wasting and underweight in Ethiopia was 40%, 9%, and 25% respectively. The percentage of children stunted and underweight is higher in rural areas than in urban areas (16), indicating inappropriate child caring practices in rural area (17). In 2016, the prevalence of stunting, wasting, and underweight in Ethiopia was estimated to be 38%, 10%, and 24% respectively. Likewise, 58% of infants under age of 6 months were exclusively breastfed. Seven percent of children ages 6-23 months meet the criteria for a minimum acceptable diet. Overall, more than half of children 6-59 months suffered from some degree of anemia (18). Figures 1.8 and 1.9 show trend and regional prevalence of child malnutrition in Ethiopia from 2000-2016.

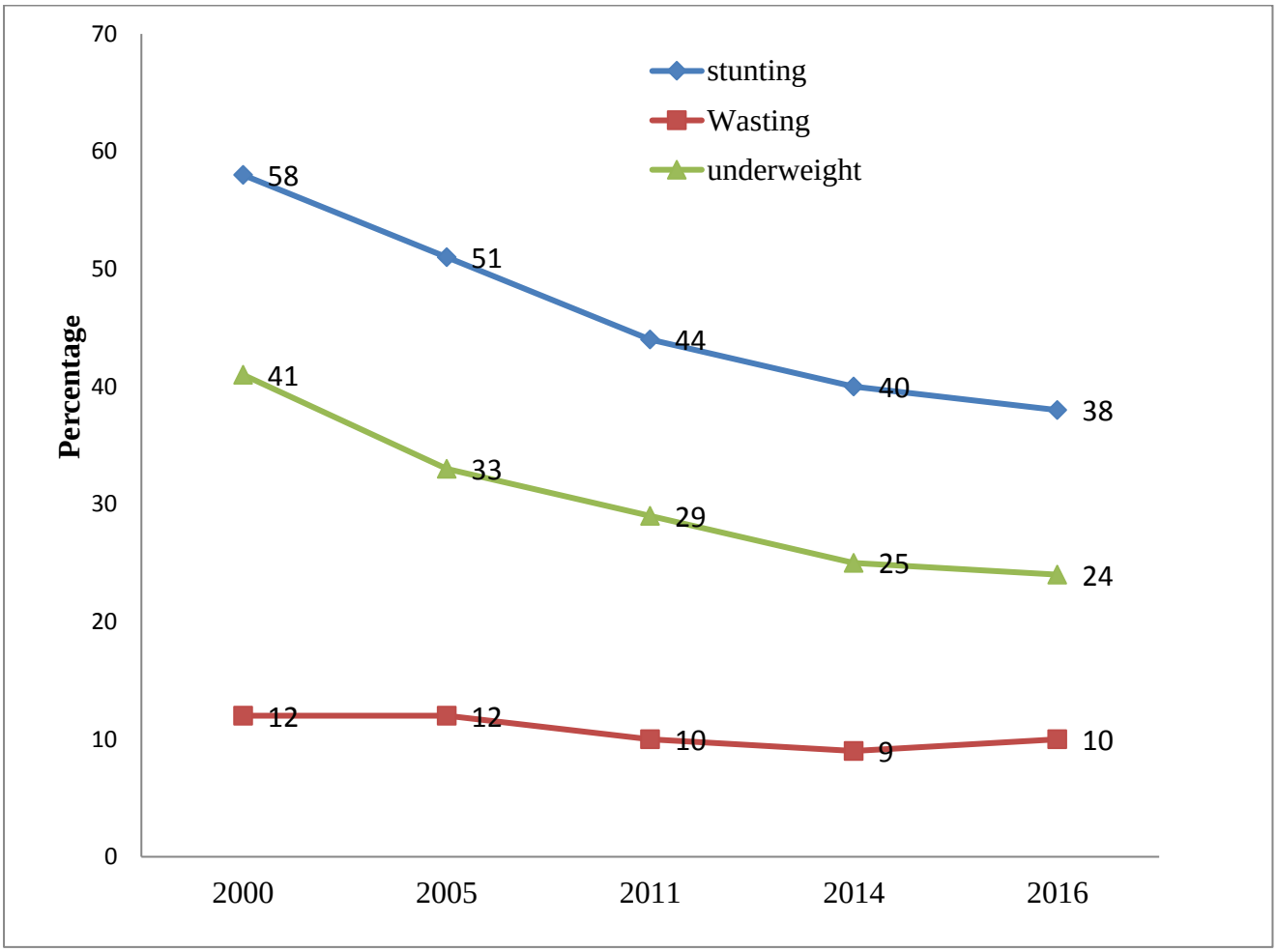

Figure 1.8. Trend of child malnutrition in Ethiopia from 2000-2016 (EDHS, 2016)

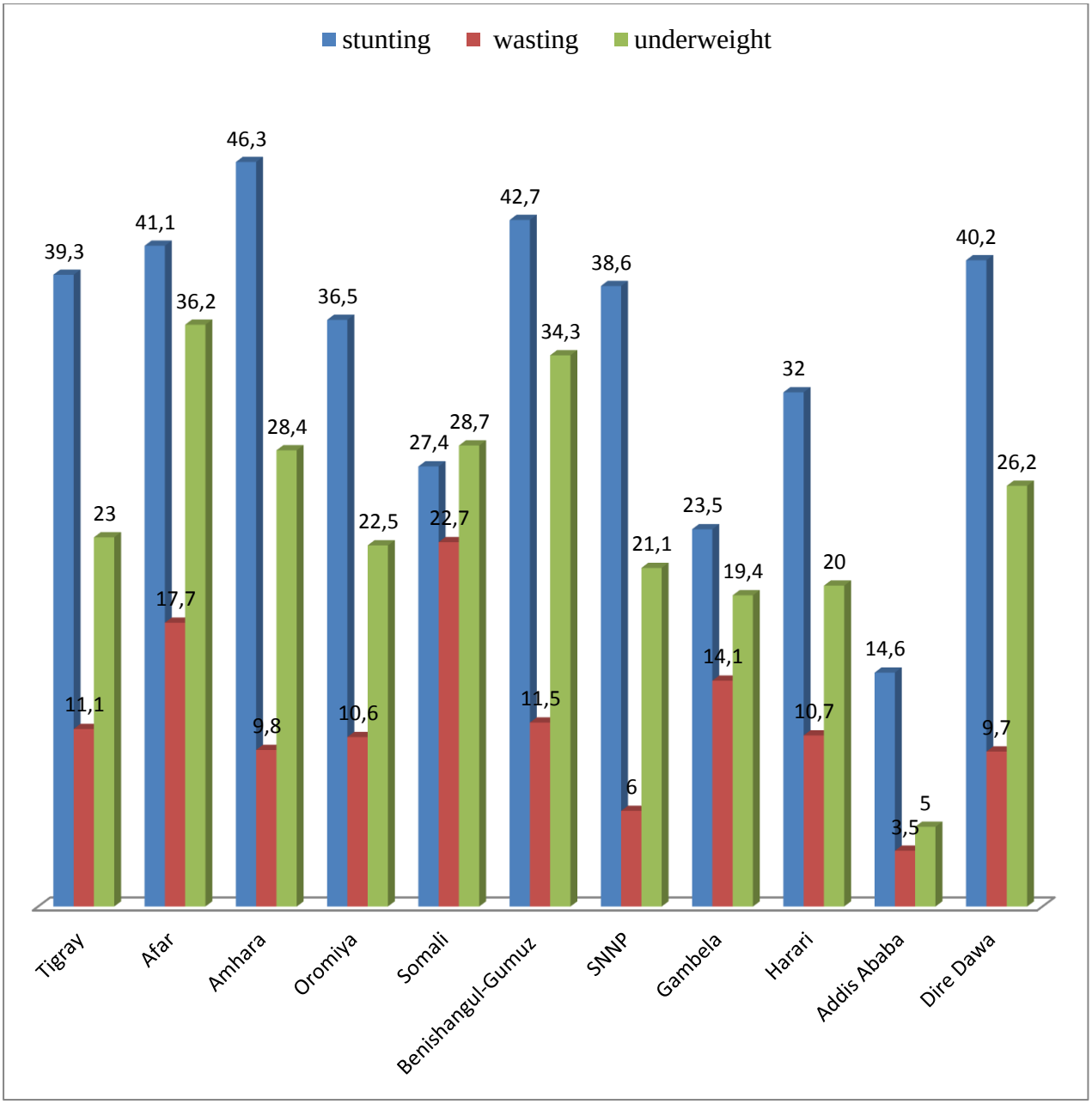

Figure 1.9. Nutritional status of children by region using EDHS 2016 (EDHS, 2016)
SNNPR: Southern Nations, Nationality and People's Region of Ethiopia

Only half of children in Ethiopia are introduced complementary foods at the appropriate time. Similarly, 25% of women of reproductive age are undernourished, which predisposes their children to low birth weight, short stature, lower resistance to infections and higher risk of disease and death (19). Ethiopia has designed a national development framework to end hunger and undernutrition. The framework was designed to help realize Ethiopia's vision of becoming a lower-middle-income country by 2025. The plan includes stunting reduction as a

key indicator and emphasizes food security and nutrition as main priorities for economic development.

The Ethiopian government recognizes that sustainable economic growth cannot be achieved without addressing malnutrition (20). Unfortunately, leadership, coordination, collaboration, advocacy, and budget are the key challenges to implement the multi-sectoral national nutrition program in Ethiopia (21,22). Figure 1.10 presents the nutritional status of children by age. The onset of growth failure begins early in life before 6 months and more increased in the 18-24 months and thereafter. This clearly indicates the problem of complementary feeding practices and child seeking behavior in Ethiopia.

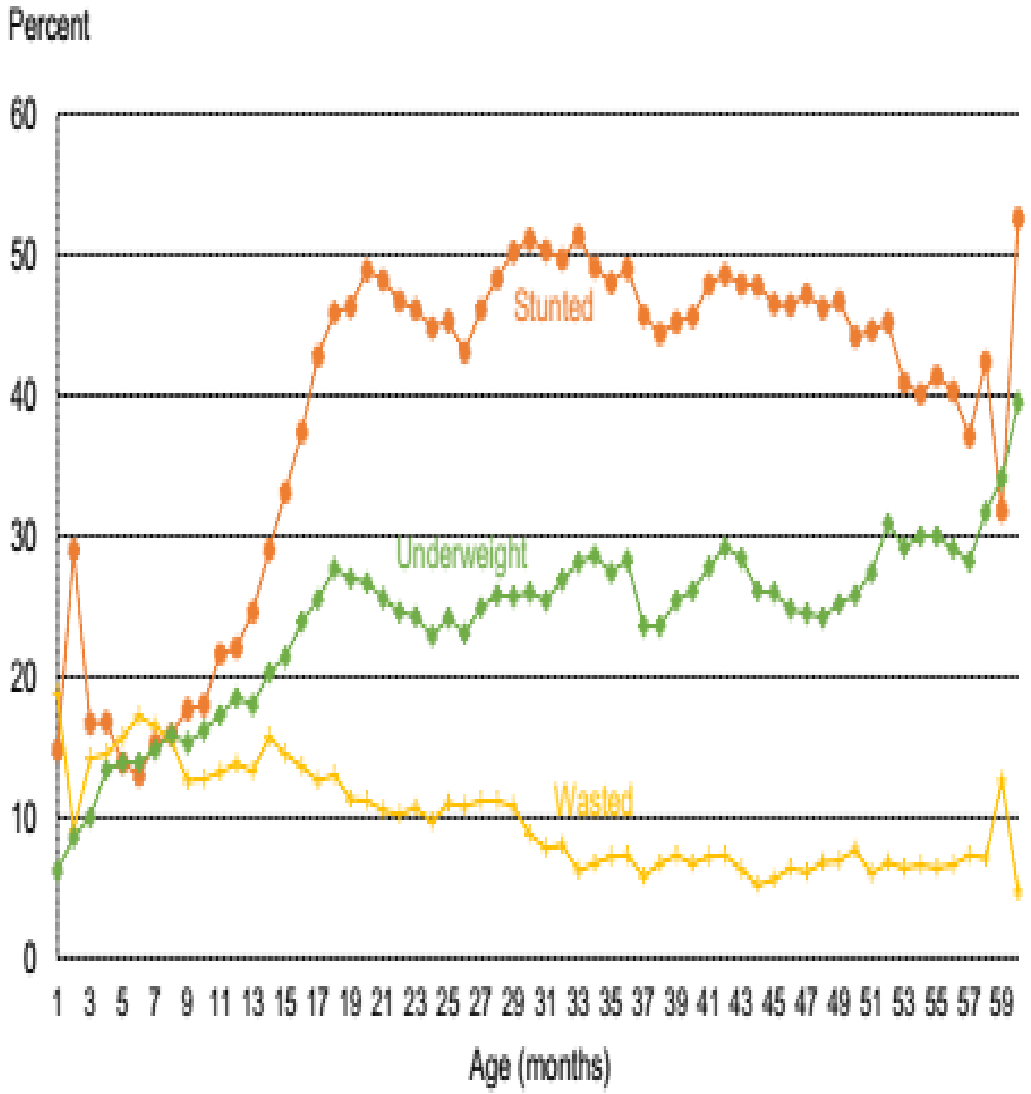

Figure 1.10. Nutritional status of children by age using EDHS 2016 (EDHS, 2016)

1.5. Cause of malnutrition

Figure 1.11 illustrates the immediate, underlying and basic causes of malnutrition.

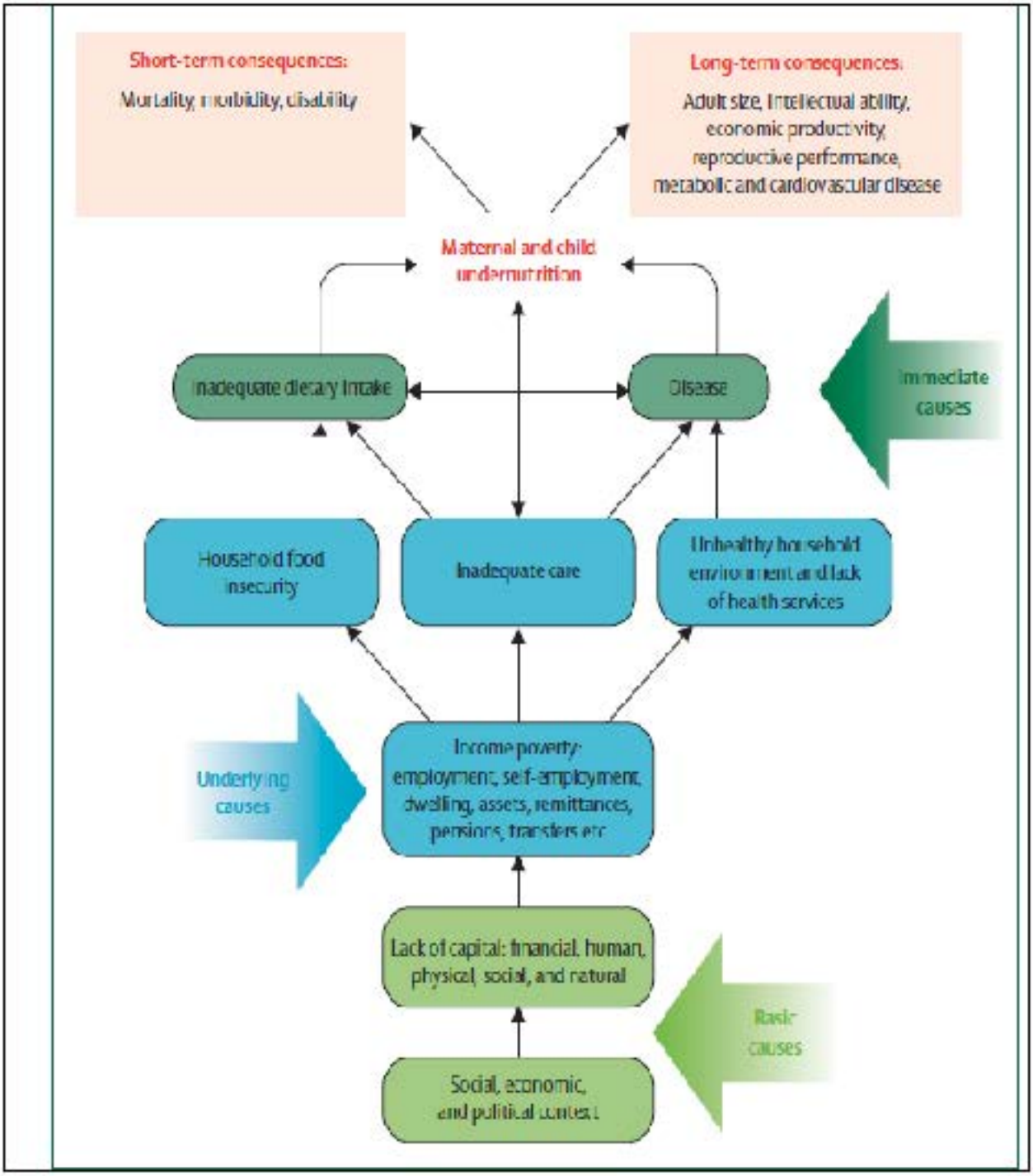

Figure 1.11. Framework for the relations between poverty, food insecurity, and other underlying and immediate causes to maternal and child under nutrition and its short-term and long-term consequences (Lancet series on maternal and child nutrition (11))

1.5.1 Immediate causes of malnutrition

Undernutrition is caused by an inadequate consumption of energy and nutrients and recurrent infections which increase requirements and prevent the body from absorbing nutrients (1,23). Deficiencies of essential vitamins and minerals have adverse effects on child survival and development (24). Forty-five percent of all deaths of children are due to fetal growth restriction, sub-optimum breastfeeding, stunting, wasting, and deficiencies of vitamin A and zinc (25).

Maternal undernutrition contributes to fetal growth restriction, risk of neonatal deaths, for survivors and of stunting (26). Low birth weight and small-for-gestational age have a strong association with wasting, stunting and underweight. They contribute to 20%-30% of childhood undernutrition (27). Therefore, good nutrition is a key to ensure optimum development and longer-term gains in human capital.

1.5.2. Underlying causes of malnutrition

Household food insecurity, inadequate care, unhealthy household environment, and lack of health services are underlying causes of malnutrition. Appropriate caring practices include breastfeeding, complementary feeding, hygiene, and health seeking behaviors support good nutrition. Caring practices are challenges during emergencies and lead to poor dietary intake and increased infections (23,28). A review in 2008 recognized that the underlying causes of undernutrition were environmental, economic, and political contextual factors (11).

Maternal undernutrition affects the composition of breastmilk. The concentration of micronutrients in breast milk is dependent on maternal status and nutrient intake (36,37). Maternal supplementation with micronutrients increases the amount secreted in breast milk, which can improve infant nutritional status (11).

1.5.3. Basic causes of malnutrition

Human resource, structural, financial resources, the political, legal and cultural factors are basic causes of malnutrition (23,38). Due to global food price volatility, mothers and children in developing countries have a limited choice, which affects both quantity and quality of the food available for consumption by children. Many organizations do not provide paid maternity leave and do not have a private place to breastfeed in working pace. Legislation of maternity leave and policies that provide time, space, and support for breastfeeding in the

workplace could reduce this barrier. Due to absence of maternity leave for six months and baby-friendly hospitals, women cease breastfeeding early in order to return to workplace. For mothers who work in farming, family and community support can help to continue breastfeeding (39).

Political attention related to under nutrition increased significantly at global, regional, and local levels over the last year (40). This increased attention creates a window of opportunity for commitments from various national governments, international organizations and funding agencies. It is also a timely effort to ensure concerted efforts, foster common understanding of the main causes of malnutrition and consensus on options for addressing malnutrition effectively among stakeholders (40,41). However, the main challenges to date are to enhance and expand the quality and coverage of nutrition-specific interventions and to maximize the nutrition-sensitivity of interventions, and to ensure common understanding between agriculture, nutrition and health sectors (40,41).

In sub-Saharan Africa, more than 95% of farmers rely on low-input low-output rain-fed agriculture associated with seasonal food insecurity and malnutrition among a great number of poor families (42). Low use of modern agricultural technology and poor market access could lead to seasonal fluctuations of household food consumption in particular in the more isolated rural households (43). In Ethiopia, rained agriculture, lack of irrigation, lack of infrastructure, population pressure, recurrent drought, erosion and land degradation, livestock disease, post-harvest and storage loss and limited market access to foods are the basic causes for seasonal variation of food security and child malnutrition (44).

1.6. The consequences of malnutrition

Figure 1.8 summarizes the short and long- term consequences of malnutrition. Globally, one third of child mortality annually is due to malnutrition (1). Malnutrition has short and long-term consequences and intergenerational effects. The long-term negative effects include impaired cognitive and physical development, reduced productive capacity, poor health, and an increased risk of degenerative diseases (7,28,45).

Undernutrition undermines the survival, growth, and development of children and diminishes the strength and capacity of nations. With persistently high levels of undernutrition in the developing world, vital opportunities to save millions of lives are lost and children are not growing and thriving to reach their full potential (8,46,47).

Malnutrition is an underlying cause of death for 2.6 million children each year, and it leaves millions with lifelong physical and mental impairments. Worldwide, more than 170 million children do not have the opportunity to reach their full potential due as a result of it. The period from the start of a mother's pregnancy through her child's second birthday is critical for nutrition as the child's brain and body are developing rapidly. At this time, good nutrition is essential as a foundation for healthy and productive future generations. If children do not get the right energy and nutrients during this period, the damage can be irreversible (39,48).

Undernutrition contributes to more than one third of all deaths in children under the age of five. Undernutrition in children under-age 2 diminishes the ability of children to learn and earn throughout their lives. Nutritional deficiencies leave children tired and weak, and lower their intelligence, leading to poor school performance. Adults who suffered from malnutrition during childhood are less productive and earn less than their healthy peers earn. Therefore, the effect of undernutrition and poverty perpetuates from generation to generation (8,46,49).

Undernutrition is strongly associated with shorter adult height, reduced economic productivity, and birth weight of offspring. Lower birth weight and undernutrition in childhood is associated with metabolic syndrome, lung function, incidence of cancers and mental illness (26,33). Chronic diseases are especially common in undernourished children who experience rapid weight gain after infancy (33,49).

1.6.1. The consequences of child caring practices

Optimal infant and young child feeding however, can prevent 1.4 million deaths every year (11). As a global public health recommendation, infants be should exclusively breastfeed for the first six months of life to achieve optimal growth, development and health (13). Exclusive breastfeeding reduces mortality from diarrhea and pneumonia, the two largest contributors to infant deaths. Continued breastfeeding up to 23 months leads to continued protection against illness, including diarrhea and respiratory infection (14).

From six months of age onwards, infants enter a particularly vulnerable period of complementary feeding during which they make a gradual transition to eating family foods. The incidence of malnutrition rises sharply during the period from 6 to 18 months of age in most countries, and the deficits acquired at this age are difficult to compensate for later in life (15). Figure 1.12 presents WHO conceptual framework on the effect on complementary feeding on childhood stunting.

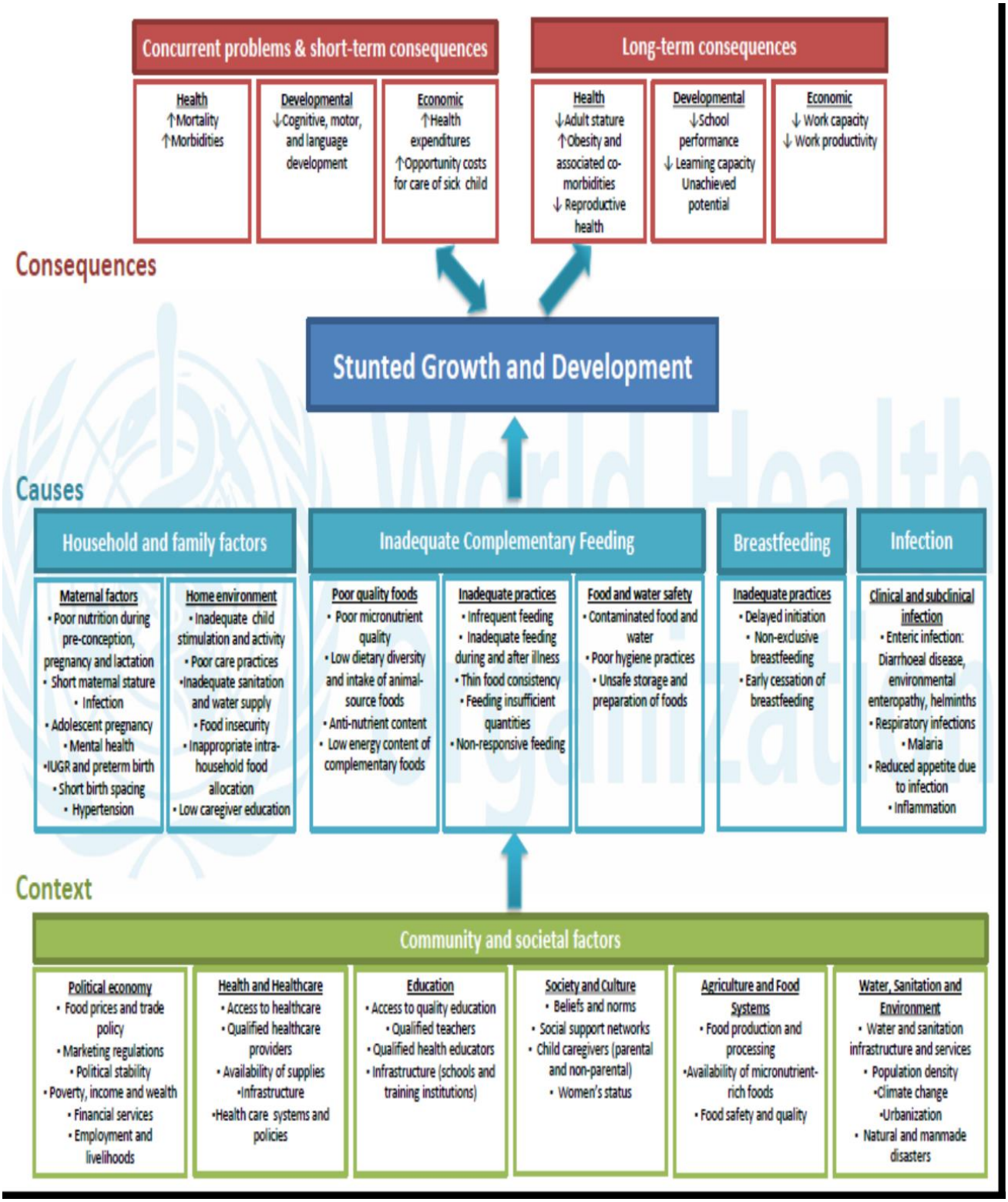

Figure 1.12. WHO conceptual framework of childhood stunting with an emphasis on complementary feeding (WHO conceptual framework on Childhood Stunting, 2013 (50))

1.6.2. The consequences of multiple anthropometric deficits

Compared to those with only single anthropometrical failure, children with more than single anthropometrical failures are more likely to have diarrhea and suffer from increased morbidity and mortality (51). Although the proportions of children suffering from multiple anthropometrical failures are likely to be substantial, only a few studies have addressed multiple anthropometrical failures, their effect (51–53). In addition, lack of an integrated approach to understand and address undernutrition in children has contributed to the fragmentation of efforts to address malnutrition, resource allocation and development of interventions (54). Identifying children with multiple anthropometric failures may therefore help prioritize and guide interventions towards the most vulnerable groups (55–58).

1.6.3. The consequences of seasonality

Due to the seasonal variability of food production, dietary intake, food security and morbidity in the developing world, many children suffer from impaired growth (29,30). Populations in many developing countries are vulnerable to seasonal food shortages due to rain-fed subsistence farming. Seasonality affects millions of the world's poor communities and is a driver of some of the most widespread diseases and food shortages (31).

When a household does not have enough food, children are vulnerable to become malnourished. Children however, have the right to a caring and protective environment in which mothers, fathers or other caregivers make sure they are well nourished with a healthy diet (1). Children who are not optimally breast-fed and suffering from micronutrient deficiencies have low chances of survival (32). Pregnancy nutritional status affect offspring body size and composition and adult livelihood (33).

Women are gatekeepers of the family diet and are key to select, prepare, and serve nutritious foods to support families and households. However, the quality of diets of women is often overlooked (34). During periods of shortage of food supply, women reduce their intakes to secure that of their infants and small children (35).

Child undernutrition generates an economic costs equivalent to between 1 and 11 percent of the total public budget allocated to health (59). Fifty-two percent of the working age population in Egypt, Ethiopia, Swaziland and Uganda currently are stunted. The working-age population has been diminished by 1 to 8 percent due to child mortality associated with

undernutrition. A reduction of the prevalence of under nutrition by half in 2025 can generate annual average savings from USD 3 million to USD376 million (59). The economic impact of malnutrition is summarized in Figure 1.13.

In Ethiopia, the majority of child undernutrition goes untreated and an estimated 44% of the health costs associated with undernutrition occurs before the child turns 1-year-old. Twenty-eight percent of all child mortality in Ethiopia is associated with undernutrition. Sixteen percent of all repeat in primary school is associated with stunting. A total of 55.5 billion Ethiopian Birr (US$4.7 billion) annual costs associated with child undernutrition, which is equivalent to 16.5% of GDP. Undernourished children are at higher risk of anemia and childhood illnesses. This causes an additional cost to the health system and families (60).

Therefore, improving nutrition in early childhood can led to substantial increases in wage rates, which suggests that investments in early childhood nutrition can be long-term drivers of economic growth (61).

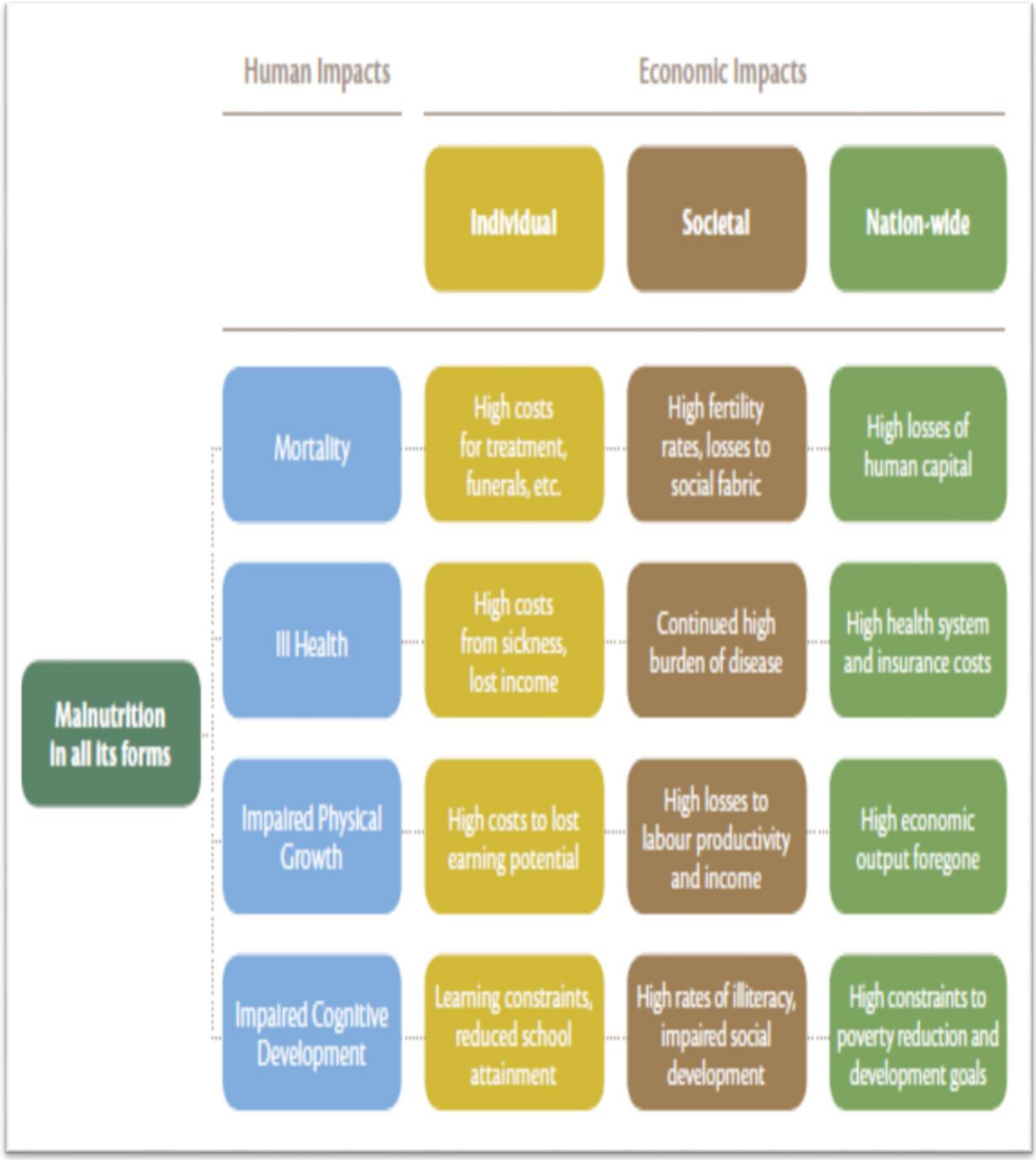

Figure 1.13. Conceptual framework to assess the economic impact of malnutrition in all its forms (Global Panel on Agriculture and Food Systems for Nutrition, 2016 (62))

1.7. Action for malnutrition

The promotion of breastfeeding and complementary feeding, provision of food supplements, micronutrient interventions, supportive strategies to improve family and community nutrition and reduction of disease burden are all acknowledged for their role to tackle under nutrition. Effective micronutrient interventions for pregnant women have increased hemoglobin and reduced the risk of low birth weight. To eliminate stunting in the longer term however, nutrition interventions should be strengthened by reduction of poverty and overall improvement of maternal education, disease burden, empowerment of women (63,64).

Reduction of child undernutrition can be achieved through improvements in women's nutrition before and during pregnancy, early and exclusive breastfeeding and good-quality complementary feeding with appropriate micronutrient interventions. Large-scale programmes including the promotion, protection, and support of exclusive breastfeeding, providing fortified foods and supplements and community-based management of malnutrition should be implemented to reduce child under nutrition. Interventions should be feasible, affordable and cost-effective and considering nutrition interventions as the best investments in development that countries can undertake (8).

Child survival should remain at the heart of international development agenda in the post-2015 era. The global health community should show steadfast commitment to child survival by building up knowledge and experience. Leadership and accountability for child survival should be strengthened and shared among the UN system, governments in high-income, middle-income, and low-income countries, and non-governmental organizations (65).

The United Nations Sustainable Development Goals are developed to complete the unfinished agenda of the Millennium Development Goals such as eradicating poverty and hunger, universal primary education, women's and girls' equality, child and maternal health and environmental sustainability (66) and respond to new global challenges (67).

All 17 sustainable development goals have a nutrition dimension. Especially, 12 of the sustainable development goals have strong and direct linkages with nutrition and relevant indicators. Nutrition is both an input and the outcome of the UN sustainable development goals and improving nutrition is hence pivotal to ensure sustainable development (6).

Nutrition plays a part in strengthening development mechanisms and instruments of economic growth strategies, health sector reform, improved governance, and human rights (67,68). Figure 1.14 illustrates the link between nutrition and sustainable development goals.

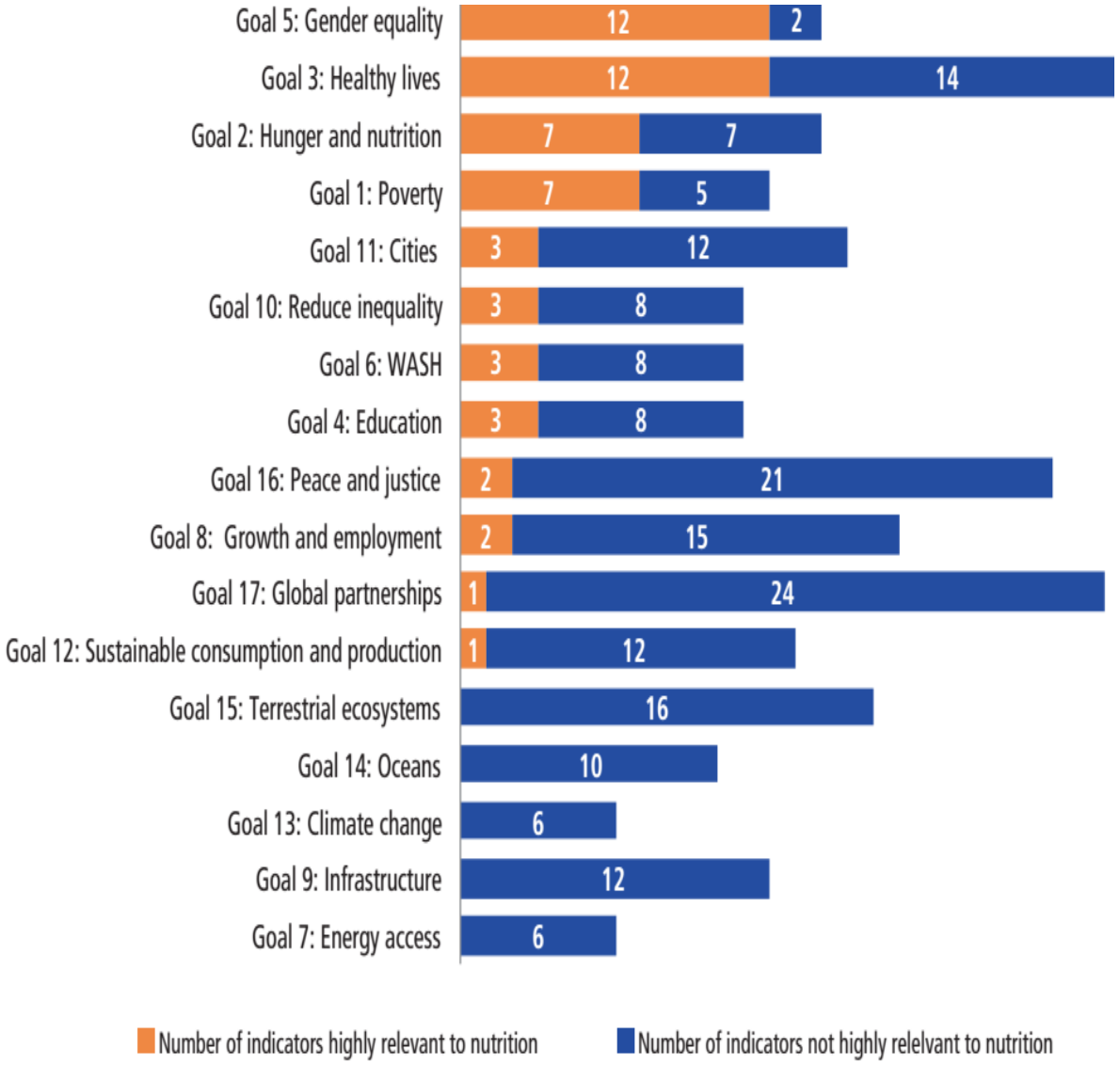

Figure 1.14. Number of indicators per sustainable development goal that are highly relevant for nutrition (Global nutrition report, 2016)

Nutrition policies and strategies must be strengthened to address the growing double burden of malnutrition. Strong coordination between actors and programmes is essential to ensure a multisectoral response to malnutrition (69,70). Accelerating progress in nutrition will require effective, large-scale nutrition programmes that address key underlying determinants of nutrition and enhance the coverage and effectiveness of nutrition interventions. Nutrition-

sensitive programmes can help to scale up nutrition-specific interventions and create an environment in which young children can grow and develop to their full potential (61,69,71).

Due to the global public health relevance, the World Health Assembly reached an agreement on the need for rapid global action on nutrition. Six global nutrition targets to be achieved by 2025were identified reducing stunting by 40%; anemia in women of reproductive age by 50%; low birth weight 30%; no increase in child overweight; wasting to less than 5% and increase exclusive breastfeeding by 50% (72).

The Scaling up Nutrition (SUN) movement convenes different stakeholders i.e. governments, civil society, the United Nations, donors, businesses and scientists to improve nutrition. The intention of the movement was to strengthen collaboration and country-led action for nutrition (73) with particular effort on the poorest and the most vulnerable groups of the population.

The motto of the SUN is ‘working together across the diversity of sectoral approaches, stakeholder interests and institutional mandates will be possible to achieve the progressive realization of the right to adequate food, and nutrition justice for all’(74). Nutrition action will be scaled up through both nutrition-specific and nutrition-sensitive interventions (26,75–77). Figure 1.15 shows the nutrition-specific, nutrition-sensitive interventions, enabling environment components, and their effects of on optimum fetal and child nutrition and developments.

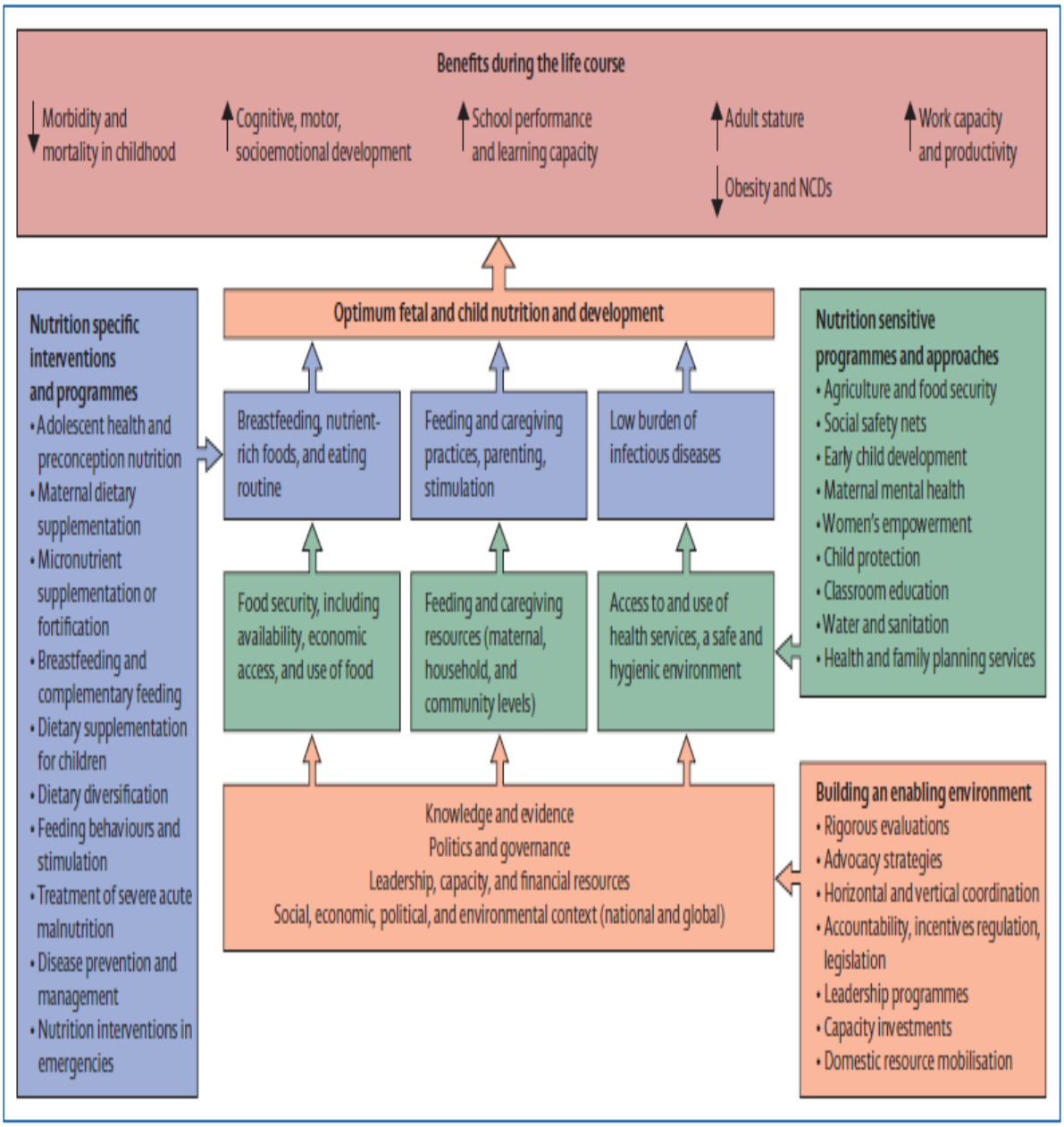

Figure 1.15. Framework for actions to achieve optimum fetal and child nutrition and development (Lancet series on maternal and child nutrition (26))

The USAID launched a multi-sectoral nutrition strategy for 2014-2025 to decrease chronic malnutrition by 20% and maintaining global acute malnutrition below the emergency threshold of 15%. The strategy has four objectives: 1) Increased equitable provision and utilization of high-quality nutrition services; 2) Increased country capacity and commitment to nutrition; 3) Increased multi-sectoral programming and coordination for improved nutrition outcomes and 4) increased global nutrition leadership (78).

The European Commission launched a new partnership to fight undernutrition with the aim of reducing chronically undernourished by seven million by 2025 (79). The European Commission also created national information platforms for nutrition initiative with partner countries like Bangladesh, Burundi, Ethiopia, Kenya, Laos and Niger to improve policies and enhances political commitment for nutrition, strengthen the analytical capacity and knowledge in nutrition and improve programmes and interventions for better nutrition (80).

In 2014, the African Union, also passed three declarations with specific commitments of ending hunger by 2025, improving nutritional status, reducing child stunting to 10% and underweight to 5% by 2025, and accelerating progress on preventing child and maternal deaths (81).

The Ethiopian government launched the multi-sectoral national nutrition program-I from 2013-2015, which help to reduce malnutrition in the country with collaboration of different sectors and stakeholders (21,22). In 2015, an ambitious initiative named ‘Sekota Declaration’ was proclaimed to end hunger and under nutrition by 2030 with the goal to improve nutrition to save lives, build resilience, increase economic productivity, and advance development (44,82).

In 2016, the Ethiopian government launched the multi-sectoral National Nutrition Program II 2016-2020 with the aim of eradicating chronic malnutrition by 2030. The strategic objectives are improving the nutritional status of women of reproductive age and adolescent girls, the nutritional status of children from birth up to 10 years, the delivery of nutrition services for communicable and non-communicable diseases, multisectoral coordination and capacity and strengthen the implementation of nutrition-sensitive intervention. The new national nutrition program aimed to reduce stunting from 40% to 26%, underweight from 25% to 13% and wasting from 9% to 4.9% (82,83).

1.8. Rationale of the study

Ethiopian children suffer from a high prevalence of malnutrition, morbidity and seasonal variation of food availability. To date, no studies have addressed child malnutrition with comprehensive analysis of child caring practices, seasons and nutrition, and their determinants. Existing research has focused on a single component of caring practices. This contributed to the fragmentation of efforts to address malnutrition, resource allocation and development of interventions (54–58). In addition, there is a gap in policies, implementation, and intersectoral collaboration related to child caring, seasonality, nutrition and their effect on child morbidities and mortality. In addition, studies to date are principally cross-sectional and provide poor guidance and evidence for policy makers to design comprehensive nutrition interventions.

The current research aimed to address and fill the existing gap on child caring practices, seasonality, nutrition and their driving factors. The findings provide input forth formulation of policy and nutrition program planning of the country and provide an entry point for integrated multisectoral nutrition interventions.

1.9. Aims of the study

The main aim of PhD project was to investigate child malnutrition in Ethiopia through a comprehensive analysis of child caring practices, seasonality of growth and nutrition, and their determinants.

1.9.1. Specific objectives

1. To determine concordance of poor child feeding and preventive behavior and its predictors in southwest rural Ethiopia;
2. To determine undernutrition and their determinants in an Ethiopian sample of children according to composite index of anthropometrical failure and conventional indices over time;
3. To compare the association of multiple anthropometrical failure and conventional indices with child morbidity and changes overtime, and
4. To investigate the seasonality of child growth velocity and deficits and their determinants in rural communities of southwest Ethiopia.

1.9.2. Research hypotheses

1. There is a significant concordance of poor child feeding and preventive behaviors in rural communities of southwest Ethiopia;
2. Conventional indices (e.g. stunting, wasting and underweight) fail to assess undernutrition as compared with composite index of anthropometrical failure;
3. Children with multiple anthropometrical failures are more likely to suffer from child morbidity compared to those with a single anthropometric failure and conventional indices over time, and
4. Children have better growth velocity in post-harvest season than pre-harvest season.

1.10. Dissertation outline

In this section, the organization of the manuscript is outlined briefly. This PhD dissertation is compiled from manuscripts, which have been published international A1 journals. Figure 1.16 describes the schematic presentation of the PhD dissertation.

Chapter 1 provides a general overview of malnutrition from global to local context, causes, consequences of malnutrition and action for malnutrition reduction. It also includes the objectives and research questions.

Chapter 2 outlines of the study setting and methods. It explains how the PhD research was conducted, where and when the research took place, the study population and what measures were used to address the PhD objectives.

Chapter 3 describes concordance of poor child feeding and preventive behavior and its predictors in southwest rural Ethiopia. It summarizes how children are suffering from child feeding and preventive behavior and uncovers the driving factors of double burden of poor child feeding and preventing behaviors.

Chapter 4 investigates the determinants and morbidities of multiple anthropometric deficits in southwest rural Ethiopia. This chapter describes the correlation between multiple anthropometric failures and child morbidities, comparing conventional indices with composite index to estimate the prevalence of undernutrition and their driving factors.

Chapter 5 assesses seasonality of child growth velocity, deficits and their determinants in southwest rural Ethiopia. It assesses seasonality as a determinant of child growth in Ethiopia. In addition, associations of seasonality and child growth velocity and growth deficits are assessed.

Chapter 6 is the general discussion. It integrates the findings from the various studies, presents possible implications of the findings for nutrition programming and suggestions for future research directions. This chapter presents the policy implication, research perspectives, future challenges and opportunities to address malnutrition in developing countries.

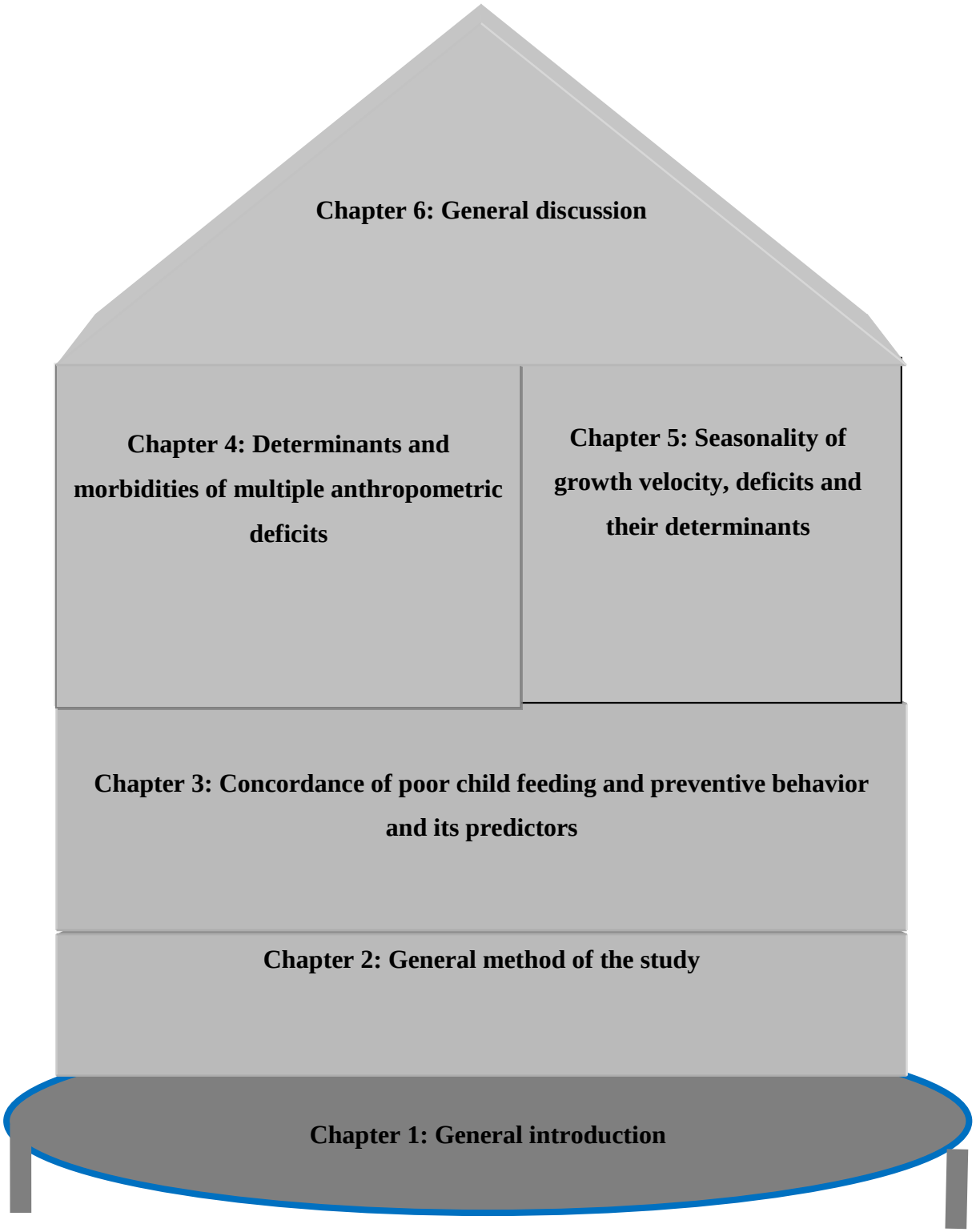

Figure 1.16. Schematic representation of the PhD dissertation

2

Chapter 2

General methods

2.1. ENGINE project descriptions

Empowering New Generations to Improve Nutrition and Economic Opportunities (ENGINE) project, a five-year programme that was conducted from September 2011-September 2016 in four regions of Ethiopia (Figure 2.1). The goal of ENGINE project was to improve nutritional status of women and young children through sustainable, comprehensive, coordinated and evidence-based interventions. The specific objectives were to strengthen the capacity to institutionalize nutrition programs and policies, improve quality and delivery of nutrition services, improve community-based nutrition care practices and adopt a rigorous and innovative research and learning agenda. ENGINE project had two sub-teams which were implementation and research teams. The project was implemented by Save the Children. The research was conducted in collaboration of Tufts University, USA with Jimma University, Hawassa University and the Ethiopian Public Health Institute.

ENGINE contained various capacity building activities and provision of technical assistance for health facility staff and frontline health and agriculture workers. It also promoted optimal maternal and infant young child feeding practices and dietary diversity through dynamic communication channels like individual counseling, innovative enhanced community conversation, mass media, radio drama, and role models and cooking demonstration. ENGINE also aimed to increase the production of micronutrient rich fruits, vegetables, animal products, and livestock as well as increased household income through livelihood and economic strengthening approaches. This was implemented through farmer training centers and school gardens. Households received training and support on the adoption of agricultural technologies and management of livestock for animal product production.

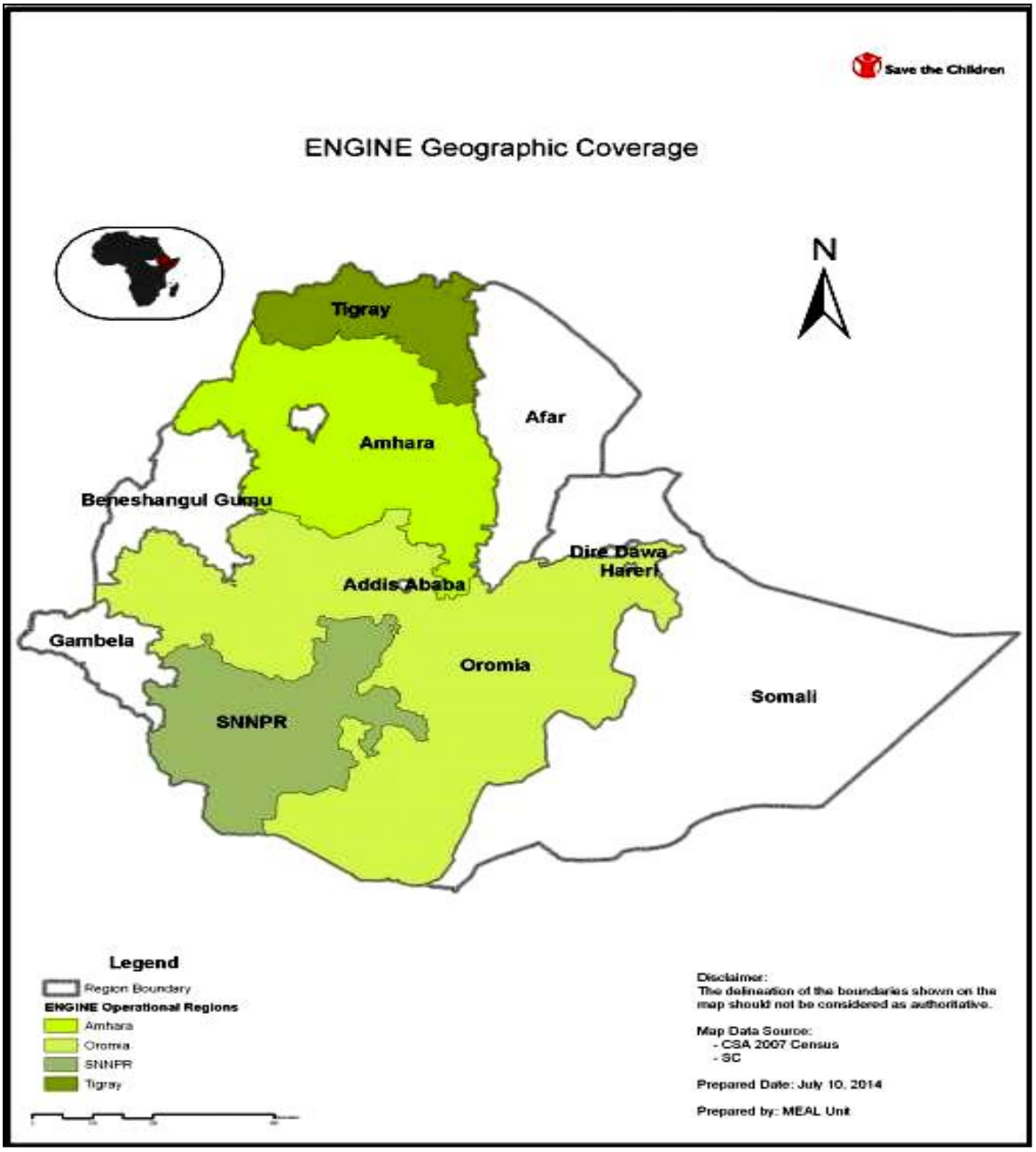

Figure 2.1. ENGINE intervention areas in four regions (Amhara, Oromiya, Tigray, and SNNPR) of Ethiopia

2.2. Study design and population

An agriculture-nutrition panel survey was carried out in collaboration of Tufts University, USA with Jimma University, Hawassa University and the Ethiopian Public Health Institute as an operational study to build research capacity in Ethiopia.

The agriculture-nutrition panel survey was conducted in a selected number of ENGINE intervention woredas with the aim of addressing seasonality of agricultural activities, food availability, household food consumptions, optimal maternal and infant young child feeding practices and dietary diversity and maternal and child nutrition status.

For the present PhD thesis, data generated from four rounds of the longitudinal panel survey was used. Round one and three were conducted from February 9-April 9/2014 and March 4-May 01/2015, which were both post-harvest seasons. Round two and four were conducted from September 22-November 19 /2014 and August 31-October 29/2015, which were pre-harvest seasons (Table 2.1). Data were collected in 20 kebeles (equivalent to a county and the smallest administrative unit in Ethiopia), located in 10 districts in Oromiya Region and Southern Nations, Nationality and People's Region of Ethiopia. Most of the households sampled lived in midland (Woina-Dega), while some were situated in the highland (Dega) areas.

Table 2.1. Agriculture-nutrition panel survey from 2014-2015

Round	Season	Start date	Completion date
Round one	Post-harvest	February 9,2014	April 9,2014
Round two	Pre-harvest	September 22, 2014	November 19,2014
Round three	Post-harvest	March 4,2015	May 1,2015
Round four	Pre-harvest	August 31,2015	October 29,2015

2.3. Sample size

The ENGINE project involved the follow-up of 1200 households to provide the opportunity to rigorously research how and why specific strategies and approaches address food security and nutrition concerns of women and children in smallholder farming households. From the 1200 households, 623, 681 712 and 737 households had children under-age of five in first, second, third and fourth waves of data collection, respectively.

All children under the age of five and their caretakers were included this study. Since the study was an open panel survey, newborn children in the sampled households during the follow-up period were included prospectively. In case there were two or more children under five years of age in a selected household, one child was selected randomly. The same children and their respective caretakers were followed and interviewed for the subsequent survey rounds (Table 2.2).

2.4. Sampling procedure

Ten districts were selected from an ENGINE project area based on logistic feasibility. Lists of all the kebeles within these ten districts were prepared. From these lists, two kebeles were randomly selected in each district. The households were recruited using the expanded program on immunization sampling method (84). First, the kebele was divided into four quarters with approximately equal household densities. Second, a household in the center of each of the quarters was identified. In each quarter, the enumerators moved in a random direction, determined by spinning a pen and selecting every second house in that direction. The number of households per kebele was determined based on probability proportional to the size of the kebele.

Table 2.2. Sample size for each region, zone, woreda, and kebele, 2014

Region	Zone	Woreda	Kebele	Sample size
Oromiya	Illu Ababora	Gechi	Chara	56
			Gito	27
	Bale	Gasera	Ilu kerisha	62
			Shelili	71
	Illu Ababora	Dedesa	Seneso	50
			Yembero	97
	South West	Wonchi	Kurfo Gute	49
	Shewa		Harro Wonchi	81
	Jimma	LemuSeka (#1)	Bontu	83
			Santo	60
	Jimma	LemuSeka (#2)	Gejeb	48
			Merochisa	58
	Jimma	Gera	Yukro	53
			Kele	44
	Jimma	Gomma	Bulbulo	60
			Limusapa	60
SNNPR	Guragie	Enemor ena ener	Gazanche	60
			Baruwa	60
	Kafa	Chena	Boba bola	79
			Gurech	42
Total				1,200

SNNPR: Southern Nations, Nationality and People's Region of Ethiopia

2.5. Measurements

Data were collected using a pretested interviewer-administered survey. The project employed a multi-disciplinary team consisting of 26 data collectors with the background of health and agriculture and six supervisors from one of the two disciplines. A structured pretested questionnaire was prepared in Afan Oromo or Amharic and administered using an electronic tablet. Supervisors transferred data to the central database via a wireless internet connection from the tablets every week. Variables, which are listed here, are common variables for all objectives and objective specific variables were mentioned under respective chapters.

Measurements related to child feeding and preventive behavior, decision-making power of women, cultural norms and decision-making power of women are explained in chapter three. Anthropometric data and estimation of undernutrition are further described in chapter four, while assessment of seasonality, growth velocity and growth deficits are included in chapter five.

2.5.1. Dietary diversity

A 24-hour qualitative dietary recall method was used to measure child dietary diversity score (CDDS) and household dietary diversity score (HDDS). The CDDS was calculated from 7 food groups according to the World Health Organization indicators for assessing infant and young child feeding practices (85):

1. Grains and tubers;
2. Milk;
3. Vitamin A-rich fruits and vegetables;
4. Other fruits, vegetables, or juices;
5. Flesh foods (meat, fish, poultry, and liver/organ meats);
6. Eggs; and
7. Legumes

The HDDS was calculated from 12 food groups according to the Food and Agriculture Organization (86):

1. Cereals;
2. White tubers and roots;
3. Vegetables;
4. Fruits;
5. Meat;
6. Eggs;
7. Fish and other seafood;
8. Legumes, nuts and seeds;
9. Milk and milk products;
10. Oils and fats;
11. Sweets; and
12. Spices, condiments and beverages

2.5.2. Household food insecurity

Household food insecurity was measured using a Household Food Insecurity Access Scale (HFIAS) adapted from household food insecurity scales that were previously validated for use in developing countries (87). The HFIAS consists of two types of related questions. The first question type is called an occurrence question. There are nine occurrence questions, which ask whether a specific condition associated with the experience of food insecurity ever occurred during the previous four weeks (30 days). Each severity question is followed by a frequency-of-occurrence question, which asks how often a reported condition occurred during the previous four weeks.

Each occurrence question consists of time frame for recall and two response options (Yes/No). Where the response 'no' is given for an occurrence question, the related frequency-of-occurrence question becomes redundant and automatically skips to the next question. Where the response 'yes' is given for an occurrence question, the frequency-of-occurrence question were asked.

Each HFIAS frequency-of-occurrence question asks the respondent how often the condition reported in the previous occurrence question happened in the previous four weeks. There were three response options representing a range of frequencies: 1 = rarely i.e. once or twice in the past 4 weeks; 2 = sometimes – 3 to 10 times in the past 4 weeks; and 3 = often i.e. more than 10 times in the past 4 weeks. Finally, the responses were summed to produce an index of household food insecurity. The distribution of the index of household food insecurity was divided into tertiles representing food-secure households, moderately food-insecure households, and highly food insecure households.

2.5.3. Morbidity

The diagnosis of the three illnesses was based on standardized assessment as used in the Demographic Health Survey questionnaire (88). Childhood morbidity was reported by the mothers. Mothers were asked if their child had any illness, diarrhea, or a cough in the 2 weeks preceding the data collection. For those children with diarrhea, parents were asked if there was blood in the stools. For those children with a cough, we asked if the child also had experienced breathing difficulties. An acute respiratory tract infection was defined as a persistent cough or difficulty in breathing during the past 2 week. An episode of diarrhea was defined as having at least three loose stools within a day (88).

2.5.4. Other measurements

Sociodemographic variables (age of the caretaker, age and sex of child, wealth index, and presence of children age <5 years); child feeding (meal frequency, breastfeeding); health-seeking behavior (feeding special foods after illness, feeding special foods during illness, child sleeps under a bed net last night); and sanitation and hygiene (storing place for clean dishes, type of toilet used, hand washing before serving a meal and child feeding) were measured using the Demographic Health Survey questionnaire (88).

2.6. Data quality

Before data collection, the questionnaire was pre-tested on 5% of the total sample that was not included in the final main sample. The pre-test was conducted in Yem Special District in SNNP Region and Bedele District in Oromiya region, which has similar characteristics to the main sample. A 12-day intensive training was provided to data collectors and supervisors prior to data collection. The training focused on how to ask questions, their meaning, and how to record the answers. The trainees were also encouraged to ask about issues that are unclear, pay close attention, and take careful notes on issues that they are not familiar. During and after data collection, supervisors monitored the data collection team to ensure their adherence to the study protocol. In addition, the data manager checked all the data submissions from the field on a weekly basis.

2.7. Ethical considerations

Ethical approval was obtained from the Institutional Review Board of the College of Health Sciences of Jimma University, Ethiopia, and the Institutional Review Board of Tufts University, USA. Written permission was obtained from each responsible body and informed verbal consent was obtained from each study participant. We received a waiver of documentation of informed consent from the Institutional Review Boards. The letter stated that respondents do not need to sign the consent statement because many are illiterate. However, there was a place on the form for the enumerator to sign in order to indicate that participants have read the consent form and that the person had agreed to participate. Data were registered and stored anonymously, and the questionnaire was administered in a confidential way.

2.8. Funding

This project is made by the support of the American people through USAID under Agreement No. AID-663-A-11-00017.

3

Chapter 3
Concordance of poor child feeding and preventive behavior and its predictors in southwest rural Ethiopia

Redrafted from: Fentahun N., Lachat C., Belachew T. Concordance of poor child feeding and preventive behavior and its predictors in southwest rural Ethiopia. ***Food & Nutrition Research 2016, 60(1): 32207***

Abstract

Background: Inappropriate child feeding and caring practices are a major cause of malnutrition. To date, no studies have examined concordance and discordance of child feeding and preventive behavior and their predictors in developing countries.

Methods: We used round one data generated from a 2 year longitudinal Agriculture–Nutrition panel survey. Generalized estimating equations were used to account for clustered observations.

Results: Concordance of poor child feeding and preventive behavior was observed in 45.1% of the children, while 45.5% of the children were suffering from discordance of poor child feeding and preventive behavior. Concordance and discordance of poor child feeding and preventive behavior had almost different predictors. Concordance of poor child feeding and preventive behavior was significantly associated with age of the caretaker of ≥ 40 years (OR=2.14; 95%CI (1.04, 4.41), low household dietary diversity (OR=3.69; 95%CI (1.93, 7.04), medium household dietary diversity (OR=2.17; 95%CI (1.17, 4.00), severe household food insecurity (OR=1.72; 95%CI (1.01, 2.93) and increase with increasing child age.

Conclusion*:* A substantial number of children in the southwest of rural Ethiopia are exposed to both poor child feeding and preventive behavior. Low household dietary diversity and extreme household food insecurity were predictors of concordance of poor child feeding and poor preventive behavior and provide useful entry points for comprehensive interventions to address child feeding and caring in the area.

Key terms: Child feeding, preventive behavior, rural Ethiopia

3.1. Introduction

Optimal infant and young child feeding can prevent 1.4 million deaths every year (11). As a global public health recommendation, infants should be exclusively breastfed for the first six months of life to achieve optimal growth, development, and health (13). Exclusive breastfeeding has a significant effect on the reduction of mortality from diarrhea and pneumonia, the two largest contributors to infant deaths. Continued breastfeeding up to 23 months leads to continued protection against illness, including diarrhea and respiratory infection (14).

From six months onward, infants enter a particularly vulnerable period of complementary feeding during which they make a gradual transition to eating family foods. The incidence of malnutrition rises sharply during the period from 6 to 18 months of age in most countries, and the deficits acquired at this age are difficult to compensate for later in childhood (15).

Promotion of breastfeeding, oral rehydration therapy, education about complementary feeding, and insecticide-treated materials jointly prevent more than one-third of all deaths (89). Child care practice refers to the provision of time, attention, and support to meet the physical, mental, and social needs of any specific child of any specific household and community (90). It encompasses promoting a safe and healthy environment, provision of adequate health care, psychosocial connections, and emotional support (91). Appropriate child care practice is key to ensure child survival, optimal growth, and development (92).

Malnutrition in Ethiopia is persistently high over the last several years due to poor child feeding and caring practices. In Ethiopia, mothers are responsible for child feeding and caring, while husbands are in control of household assets, purchasing food or provision of financial means to women to purchase food from the market (93).

Although the government tries to recognize the role of women and promote active participation in society, the status of women remains poor (94). The Ethiopian government is highly committed to harmonize with a multisectoral approach to addressing malnutrition. The national nutrition strategy and the national nutrition program are two policy instruments that have been developed to galvanize multi-sectoral approach (95). Although both documents emphasize both proper child feeding and preventive behavior, there is no evidence regarding to what extent they occur simultaneously and who is affected.

A suitable feeding and use of preventive behavior is needed to identify vulnerable age groups and to monitor interventions in developing countries (96). Most research regarding optimal infant and young child feeding practices; however, has focused on a single component of optimal infant and young child feeding practices at a time. This has complicated communicating research findings, thereby providing poor guidance for policy makers towards the best use of scarce resources. Fragmentation of assessing child health status may have hampered understanding overall feeding patterns and its relation with child health and nutrition outcomes (97). A combination of feeding and use of preventive behavior is key to provide sufficient information on child growth, survival, and nutritional status (98).

The aim of this study was to assess the concordance and discordance of child feeding and preventive behavior and their predictors in southwest rural Ethiopia. These findings are expected to contribute to the formulation of policy and planning, implementation and evaluation of the nutrition program of the country. It will help to substantiate the arguments for integrated multisectoral interventions to reduce the persistent high level of stunting in the country.

3.2. Methods and materials

3.2.1. Study population

We used round one data generated from 2-year longitudinal Agriculture–Nutrition panel survey conducted February 9 to April 9, 2014.

3.2.2. Measurements

3.2.2.1. Child feeding and preventive behavior

Child feeding and preventive behavior practice indices for the different age groups were created according to previous guidelines (97,99). A child-feeding index was derived as the summation of breastfeeding, bottle-feeding, frequency of complementary feeding and child dietary diversity. Similarly, preventive behavior was derived as the sum of washing hands before preparing the food, washing hands before feeding a child, child sleep under a bed net, feeding special foods when a child is ill, and feeding a child special foods after illness (Table 3.1). Child feeding practices are age-specific. At 6-9 months, breastfeeding plus the gradual introduction of complementary foods; 9–12 months, breastfeeding, but increasing the amount and frequency of complementary feeding; 12-36 months, continued breastfeeding for as long

as possible, gradual transition to the family diet, and focus on dietary quality, and age above 37 months (85,99).

At age of 6-12 and 13-36 months, 60% and 70-90 % of energy need supplied from breastfeeding and complementary feeding respectively. Practices were defiend as positive or negative based on current child feeding recommendations (100). Based on above the recommendation, we assigned score 0 for a potentially harmful practice and score 1 for a positive practice. Practices considered important at a given age, such as breastfeeding between 6 and 12 months of age, or frequency of complementary feeding between 13 and 36 months of age received a score of 2 and 3 respectively (99).

The scores were summed to generate the child feeding and use of preventive behavior indices. Finally, the child feeding and preventive behavior indices were dichotomized each as poor "1" for those having a score below median value and good "0" for those having a median value score and above. We defined concordance as children having poor child feeding and poor preventive behavior and discordance as children having poor child feeding and good preventive behavior and good child feeding and poor preventive behavior.

Table 3.1. Variables and scoring system used to create child feeding and preventive behavior for children age 6-60 months, by age group, 2014

Variables	**6-8 months**	**9-12 months**	**13-36 months**	**37-60 months**
		Feeding components		
Breast feeding	No = 0 Yes = 2	No = 0 Yes = 2	No = 0 Yes = 1	No = 1 Yes = 0
Uses bottle	No = 1 Yes = 0	No = 1 Yes = 0	No = 1 Yes = 0	No = 1 Yes = 0
Dietary diversity (Past 24 hours)	None of the food/groups: Score = 0 One food/group: Score = 1 Two or more foods /groups:	None of the food/groups: Score = 0 One of two food/groups: Score = 1 Three or more food/groups:	None or one of the food/groups: Score = 0 Two or three foods/groups: Score = 1 Four or more	None or one of the food/groups: Score = 0 Two or three foods/groups: Score = 1 Four or more

Variables	6-8 months	9-12 months	13-36 months	37-60 months
	Score = 2	Score = 2	food/groups: Score = 2	food/groups: Score = 2
Frequency of feeding Solids/semisolid (Past 24 hours)	Not at all: Score = 0 Once: Score = 1 Two or more times: Score = 2	Not at all: Score = 0 Once or twice: Score = 1 Three or more times: Score = 2	Not at all or once: Score = 0 Twice: Score = 1 Three times: Score = 2 Four times or more: Score = 3	Not at all or once: Score = 0 Twice: Score = 1 Three times: Score = 2 Four times or more: Score = 3
Preventive behavior components				
Washing hands before preparing the food	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1
Washing hands before feeding a child	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1
Child sleep under a bed net last night	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1
Fed special foods when the child is ill?	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1
Fed special food to child after illness	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1	No = 0 Yes = 1
Minimum/maximum	0/12	0/12	0/12	0/12

3.2.2.2. Household dietary diversity score (explained in chapter 2)

Household dietary diversity score (HDDS) was calculated from 12 food groups according to the Food and Agriculture Organization. The HDDS ranged from 1-12 and ranked from low dietary diversity (≤ three food groups), medium dietary diversity (four and five food groups) and high dietary diversity (≥ six food groups) (86).

3.2.2.3. Household food insecurity (explained in chapter 2)

Food insecurity responses were summed to produce an index of household food insecurity. The distribution of the index of household food insecurity was divided into four categories representing food secure households, occasional food insecurity, moderately food insecure and severely food insecurity (101).

3.2.2.4. Cultural norms

The influence of cultural norms on child feeding and preventive behavior was assessed using four items with four point Likert scales (from strongly agree=1 to strongly disagree=4) adapted from similar studies conducted in low-and-middle-income countries (102). Scale reliability coefficient and experts on the topic were used to check the internal consistency and content validity of the measurements. The internal consistency of the cultural norm scale was 0.9. The distribution of the index of the cultural norm was divided into tertiles representing households who have low adherence to local cultural norms, households who have medium adherence to local cultural norms and households that have high adherence to local cultural norms on child feeding and caring practices.

3.2.2.5. Decision-making power of women

The decision-making power of women was measured using 11 items with four point Likert scales, with 1representing ‘not at all’ to 4designating ‘to high extent’, adapted from similar studies conducted in low- and middle-income countries (103). Scale reliability coefficient and experts in the area were used to assess the internal consistency and content validity of the measurements. The internal consistency of the cultural norm was 0.7. The distribution of women’s decision-making index divided into tertiles representing low, medium, and high women decision-making power.

3.2.2.6. Caretaker’s knowledge on nutrition

Five questions with ‘true/false’ were prepared to measure, caretaker’s knowledge on nutrition. The distribution of index of nutrition knowledge was ranked and divided into tertiles representing poor, fair, and good nutrition knowledge.

3.2.3. Data analysis

The data were checked for distribution, missing values, and outliers, cleaned, and analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. (Armonk, NY: IBM Corp) and STATA 11 Software (Stata Corp, College Station, TX). Descriptive analyses were conducted to describe the characteristics of the study participants. Since the study was conducted in different districts, we accounted for the clustered nature of the measurements during the analyses. For this purpose, generalized estimating equations were used to adjust the standard errors.

A generalized estimating equation with a logic function was used to determine the predictor of concordance and discordance of child feeding and preventive behavior in a child. An exchangeable correlation structure was chosen for the main models by assuming two observations are equally correlated within a cluster, with no correlation between observations from different cluster correlations. The generalized estimating equations were adjusted for decision-making power of women, the age of caretaker, educational status of caretaker, the age of child, household dietary diversity, the influence cultural norms on child feeding and preventive behavior, and household food insecurity. Multicollinearity and interaction terms were checked during generalized estimating equations analyses. Finally, the results were reported as odds ratio (OR) and 95% confidence intervals (CI).

3.3. Results

A total of 623 children under the age of 5 years were involved in the study. Out of 623, 13 children with missing data on child feeding and preventive behavior were excluded from the analyses. Table 3.2 shows the child feeding practices in southwest rural Ethiopia. Fifty-nine percent of mothers exclusively breastfed their index children for 6 months.

The most common reasons cited for terminating breastfeeding were pregnancy (33.9%), not having enough breast milk (16.1%), and being tired of breastfeeding (12.6%). Seventy-one percent of mothers started complementary feeding at the age of 6-9 months. The median age of the introduction of complementary feeding was 6 months, and 43.8 and 59.0% of mothers did not administer special food to their child during and after illness, respectively.

Out of 592 children, 91.0% had either feeding or preventive behavior problems. Of those children, 45.1% had concordance of poor child feeding and preventive behavior. An estimated 32.3% of children had only poor child feeding and good preventive behavior, and 13.2% of children had poor preventive behavior and good child feeding practices. Only 9.4% of children, however, had both good child feeding and preventive behavior.

We also observed that out of 610 children, 85.1% did not sleep under a bed net during the night before the interview, and 23.6% reported an illness in the past 2 weeks. Out of 65 children who had diarrhea, 58.5% were not given any liquid. Similarly, of 136 children who had any illness or symptoms, 51.5% reported to have sought health services outside the home. Regarding health seeking behaviors, 45.7% received help from private clinics, while the health extension workers treated 28.6% children.

Table 3.2. Child feeding practices in southwest rural Ethiopia, 2014

		Frequency(n)	Percentage
Did you ever breastfeed	No	120	19.7
	Yes	490	80.3
How long after birth,	Within first hour		
Did you first put to the breast?	after birth	262	53.5
	After first hour	181	36.9
	After one day	39	8.0
	Don't remember	8	1.6
During the first three days after delivery,	No	202	41.2
did you give the liquid that came from	Yes	283	57.8
your breasts to your baby?	Don't know	5	1.0
During the first three days after delivery,	No	450	91.8
did you give baby anything else to eat or	Yes	38	7.8
drink before feeding him/her breast milk?	Don't know	2	0.4
	Milk (other than		
	breast milk)	2	5.7
Baby eat or drink before feeding him/her	Butter	14	40.0
breast milk	Plain water	7	20.0
	Water with		
	sugar or salt	11	31.4
	Traditional herbs		
	with water	1	2.9
	<6 months	41	23.8
Duration of breast feeding	6-8 months	2	1.2
	9-12 months	5	2.9
	13-24 months	124	72.1
Did baby drink anything from a bottle with	No	66	10.8
a nipple yesterday or last night	Yes	544	89.2

Table 3.3 describes the X^2-square associations of concordance of poor child feeding and preventive behavior in southwest rural Ethiopia. Age of the child, household dietary diversity, household food insecurity, educational status of the caretaker and age of the caretaker had significant association with concordance and discordance of poor child feeding and preventive behavior. However, the influence of cultural norms on child feeding and caring practice was only associated with poor child feeding and good preventive behavior.

Table 3.3. X^2-Square association of concordance and discordance of child feeding and preventive behavior in southwest rural Ethiopia, 2014

	Concordance (poor child feeding and poor preventive behavior)	**Discordance (poor child feeding and good preventive behavior)**	**Discordance (good child feeding and poor preventive behavior)**	**P-value**
Age of the child				P=0.001*
6-8 months	3(0.5%)	11(1.9%)	2(0.3%)	
9-12 months	12(2.0%)	26(4.4%)	10(1.7%)	
13-36months	155(26.2%)	31(5.2%)	133(22.5%)	
37-60months	97(16.4%)	10(1.7%)	46(7.8%)	
Total	267(45.1%)	78(13.2%)	191(32.3%)	
Caretaker education				P=0.05**
Illiterate	186(31.4%)	43(7.3%)	122(20.6%)	
Primary education	79(13.3%)	33(5.6%)	64(10.8%)	
Secondary education	2(0.3%)	2(0.3%)	5(0.8%)	
Total	267(45.1%)	78(13.2%)	191(32.3%)	
Age of the caretaker				P=0.001**
<=20 years	12(2.0%)	10(1.7%)	20(3.4%)	
21-30 years	134(22.6%)	35(5.9%)	108(18.2%)	
31-40 years	90(15.2%)	26(4.4%)	55(9.3%)	
> 40 years	31(5.2%)	7(1.2%)	8(1.4%)	
Total	267(45.1%)	78(13.2%)	191(32.3%)	

	Concordance (poor child feeding and poor preventive behavior)	Discordance (poor child feeding and good preventive behavior)	Discordance (good child feeding and poor preventive behavior)	P-value
Household dietary diversity				P=0.001*
Low	141(23.8%)	9(1.5%)	84(14.2%)	
Medium	110(18.6%)	55(9.3%)	78(13.2%)	
High	16(2.7%)	14(2.4%)	29(4.9%)	
Total	267(45.1%)	78(13.2%)	191(32.3%)	
Cultural norms				P=0.05***
High	90(16.2%)	14(2.5%)	72(13.0%)	
Medium	89(16.1%)	30(5.4%)	50(9.0%)	
Low	70(12.6%)	27(4.9%)	56(10.1%)	
Total	249(44.9%)	71(12.8%)	178(32.1%)	
Household food insecurity				P=0.001*
Food secure	88(14.9%)	46(7.8%)	76(12.8%)	
Occasional	14(2.4%)	4(0.7%)	25(4.2%)	
Moderate	80(13.5%)	11(1.9%)	56(9.5%)	
Severe	85(14.4%)	17(2.9%)	34(5.7%)	
Total	267(45.1%)	78(13.2%)	191(32.3%)	

**: Significant for all;*
***: significant for both poor child feeding and preventive behavior;*
****: significant for good feeding and poor preventive behavior*
#: show the X^2-Square results

Table 3.4 shows the comparison of factors associated with concordance and discordance of poor child feeding and preventive behavior in southwest rural Ethiopia. Concordance and discordance of poor child feeding and preventive behavior had almost different predictors. Children at an early age, having a young caretaker and living in high household dietary diversity were less likely to suffer from concordance of poor child feeding and preventive behavior. Children who live in a food insecurity household suffered from both concordance and discordance of poor child feeding and preventive behavior. Children who live in a household with a high adherence to local cultural norms only suffered from discordance of poor child feeding and preventive behavior.

Table 3.4. Comparison of factors associated with concordance and discordance of child feeding and preventive behavior in southwest rural Ethiopia, 2014

	Concordance (poor child feeding and poor preventive behavior)	**Discordance (poor child feeding and good preventive behavior)**	**Discordance (good child feeding and poor preventive behavior)**
	AOR (95.0% CI)	**AOR (95.0% CI)**	**AOR (95.0% CI)**
Age of caretaker			
≤20 years	0.5(0.26,1.11)	1.3(0.66, 2.53)	1.3(0.52, 3.33)
31-40 years	1.2(0.80, 1.84)	0.8(0.51,1.22)	1.5(0.76,2.87)
≥ 40 years	2.1(1.04, 4.41)*	0.4 (0.17,0.94)*	1.7(0.58, 4.96)
21-30 years (Ref)	1	1	1
Age of child			
6-8 months	0.1(0.03,0.42)**	0.2(0.03,0.72)**	10.5(3.30,33.47)**
9-12 months	0.2(0.07,0.34)**	0.4(0.19,0.97)*	8.9(3.33,23.56)**
13-36 months	0.6(0.39,0.92)**	1.5(0.98,2.41)	2.0(0.83,4.62)
37-60 months (Ref)	1	1	1
Caretaker education Illiterate	2.5(0.55,11.23)	0.9(0.24,3.09)	0.4(0.07,2.21)
Primary education	2.1(0.47,9.72)	0.9(0.24,3.12)	0.7(0.12,3.72)
Secondary education(Ref)	1	1	1
Household food insecurity			
Severe	1.7(1.01,2.93)*	0.6 (0.34,1.08)	1.4 (0.66,2.95)
Moderate	1.1 (0.67,1.76)	1.2(0.71,1.94)	0.6(0.28,1.43)
Occasionally	0.5(0.24,1.03)	2.8(1.40,5.60)**	0.7(0.22,2.34)
Food secure (Ref)	1	1	1
Household dietary diversity			

	Concordance (poor child feeding and poor preventive behavior)	Discordance (poor child feeding and good preventive behavior)	Discordance (good child feeding and poor preventive behavior)
	AOR (95.0% CI)	**AOR (95.0% CI)**	**AOR (95.0% CI)**
Low	3.7(1.93,7.04)**	0.9(0.05,1.72)	0.2(0.07,0.58)*
Medium	2.2(1.17,4.00)*	0.8(0.42,1.34)	1.3(0.62,2.74)
High (Ref)	1	1	1
Women decision making			
Low	0.8(0.48,1.25)	1.2(0.72,1.92)	1.3(0.66,2.69)
Medium	0.8(0.48,1.18)	1.2(0.72,1.85)	1.1 (0.56,2.34)
High(Ref)	1	1	1
Nutrition knowledge of caretaker			
Poor	1.3 (0.79, 2.19)	0.8 (0.47,1.38)	0.9(0.37, 2.05)
Fair	1.0(0.64, 1.60)	1.2(0.72, 1.85)	1.2 (0.59, 2.29)
Good (Ref)	1	1	1
Cultural norms			
High	1.0(0.55,1.66)	1.3(0.75, 2.26)	0.4(0.19,0.94)*
Medium	1.0(0.59,1.63)	1.0(0.61,1.72)	1.1(0.54,2.15)
Low (Ref)	1	1	1

AOR: Adjusted Odds Ratio,

CI: Confidence Interval;

***: Significant at P<0.001;*

**: Significant at P<0.05*

(Ref): Reference category

3.4. Discussion

This study presents findings on the concordance and discordance of child feeding and preventive behavior and compares factors associated with child feeding and preventive behavior in southwest of rural Ethiopia. Almost all children were suffering from either child feeding or preventive behavior problems. Of those children and in almost half of the children in the sample, poor child feeding and preventive behavior occurred. In only a minority of children, however, relatively good feeding practices were observed despite poor preventive behavior. The presence of low health services, poor sanitation, and lack of commitment addressing child nutrition in developing countries may have contributed to the problem of low feeding and preventive behavior. Therefore, a reduction in child mortality can only be reached when child feeding and preventive behavior are prioritized in national policies and strategies (104,105).

Gender-based differences in concordance and discordance of poor child feeding and poor preventive behavior were not observed in our sample. The reasons were cross-sectional nature of the data and cultural influence to tell the gender-based difference in child feeding and preventive behavior. This result was supported by a study conducted in rural Cambodia (98), which indicated that promoting gender equality in child feeding and preventive behavior has a positive impact on the reduction of childhood malnutrition and mortality. Studies from Bangladesh and India, however, showed that male children had higher child feeding and caring practices (101,106).

Caretaker education was not significantly associated with concordance and discordance of poor child feeding and preventive behavior in our sample. The reasons were that the majority of the caretakers were homogenous in their educational status and they are illiterate and 1-12 grade education curricula had no nutrition education components. Therefore, education alone is not the guarantee for best child feeding unless the caretaker is equipped with nutrition knowledge and skills. This finding is supported by data from rural Cambodia (98), but findings from rural Bangladesh showed that maternal education was significantly associated with child feeding and caring practices (101).

A similar study conducted in Benin showed that maternal education through 4 years of schooling was associated with improved child feeding. However, maternal schooling beyond 4 years is negatively associated with child weight (107). Findings from the United States

show that college-educated mothers were significantly more likely to comply with supplied feeding recommendations (108).

Children not living in households with high household dietary diversity were more likely to suffer from concordance of poor child feeding and poor preventive behavior but not in discordance. Inappropriate complementary feeding practices increase the incidence of malnutrition, a high rate of infectious diseases, and adversely affect child growth and development (13,26). Demographic and health surveys data of 11 countries showed that household dietary diversity was associated with child feeding and preventive behavior (109), indicating household dietary diversity to be a vital component of ensuring child feeding and preventive behavior.

Children living in severe food insecurity households were more likely to suffer from concordance of poor child feeding and poor preventive behavior but not in discordance. As observed in Bangladesh, children from households suffering from occasionally or intermittently household food insecurity were more likely to have high caring practices (101).

Facing household food insecurity, women are particularly vulnerable to nutrient inadequacies related to physiological vulnerability during childbearing and experience fatigue, which limits their ability to fully satisfy infant needs. The limitations impair child growth and cognitive development, which may persist into adulthood and transmit to the next generation (35) indicating that household food security is the vital component of assuring child feeding and preventive behavior. Therefore, household food insecurity problems must be addressed to reduce malnutrition in southwest rural Ethiopia.

Women decision-making power was not associated with concordance and discordance of poor child feeding and preventive behavior in our sample. A study conducted in rural Chad showed that decision-making power of women was associated with child feeding and preventive behavior (110).

Caregivers have great influence on child-feeding practices, willingness to seek advice during childhood illnesses, and the number of individuals available to assist with domestic tasks was a factor associated with child feeding and nutritional status (111). This study focused on the decision-making power of women on agricultural activities. Increasing decision-making power of women on agricultural activities alone had no an effect on child feeding and

preventive behavior. Therefore, women decision-making on agriculture and nutrition must be promoted to improve child feeding and preventive behavior.

At younger ages, children (6-12 months) were less likely to suffer from concordance and discordance of poor child feeding and preventive behavior, but they suffer more from discordance of poor child feeding and preventive behavior. The empirical evidence shows that child feeding and preventive behavior are interdependent (112). A similar study conducted in rural Cambodia and Ghana showed that the age of the child was strongly associated with child feeding and preventive behavior (98,113), indicating that concordance of child feeding and preventive behavior with the age of the child is a vital issue to address any child feeding and preventive behavior problems.

The nutrition knowledge of the caretaker was not associated with concordance and discordance of poor child feeding and preventive behavior in our sample. Due to the homogeneous nature of the study participants, nutrition knowledge of caretaker was not significant for child feeding and caring practices. The study conducted in Ethiopia showed that nutrition knowledge has a positive effect on child feeding and preventive behavior (114).

A similar study conducted in Ghana revealed that nutrition knowledge of the mother was positively associated with child feeding practices (112). Even though, nutrition knowledge of caretaker was not associated with low child feeding or low preventive behavior, creating awareness about child feeding and preventive behavior is the best option to prevent malnutrition, morbidity, and mortality in southwest rural Ethiopia.

Discordant poor child feeding and preventive behavior was found in children living in households with a high adherence to local cultural norms. In low- and middle-income countries, acceptable infant feeding practices are complex and vary from one society to another due to socio-cultural factors (15). A study conducted in Ghana and Ethiopia (102,115) reported that there are many socio-cultural factors and misconceptions that are associated with child feeding and preventive behavior. Therefore, nutrition education that considers the socio-cultural factors and misconceptions is essential to effectively address child feeding and use of preventive behavior in low- and middle-income countries.

The strength of the study was its focus on concordance and discordance of poor child feeding and preventive behavior in southwest of rural Ethiopia. Estimates on the concordance and discordance of poor child feeding and preventive behavior in children can guide planning,

implementation, and evaluation of integrated promotion of optimal caring and feeding behaviors in low- and middle-income countries. Such knowledge can also strengthen partnerships between nutrition, agriculture, and health by clearly indicating specific tasks among various sectors that work on reduction of chronic malnutrition. However, since the study uses the data from the post-harvest season, it may not be generalized to other seasons. In addition, due to the cross-sectional nature of the data, causal effects cannot be inferred.

3.5. Conclusion

Almost half of the children suffered from concordance of poor child feeding and preventive behavior in rural southwest Ethiopia. Household dietary diversity, household food insecurity, age of the child, and age of the caretaker were associated factors of concordance of poor child feeding and preventive behavior in southwest rural Ethiopia. This finding provides a useful entry point to address child feeding and preventive behavior in an integrated way through multisectoral collaboration. Specific attention is required for children during the complementary feeding period and those in the food insecure households who are highly at risk. The findings call for comprehensive interventions to address child feeding and preventive behavior in the area to prevent the pervasively high level of stunting in rural Ethiopia.

4

Chapter 4

Determinants and morbidities of multiple anthropometric deficits in southwest rural Ethiopia

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Abstract

Objective*:* The aim of this study was to compare undernutrition with child morbidity and their determinants according to a composite index of anthropometrical failures and conventional indices.

Methods*:* We used data generated from three rounds of a longitudinal panel survey conducted in ten districts in Oromiya Region and the Southern Nations, Nationality and Peoples Region of Ethiopia. We estimated undernutrition using conventional indices and composite index of anthropometrical failures. The hierarchical nature of the data Applied nutritional investigation was taken into account during the statistical analysis using a two-level mixed-effects logistic regression model.

Results: A composite index of anthropological failure, estimated 45.1%, 42.4%, and 46.4% of the children were undernourished in round one, two, and three, respectively. The conventional indices estimated 38.3%, 37.8%, and 39.5% stunted in round one, two, and three, respectively. Being female (odds ratio [OR], 7.4; 95% confidence interval [CI], 3.9–14.0); low dietary diversity (OR, 3.1; 95% CI, 1.6–5.9); medium dietary diversity (OR, 1.9; 95% CI, 1.1–3.3), and no special foods during illness (OR, 1.8; 95% CI, 1.2–2.8) were determinant of multiple anthropometrical failures. Similarly, being female (OR, 5.0; 95%CI, 2.6–9.5); low dietary diversity (OR, 3.1; 95% CI, 1.5–6.5); medium dietary diversity (OR, 1.9; 95% CI, 1.1–3.4; no special foods during illness (OR, 1.8; 95% CI, 1.2–2.7) and absence of under 5 children in the household (OR, 0.4; 95%CI, 0.2-0.8) were also determinant of stunting. Children with multiple anthropometrical failures were 3 times more likely to report child morbidities (OR, 2.6; 95% CI, 1.1–5.9). However, none of the conventional indices (such as stunting (OR, 1.1; 95% CI, 0.8–1.4), wasting (OR, 0.9; 95% CI, 0.5–1.6) and underweight (OR, 1.4; 95% CI, 1.0–2.0) were associated with any of the reported child morbidities.

Conclusion: The conventional indices underestimated the prevalence of undernutrition by 20.7%. Children with multiple anthropometrical failures are at high risk for developing child morbidities and should benefit from nutrition intervention to reduce child morbidities.

Key terms: anthropometrical failure, malnutrition, children, child morbidities

4.1. Introduction

Addressing childhood undernutrition effectively remains a global challenge (26). Despite some positive developments, undernutrition is still a global concern and various low-income and middle-income countries face substantial increases in child mortality and overall disease burden (116).

The three anthropometric indices stunting, wasting and underweight have been used to evaluate the nutritional status of children for many years (9,10).These indices, however, reflect different dimensions of undernutrition and are not mutually exclusive. For instance, although underweight is a composite index of stunting and wasting, it does not make a distinction between them (117,118). Given the different degrees of overlap between the indices (i.e. stunting, wasting and underweight), underweight children will experience both stunting and/or wasting, stunted children might not be underweight, and children might simultaneously experience all three forms of anthropometric failure in the population. As a result, none of the three conventional indicators reflects the overall burden of undernutrition in a population (52,53).

Compared with those with only a single anthropometrical failure, children with multiple anthropometrical failures are more likely to have diarrhea and suffer from increased morbidity and mortality (51). Although the proportions of children suffering from multiple anthropometrical failures are likely to be substantial, only a few studies have addressed multiple anthropometrical failures and their effects (51–53).

Additionally, the lack of an integrated approach to understand and address undernutrition in children has contributed to the fragmentation of efforts to address malnutrition, resource allocation, and development of interventions (54). Identifying children with multiple anthropometric failures may therefore help prioritize and guide interventions toward the most vulnerable groups (55–58).

Malnutrition in Ethiopia is persistently high due to insufficient food availability; poor water quality, hygiene, and sanitation; maternal well-being and quality of caring practices including women’s decision-making power; and control of resources (95). The Ethiopian government has developed a comprehensive and harmonized approach to addressing malnutrition. The National Nutrition Strategy and the National Nutrition Program are two key policy instruments that have been developed in this regard (95).

The few studies that compared the use of a composite index of anthropometrical failures with conventional indices were cross-sectional and did not assess variations of findings over time. Additionally, these studies did not assess or compare determinants of composite index of anthropometrical failures with those of conventional indices.

The first aim of this study was to address undernutrition and their determinants in an Ethiopian sample of children according to composite index of anthropometrical failure and conventional indices over time. The second aim was to determine and compare the association of multiple anthropometrical failure and conventional indices with child morbidity and changes over time.

We hypothesized the following:

1. A composite index of anthropometrical failure estimates a higher prevalence of undernutrition in the population compared with the conventional indices over time,

2. Children with multiple anthropometrical failures are more likely to suffer from child morbidity compared with those with a single anthropometric failure over time, and

3. The observed difference between the conventional and anthropometrical failures would persist over time.

4.2. Methods and materials

We used data generated from three rounds of a longitudinal panel survey conducted in ten districts.

4.2.1. Measurements

4.2.1.1. Anthropometric data

Nurses carried out the anthropometric measurements of the caretaker and children <5 years in the household. The weight and length/height measurements were taken twice for each eligible respondent and standard procedures were followed to ensure accuracy and precision. A SECA weight scale and length/ height boards were used to measure weight and length/height with a precision of 100 g and 1 mm, respectively. Height of children >24 months was measured standing, whereas length of those <24 months was obtained while lying down. The height and weight of the caretaker and children were measured wearing light clothes and

without shoes. Stunting, wasting, and underweight were defined using the World Health Organization's (WHO) growth standard 2006 and –2 z-scores as a cut-off (9).

4.2.1.2. Estimation of undernutrition

We estimated the prevalence of undernutrition in the sample using conventional indices (i.e., stunting, wasting, and underweight) and applied Svedberg's model (119). This model classifies children into seven categories:

1. No anthropometric failure: normal weight for age (WAZ), height for age (HAZ), and weight for height (WHZ) z-scores;
2. Stunted only: HAZ < 2 z-scores with normal WAZ and WHZ;
3. Wasted only: HAZ < 2 z-scores with normal HAZ and WAZ;
4. Underweight only: WAZ< 2 z-scores with normal WHZ and HAZ;
5. Stunted and underweight: HAZ and WAZ < 2 z-scores with normal WHZ;
6. Wasted and underweight: WHZ and WAZ < 2 z-scores with normal HAZ;
7. Stunted, wasted, and underweight HAZ, WHZ, and WAZ < 2 z-scores.

Finally, we created two groups of children. Group 1 were those with no anthropometrical failure (category 1: normal WAZ, HAZ, and WHZ), and group 2 were those with multiple anthropometric failures (sum of groups 2–7).

4.2.1.3. Dietary diversity (explained in chapter 2)

Child dietary diversity score (CDDS) and household dietary diversity score (HDDS) were divided into tertiles representing low, medium, and high dietary diversity.

4.2.1.4. Household food insecurity (explained in chapter 2)

Household food insecurity was divided into tertiles representing food secure households, moderately food insecure households, and highly food insecurity households.

4.2.2. Data analysis

Data were verified for distribution, missing values, and outliers, and were cleaned and analyzed using STATA11 for Windows (STATA Corporation, College Station, TX, USA). Anthropometric indices of HAZ, WAZ, and WHZ were calculated using the WHO AnthroPlus2007. Children with extreme values of weight and height/length measurements were excluded from the sample for the z-score calculation and then their z-scores were imputed with the series mean value.

Exploratory analyses were conducted to examine the data over the different measurements. The hierarchical nature of the data (measurements clustered within subjects) was taken into account during the statistical analysis using a two-level mixed-effects logistic regression model (level 2: individual and level 1: measurements). An unstructured correlation matrix chosen for the main models assuming that the repeated measures were not equally correlated within subjects and clusters, and no correlation existed between observations from different cluster correlations.

A test of parameters showed that a time fixed-effect variable was needed in the fixed-effect model of wasting, diarrhea, and acute respiratory infection. The fixed time effects were not required in the models for multiple anthropometric failures, stunting, and general child morbidity. A chi-square test was conducted to examine changes in wasting, underweight, stunting, multiple anthropometric failures, and child morbidities over time.

First, multiple anthropometric failures, stunting, and wasting were used as dependent variables. The models were constructed by adjusting for child dietary diversity, age of child, age of caretaker, child's sex, presence of other children <5 years in the household, feeding special foods during illness, and exclusive breastfeeding. Second, child morbidities were used as dependent variables to show the association of multiple anthropometric failures, stunting, and wasting with child morbidities. The models were adjusted for age of the child, personal hygiene, a place to store clean dishes, and exclusive breastfeeding. A mixed-effects logistic regression model was used to analyze the relationship between a binary outcome variable and a group of predictor variables. Following a previously described method, we use an odds ratio (OR) and 95% confidence interval (CI) to report the associations (120).

4.3. Results

We excluded children who had only one observation and those who were mismatched during the follow-up survey in analysis. Therefore, 579, 674, and 674 children age <5 years were included in the analysis of rounds 1, 2, and 3, respectively. Among children who were included in the analysis, nine (1.6%) in round 2 and nine (1.3%) in round 3 were excluded.

Table 4.1 compares the estimated prevalence of child undernutrition according to conventional indices and a composite index of anthropometric failures over the three rounds. Overall, data was obtained on a sample of 50.6% female and 49.4% male participants. The

overall mean age of the children was 34.5±15.9 months (i.e. round 1: 28.8±14.0 months; round 2: 34.2±15.7 months; round 3: 39.8±15.8 months). An estimated 38.3%, 37.8%, and 39.5% of children were stunted at rounds1, 2 and 3 respectively. Similarly, 7.8%, 4.3%, and 6.1% of children were wasted at rounds 1, 2 and 3 respectively. An estimated 24.4%, 24.2%, and 30.4% of children were underweight at rounds 1, 2 and 3 respectively.

Table 4.1. Comparison of child undernutrition according to conventional indices and CIAF during follow up period in southwest rural Ethiopia, 2014-2015

	Round of survey			
	Round 1 (N=579)	**Round 2 (N=674)**	**Round 3 (N=674)**	**P**
Undernutrition according to the conventional indices				
Stunting	222(38.3%)	255(37.8%)	266(39.5%)	0.82
Wasting	45(7.8%)	29(4.3%)	41(6.1%)	0.035
Underweight	141(24.4%)	163(24.2%)	205(30.4%)	0.014
Undernutrition according to the CIAF				
No anthropometric failure	318(54.9%)	388(57.6%)	361(53.6%)	
Stunting only	105(18.1%)	118(17.5%)	98(14.5%)	
Wasting only	15(2.6%)	5(0.7%)	10(1.5%)	
Underweight only	10(1.7%)	10(1.5%)	18(2.7%)	
Stunting and underweight	101(17.4%)	129(19.1%)	156(23.2%)	
Wasting and underweight	14(2.4%)	16(2.4%)	19(2.8%)	
Stunting, wasting and underweight	16(2.8%)	8(1.2%)	12(1.8%	
Overall undernutrition (A+B+C+D+E+F)	261(45.1%)	286(42.4%)	313(46.4%)	0.32
Child morbidity				
Any morbidity	135(23.3%)	167(24.8%)	181(26.9%)	0.35
Diarrhea	49(36.3%)	38(22.8%)	37(20.4%)	0.003
Acute respiratory infection	86(63.7%)	116(69.5%)	102(56.4%)	0.013

CIAF=Composite index of anthropometric failure

No anthropometric failure: child that is not stunted, wasted and underweight according to WHO 2006 growth reference cut-offs

According to a composite index of anthropometrical failure, 45.1%, 42.4%, and 46.4% of the children were undernourished at rounds 1, 2, and 3, respectively. The composite index of anthropometrical failure identified more undernutrition (6.8% and 20.7%, 4.6% and 18.2%, and 6.9% and 16%) compared with stunting and underweight indices at rounds 1, 2, and 3, respectively. Of all undernourished children, 22.4%, 19.7%, and 18.7% of the children experienced one anthropometrical failure at rounds 1, 2, and 3, respectively. An estimated 19.7%, 21.5%, and 26% of children experienced two anthropometric failures at rounds 1, 2, and 3, respectively.

According to conventional indices, 20.2% and 12.7% of the children remained classified as stunted and underweight in the three rounds. However, according to the composite index of anthropometric failure, 25% of the children remained undernourished in the three rounds. The prevalence of wasting and underweight showed a significant change (decrease and increase, respectively) over time in the three rounds. Prevalence estimates of the composite index of anthropometric failure and stunting, however, remained similar in the different rounds.

Table 4.2 describes the bivariate association of multiple anthropometrical failures. Age and sex of the child, child's dietary diversity, household dietary diversity, household food insecurity, feeding special foods during and after illness, health seeking behaviors, sanitation, and personal hygiene were significantly associated with anthropometrical failures.

Table 4.2. Association between multiple anthropometric failures and selected exposure variables in southwest rural Ethiopia, 2014-2015

		No anthropometric failure (N=1,067)	Anthropometric failure (N=860)	P
Age of child	≤6 months	43 (78.2%)	12(21.8%)	0.001
	7-12 months	105 (72.4%)	40(27.6%)	
	13-24 months	213 (52.5%)	193(47.5%)	
	25-36 months	250 (51.6%)	235(48.4%)	
	37-48 months	258(54.3%)	217(45.7%)	
	>48 months	198 (54.9%)	163(45.2%)	
Sex of the child	Female	429(44.0%)	547(56.1%)	0.001
	Male	638 (67.1%)	313(32.9%)	
Child dietary diversity	Low	236(51.1%)	226(48.9%)	0.002
	Medium	495(54.2%)	418(45.8%)	
	High	336(60.9%)	216(39.1%)	
Household dietary diversity	Low	385 (51.3%)	365(48.7%)	0.008
	Medium	340(56.2%)	265(43.8%)	
	High	342(59.8%)	230(40.2%)	
Household food insecurity	Food secure	399(57.7%)	293(42.3%)	0.002
	Moderately food insecure	364 (58.6%)	257(41.4%)	
	Highly food insecure	304(49.5%)	310(50.5%)	
Feeding special foods after illness	No	648 (53.2%)	571(46.8%)	0.01
	Yes	419 (59.2%)	289(40.8%)	
Feeding special foods during illness	No	396(50.6%)	387(49.4%)	0.001
	Yes	671(58.7%)	473(41.3%)	
Child sleep under a bed net last night	No	875(53.7%)	754(46.3%)	0.001
	Yes	192(64.4%)	106(35.6%)	
	Shelf, table, chair	822(56.9%)	624(43.2%)	0.001
	Floor	131 (44.4%)	164(55.6%)	
Storing place for clean dishes	Hanging on the wall	61(61.0%)	39(39.0%)	
	Covered container	8 (47.1%)	9(52.9%)	

No anthropometric failure: child that is not stunted, wasted and underweight according to WHO 2006 growth reference cut offs

Anthropometric failure: child with stunting only; wasting only; underweight only; stunting and underweight; wasting and underweight; and stunting, wasting and underweight according to WHO 2006 growth reference cut-offs

Multiple anthropometrical failures, stunting, and wasting had similar determinants (Table 4.3). However, children had a higher likelihood of having multiple anthropometrical failures

compared with being stunted or wasted. Shared determinants of multiple anthropometrical failures, stunting, and wasting were the age of the child, being female, and the reporting that the child did not feed special foods during illness. Lower child dietary diversity was a determinant of both multiple anthropometric failures and stunting.

Table 4.4 reports the association of multiple anthropometric failures and conventional indices with child morbidities. Stunting only and the simultaneous occurrence of wasting and underweight were determinants of having any child morbidity. Similarly, underweight only and stunting only were determinants of diarrhea and acute respiratory infection incidences, respectively. Children with three anthropometric failures were 2.6 times more likely to report morbidities. These children were also 3.2 times more likely to have an acute respiratory infection. However, none of the conventional indices was an associated with any of child morbidities reported.

Table 4.3. Determinants of child undernutrition in southwest rural Ethiopia from mixed-effects logistic regression, 2014-2015

	CIAF	Stunting	Wasting
FIXED EFFECT	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Time[A]	-	-	0.99(0.73,1.33)
Age of the child(Months)	1.03(1.02,1.05)*	1.04(1.02,1.05)*	0.97(0.95,0.99)*
Sex of the child			
Female	7.41(3.90,14.04)*	4.99(2.62,9.53)*	5.44(2.84,10.41)*
Male	1	1	1
Presence of under 5 children			
No	0.53(0.28,0.99)	0.42(0.22,0.81)**	1.03(0.52,2.04)
Yes	1	1	1
Child dietary diversity			
Low	3.11(1.63,5.90)*	3.10(1.47,6.51)**	3.16(0.45,22.35)
Medium	1.93(1.13,3.30)**	1.89(1.06,3.35)**	1.87(0.53,6.64)
High	1	1	1
Feeding special foods during illness			
No	1.82(1.20,2.76)**	1.78(1.16,2.74)*	1.70(1.01,2.87)**
Yes	1	1	1
RANDOM EFFECT (Estimate with Standard Error)			
Variance of Random Intercept	2.13(0.86)	2.44(0.84)	1.40(0.83)
Variance of Random Slope	1.04(0.26)	1.02(0.26)	0.22(0.44)
Covariance of Random Intercept and Slope	0.49(0.47)	0.43(0.44)	1(0.0001)

**: significant P<0.001; **: significant P< 0.05 AOR= Adjusted Odd Ratio*

No anthropometric failure: child with no stunting, wasting and underweight

Anthropometric Failure: stunting only; wasting only; underweight only; stunting and underweight; wasting and underweight; and stunting, wasting and underweight

CIAF=Composite index of anthropometric failure

[A]Since the prevalence of wasting changed significantly during the follow-up period, a variable for follow up time was added to the model

Table 4.4. The association of multiple anthropometric failures on child morbidity in southwest rural Ethiopia from mixed-effects logistic regression, 2014-2015

	General Morbidity	Diarrhea	Acute Respiratory Infection
	AOR (95%CI)	**AOR (95%CI)**	**AOR (95%CI)**
Undernutrition according to the CIAF			
Component level[A]			
Time[B]	-	0.79(0.57,1.11)	1.14(0.95,1.37)
Stunting only	2.55(1.11,5.89)**	0.64(0.16,2.53)	3.23(1.39,7.52)*
Wasting only	0.93(0.64,1.34)	0.54(0.24,1.24)	1.21(0.81,1.80)
Underweight only	0.74(0.26,2.14)	15.78(1.61,154.96)**	0.57(0.15,2.13)
Stunting and underweight	1.33(0.57,3.13)	0.25(0.02, 2.49)	0.92(0.34,2.54)
Wasting and underweight	1.41(1.01,2.00)**	1.74(0.89,3.39)	1.07(0.72,1.57)
Stunting, wasting and underweight	0.75(0.32,1.72)	1.02(0.15,6.84)	1.12(0.47,2.69)
No failure	1	1	1
Magnitude level[A]			
Time[B]	-	0.80(0.58,1.10)	1.14(0.94,1.36)
One anthropometric failure	0.9(0.65,1.30)	0.69(0.34, 1.40)	1.12(0.77,1.61)
Two anthropometric failures	1.2(0.87,1.70)	1.63(0.87, 3.07)	1.07(0.74,1.55)
Three anthropometric failures	2.58(1.11,5.86)**	0.65(0.17, 2.51)	3.24(1.39,7.52)**
No failure	1	1	1
Undernutrition according to the conventional indices[A]			
Time[B]	-	0.79(0.57,1.08)	1.14(0.95,1.37)
Stunting	1.05(0.76,1.44)	0.79(0.41,1.51)	1.28(0.99,1.83)
Wasting	0.93(0.54,1.60)	1.05(0.40,2.81)	1.48(0.82,2.65)
Underweight	1.36(0.95,1.96)	1.55(0.75,3.22)	0.92(0.62,1.39)

** Significant at P<0.001; **Significant at p<0.05*

CIAF=Composite index of anthropometric failure

AOR= Adjusted Odd Ratio

[A]Analyzed using a mixed logistic model with random effects, adjusted for the age of the child, duration of exclusive breastfeeding, personal hygiene and household sanitation

No anthropometric failure=child with no stunting, wasting and underweight

[B]Since the prevalence of diarrhea and acute respiratory infection changed significantly during the follow-up period, a variable for the time effect was added to the model

4.4. Discussion

Low- and middle-income countries such as Ethiopia face persistent high rates of malnutrition with the associated mortality and overall disease burden (11,26). Although children are suffering from multiple anthropometrical failures, only a few studies, to our knowledge, have addressed determinants and morbidities of multiple anthropometrical deficits. The present study compared the estimates of prevalence and child morbidities from a classical approach to measure malnutrition with those from multiple anthropometric failures in southwest rural Ethiopia.

The prevalence of undernutrition in the present sample was substantially different when estimates used a composite index of anthropometric failure or conventional indices in three rounds. The conventional indices underestimated the prevalence of under nutrition by 20.7% compared with a composite index of anthropometrical failure. This difference is attributable to the overlap of underweight, stunting, and wasting in the conventional indices (51–53,55–58). Using a composite index for anthropometric failure is therefore an option to accurately estimate the prevalence of undernutrition in a population, where undernutrition is highly prevalent (121–123).

Prevalence estimates from conventional indices indicated that about 10% of the children remained undernutrition in the three rounds. The composite index of anthropometrical failure, however, identified 2.5 times more undernutrition in the population than conventional indices in the three rounds. Again and confirming findings of previous studies (51–53,55–58), the overlap of underweight, stunting, and wasting in conventional indices was substantial.

The ambiguity caused by this overlap hampers targeted interventions to address specific forms of malnutrition. There is a growing body of evidence that undernutrition in developing countries can only be addressed with an integrated framework for understanding undernutrition and commitment to address undernutrition. The fragmentation of interests on malnutrition has hampered advocacy efforts that bring attention and resources to child nutrition (53,54).

In the present study, almost one-third of children experienced two or more anthropometrical failures. These estimates are considerably higher than those of a single anthropometrical failure in other countries (52,56,118). Nevertheless, this finding was similar to the study conducted in India (121), indicating that experiencing two or more anthropometrical failures is the key challenge in developing countries.

Factors contributing to the high occurrence of anthropometrical failures in developing countries are low utilization of health services, poor sanitation, and lack of commitment and accountability to address child nutrition (65,104,124,125). Global and regional nutrition programs should design strategies to create awareness in the scientific communities and policymakers about classification of undernutrition and multiple anthropological failures.

Although previous studies used conventional indices and a composite index of anthropometrical failure for estimation of undernutrition, none compared determinants of multiple anthropometrical failures with those of stunting and wasting. Similarly, the previous studies used cross-sectional data to estimate undernutrition in the population, which does not allow analyzing how children fare over time and temporal stability of determinants of composite index of anthropometrical failures and conventional indices.

The present study demonstrated that multiple anthropometrical failures, stunting, and wasting had similar determinants and that their determinants were stable over time. Despite this, however, children had a different likelihood of experiencing multiple anthropometrical failures, stunting, and wasting. Children had a higher likelihood of developing multiple anthropometric failures compared with being stunted or wasted.

The likelihood of having multiple anthropometric failures at 12 months of age was six times higher than at 6 months. It is well known that from the age of 6 months onward anthropometric failure increases gradually. The underlying factors of anthropometric failures from age 6 months onward are intake of unsafe complementary foods, low frequency of consumption, and low quality and diversity (13,64,88,126).

Female children suffered more from multiple anthropometric failures than males in the present. Malnutrition often caused by sex discrimination in food distribution, remains a challenge in many developing countries (127). Various reports indicate that female children suffer more from malnutrition. Prenatal health seeking behavior discriminates against female children, and female children received poorer treatment for various infections (128). This presents additional challenges to address eradicate extreme poverty and hunger, achieve universal primary education, promote sex equality, empower women, and reduce child mortality.

Children having low or medium child dietary diversity had high likelihoods of developing multiple anthropometric failures. Globally, only 60% of children ages 6 to 8 months receive solid, semisolid or soft foods, highlighting deficiencies in the timely introduction of complementary foods (4). Additionally, nutrition programs in low- and middle-income settings continue to receive insufficient attention. A comprehensive, multipronged approach is needed, with both crosscutting and targeted strategies at community, health system, and national levels to address undernutrition (13).

None of the previous studies on child morbidities addressed the association with stunting only, simultaneous occurrences of wasting and underweight. Our study showed that children with stunting only and simultaneous occurrences of wasting and underweight were more likely to report child morbidities. Evidence shows that stunted children had an elevated risk for respiratory infections and diarrhea. Severely stunted children also had a threefold increased risk for mortality from other infections, including sepsis, meningitis, tuberculosis, hepatitis, and cellulitis (129).

Children who were underweight only were more likely to develop an episode of diarrhea. Underweight is significantly associated with a subsequent risk for diarrhea and pneumonia episodes (130). In addition to underweight only, washing hands before serving a meal, hand wash before feeding a child, stores of washed dishes on the floor and store of washed dishes in the covered container were key determinants of the diarrhea episodes (131–133).

Furthermore, children with multiple anthropometrical failures were more likely to report any morbidity. Under those circumstances, children with multiple anthropometrical failures also were more likely to developing an acute respiratory infection. However, the conventional indices such as stunting, wasting, and underweight were not associated with any of the child morbidities. Children with multiple anthropometrical failures are known to suffer from morbidity and mortality in developing countries (51,55).

The strength of this study was the longitudinal design and efforts to ensure quality during data collection. The finding provides new insights for the nutrition researchers and policymaker in developing countries. Use of the self-reported questionnaire show ever, may have underestimation or overestimation of the incidence of child morbidity.

4.5. Conclusion

The present study compared undernutrition and its association of multiple anthropometric failures with child morbidities in southwest rural Ethiopia. In our sample, almost half of the children suffered from undernutrition. A composite index of anthropometrical failure estimated a higher proportion of undernutrition in the population than conventional indices over time. Children were more likely to develop multiple anthropometrical failures compared with stunting or wasting. Presence of multiple anthropometrical failures was also associated with child morbidity. This was not the case for conventional indices such as stunting, wasting, and underweight.

5

Chapter 5

Seasonality and determinants of child growth velocity and growth deficit in rural southwest Ethiopia

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Abstract

Background: Ethiopia faces cyclic food insecurity that alternates between pre- and post-harvest seasons. Whether seasonal variation in access to food is associated with child growth has not been assessed empirically. Understanding seasonality of child growth velocity and growth deficit helps to improve efforts to track population interventions against malnutrition. The aim of this study was to assess child growth velocity, growth deficit, and their determinants in rural southwest Ethiopia.

Method: Data were obtained from four rounds of a longitudinal panel survey conducted in ten districts in Oromiya Region and Southern Nations, Nationality and Peoples Region of Ethiopia. The hierarchical nature of the data was taken into account during the statistical analyses by fitting a linear mixed effects model. A restricted maximum likelihood estimation method was employed in the analyses.

Result: Compared to the post-harvest season, a higher length and weight velocity were observed in pre-harvest season with an average difference of 6.4 cm/year and 0.6 kg/year compared to the post-harvest season. The mean height of children in post-harvest seasons was 5.7 cm below the WHO median reference height. The mean height of children increased an additional 3.3 cm [95% CI (2.94, 3.73)] per year in pre-harvest season compared to the post-harvest season. Similarly, the mean weight of children increased 1.0 kg [95% CI (0.91, 1.11)] per year more in the pre-harvest season compared to the post-harvest season. Children who had a low dietary diversity and were born during the lean season in both seasons had a higher linear growth deficit. Being member of a highly food insecure household was negatively associated with higher weight gain. Having experienced no illness during the previous two weeks was positively associated with linear growth and weight gain.

Conclusion: Child growth velocities and child growth deficits were higher in the pre-harvest season and post- harvest season respectively. Low dietary diversity and being part of a highly food insecure household were significantly risk factors for decreased linear growth and weight gain respectively.

Key terms: seasonality, growth velocity, growth deficit, rural Ethiopia

5.1. Background

Due to seasonal variability of food production, dietary intake, food security and morbidity in the developing world, many children suffer from impaired linear growth (29,30). Populations in low- and middle-income countries are vulnerable to seasonal food shortages due to rain-fed subsistence farming. Seasonality of food access affects millions of the world's poor communities and contributes to some of the most widespread diseases (31).

In sub-Saharan Africa, more than 95% of farmed lands rely on low input and low output rain-fed agriculture. This results in seasonal food insecurity and malnutrition among a great number of poor families (42). Low use of agricultural technology and poor market access contribute to seasonal fluctuations of household food consumption in particular in the more isolated rural households (43).

Climate change represents a major threat to the coming decades, particularly in Africa, which has more climate-sensitive economies than any other continent in the world. Climate change is expected to increase the burden of under-nutrition in particular in rural households (134,135). Climate change worsens the existing problem of under-nutrition in Africa and will further challenge the current efforts to reduce poverty and under-nutrition (136,137).

The causes malnutrition include household food insecurity, inadequate care for women and children, and unhealthy environments, poor sanitation and hygiene or lack of health services (3). As all underlying causes of malnutrition are potentially seasonal, information on seasonal changes in determinants of malnutrition and their effect on linear growth is essential to improve planning and targeting of food security and nutrition-sensitive interventions in agriculture and, ultimately, child well-being (138,139).

To date, the Demographic and Health Surveys and majority of child growth studies do not consider the seasonal changes when assessing child growth. This hampers assessment of nutritional status of children in many resources limited countries and seasonal priorities. Understanding seasonality of child growth can improve models and simulations to track of success in the fight against malnutrition (140,141).

The aim of this study was to determine seasonality and determinants of child growth velocity and growth deficit in rural southwest Ethiopia. We hypothesized that (i) children had a higher growth velocity in the post-harvest season than pre-harvest season, (ii) children had a lower

child growth deficit in the post-harvest season than pre-harvest season, and (iii) there is a difference in child growth deficit between post and pre-harvest seasons due to seasonal variability of dietary intake, food security, season of child birth and morbidity.

5.2. Methods and materials

5.2.1. Study design and population

Data for the present study were obtained from four rounds of a longitudinal panel survey conducted in ten districts (woredas) encompassing 20 counties (kebeles) in Oromiya Region and Southern Nations, Nationality and Peoples Region of Ethiopia.

5.2.2. Measurement

5.2.2.1. Seasonality of child growth

According to the Ethiopian National Meteorological Agency, Ethiopia has four agricultural seasons based on the average trends of the weather and rainfall. Summer (lean season) includes three months such as June, July and August characterized by heavy rainfalls. Spring (pre-harvest season) includes September, October and November. Winter (harvest season) includes December, January and February. Autumn (post-harvest season) runs from March till and May (142). In summer (lean season), 97% of all crops and 96% of total cereals are cultivated. The pre-harvest season and post-harvest are typically used as transition phases between the lean and harvest seasons (143,144).

For the present study, we considered the two main cropping seasons in southwest Ethiopia: the pre-harvest season (September – November) and post-harvest (late February - May). We collected data twice per year during two years to assess seasonality of child growth. Data from round one and three were conducted from February 9 till April 9, 2014 and March 4 till May 01, 2015, which was the post-harvest season. Round two and four were conducted from Sept 22 till November 19, 2014 and August 31 till October 29, 2015, which was the pre-harvest season (145).

5.2.2.2. Anthropometric data

A SECA weight scale and length/height boards were used to measure weight and length/height with a precision of 100 gram and 1 mm, respectively. Height of children older than 24 months was measured standing while the length of those younger than 24 months was

measured in recumbent position as recommended by WHO (146). The height and weight of caretakers and children were measured without shoes and light clothes (9). To account for differences due to measurement method, 0.7 cm was added to the height values before merging them with the length data (146).

5.2.2.3. Growth velocity

Growth velocities were included height and weight velocity. Growth velocity is the change in measurements or increments in weight and length/height from one visit to the next visit. This provides information on growth monitor progress. It indicates the velocity or the rate of growth per unit of time (147).

Before calculating the growth velocity, we constructed Lambda-Mu-Sigma Method (LMS method) which summarizes three curves representing the median (M), the coefficient of variation (S), and the skewness of distribution (L) to pool the age of the child in different rounds (148,149). Similarly, length and weight increased much more rapidly in first few months of life compared with the later ages. To address this, age was transformed before smoothing of the centile curve (150). Growth velocities were calculated as follows: $V = M_{n+1} - M_{n/Tn+1-Tn}$, M_n and M_{n+1} were measurements at adjacent occasions, and $Tn+1-Tn$ were the time measurements at adjacent occasions (151).

5.2.2.4. Child growth deficits

Child growth deficits were included child linear growth and weight gain. Child growth deficits are representative of physical growth and indicate differences in size over a period of time (146,147). We measured child growth deficits (linear growth and weight gain) for longitudinal data using absolute value of height and weight according to WHO recommendation (146).

5.2.2.5. Dietary diversity (explained in chapter 2)

The child dietary diversity score (CDDS) and household dietary diversity score (HDDS) for present study were divided into tertiles representing low, medium and high dietary diversity.

5.2.2.6. Household food insecurity (explained in chapter 2)

Household food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS). Household food insecurity for present study was divided into tertiles representing

food secure households, moderately food insecure households and highly food insecurity households.

5.2.3. Data analysis

The data were verified for distribution, missing values and outliers, then cleaned and analyzed using STATA11 version for Windows (STATA Corporation, College Station, TX, USA). We excluded children who had only one observation during the follow-up survey from analysis. Exploratory analyzes were conducted to examine the sample characteristics over the different measurements and rounds. The hierarchical nature of the data was taken into account during the statistical analysis using linear mixed effects model fitted with restricted maximum likelihood estimation method. The models were adjusted for age of the child, seasons of child birth, sex of the child, any illness in the past two weeks, child dietary diversity and household food insecurity classification. Multi-collinearity and interaction term were verified in the models. The results are in terms of parameter estimates, standard errors and 95% confidence interval (CI) expressing the findings.

5.3. Results

From the total sample, 579, 674, 674 and 680 children under age of five years were included in the analysis of round one, two, three and four, respectively. Of the children who were included in the analysis, nine (1.6%) individuals in round two, 9 (1.3%) individuals in round three and 17(2.5%) individuals in round four had missing data for all variables.

Overall, 50.8% female and 49.2% of male participated in this study. The overall mean age of the children was 37.2±16.6 months (i.e. round one =28.8±14.0 months, round two =34.2±15.7 months, round three=39.8±15.8 months and round four=45.1±16.1 months). More than half (55.4%) of the children were under age of 12-36 months.

Figure 5.1 shows the median values for height and weight velocity of the children by season and age. A marked decrease in the growth velocity is observed from the first year to the second year of the child. A higher length and weight velocity were observed in pre-harvest season compared with post-harvest season (length velocity = 6.4 cm/year and weight velocity = 0.6 kg/year). Female children showed the highest length velocity in pre-harvest season with an average difference of 4.7cm/year, while male children had the highest weight velocity in pre-harvest season with an average difference of 0.6kg/year.

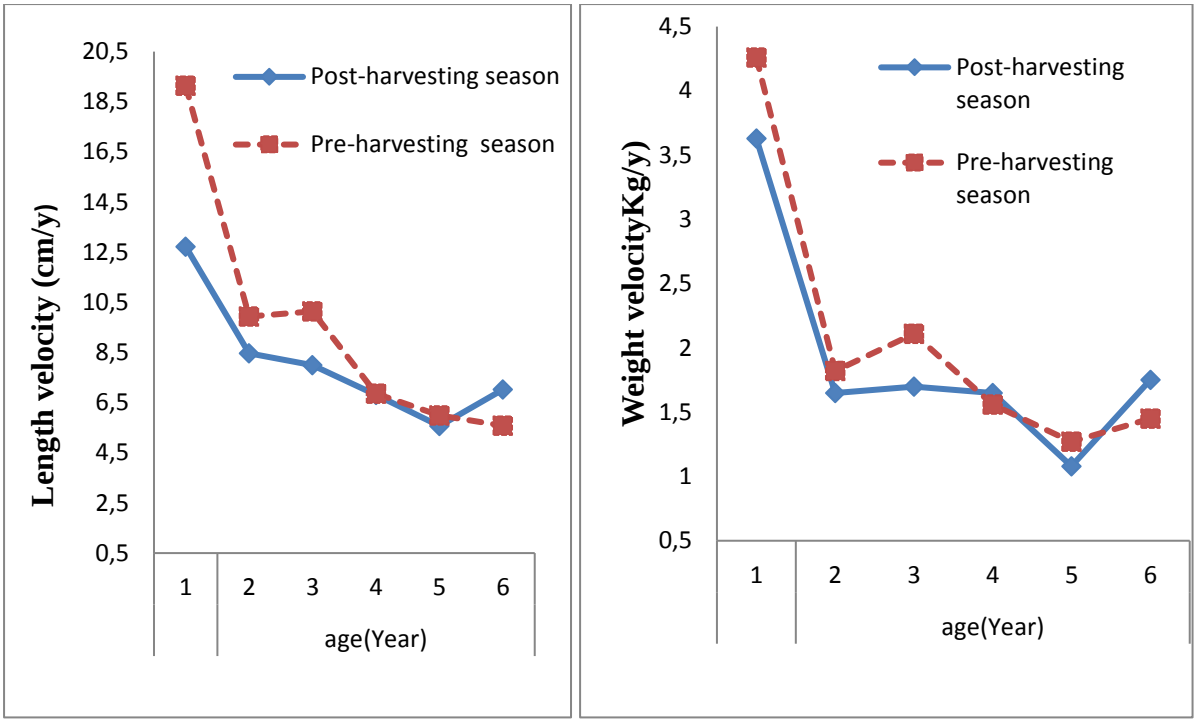

Figure 5.1. Median length (left) and weight velocity (right) of children in southwest rural Ethiopia by seasons and age, 2014-2015

The growth of almost all children was between WHO median and -2 z-scores and with a similar growth trend over time. Figure 5.2(a&b) shows the seasonal variation in absolute mean length by age and sex of the children. Children had a lower growth deficit compared to the median in the post-harvest season than pre-harvest season. In the pre-harvest season, children had a mean height of 4.3 cm below the heights that corresponded to WHO reference, while post-harvest season children had a height of 5.7 cm below the heights that corresponding to WHO reference. In the pre-harvest season, female and male children had mean heights of 4.7 cm and 4.0 cm below the height corresponding to WHO Median reference respectively. However, this deficit increased to 5.6 cm and 5.7cm in the post-harvest season for female and male respectively.

A) Female

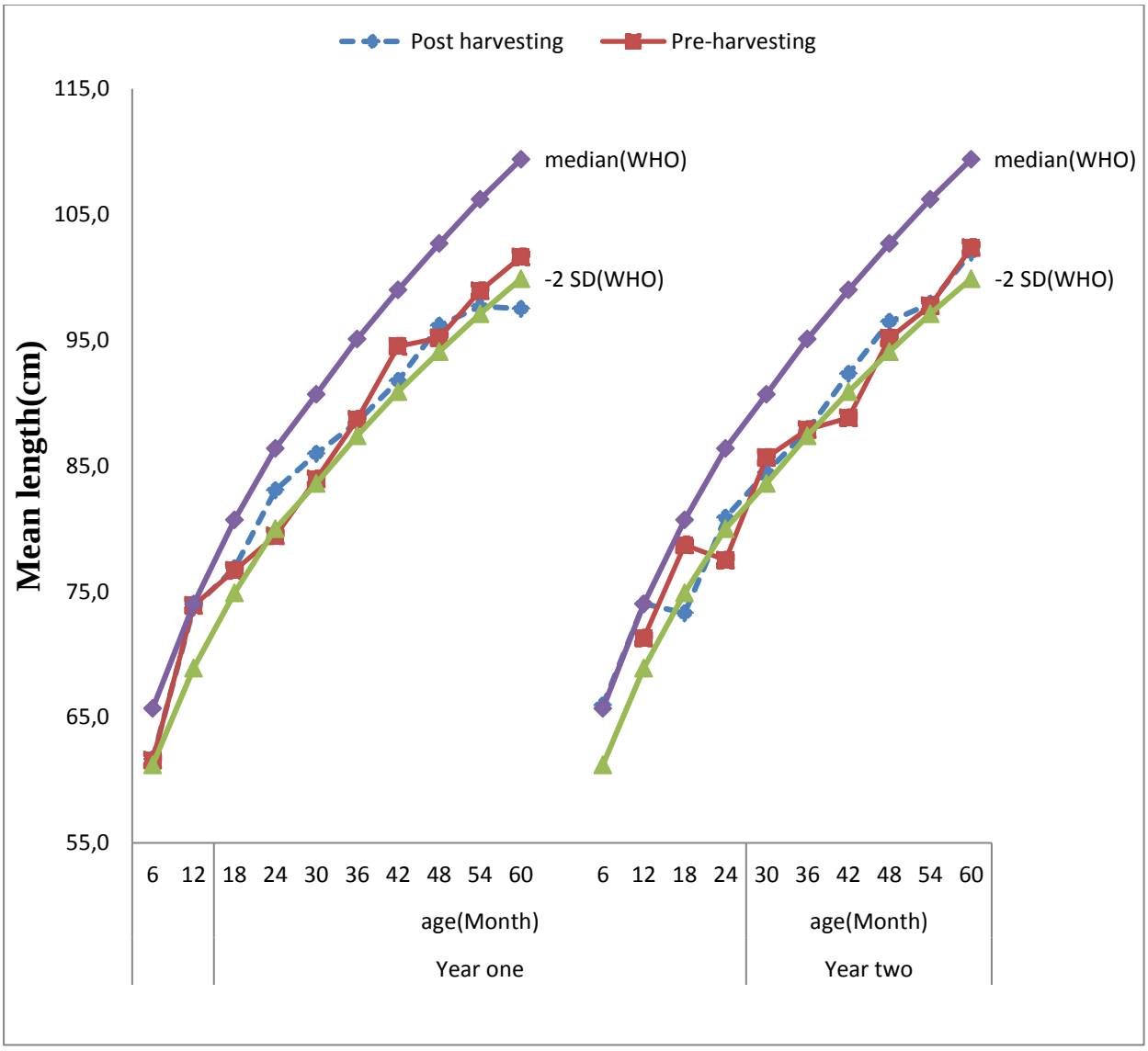

Figure 5.2(a). Mean height of female children by year in post and pre-harvest seasons in southwest Ethiopia

SD = World Health organization child growth standard reference -2 standard deviation

Median WHO= World Health organization child growth standard reference= 50%

B) Male

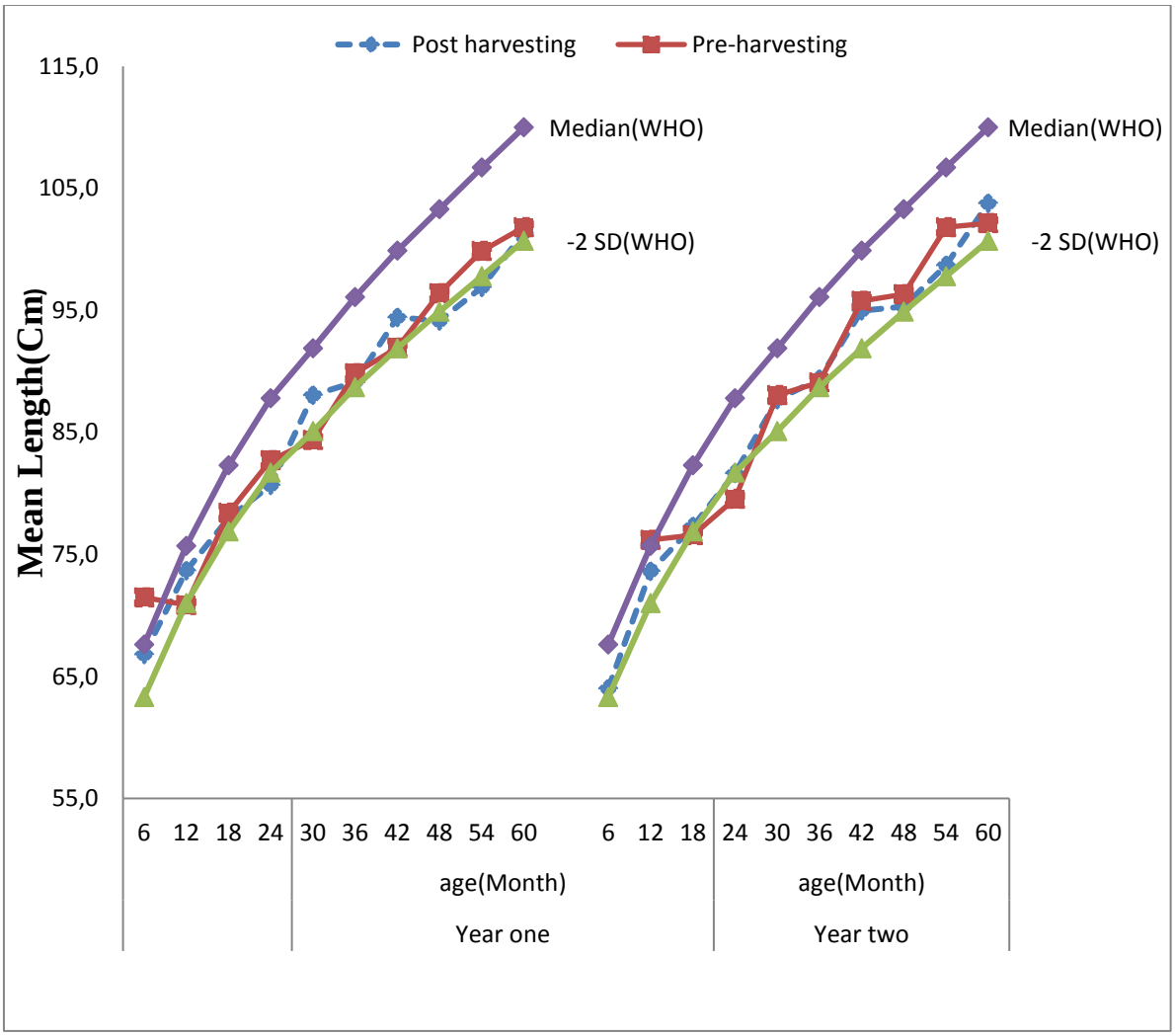

Figure 5.2(b). Mean height of male children by year in post and pre-harvest seasons compared to the WHO reference 2006.

SD = World Health organization child growth standard reference -2 standard deviation

Median WHO= World Health organization child growth standard reference= 50%

Table 5.1 explains the bivariate association of seasons and exposure variables. Household food insecurity, household dietary diversity, and type of individual food groups consumed (i.e. vitamin A rich vegetables and fruits intake, flesh foods in take, egg intake and legumes intake) were significantly associated with seasonality. Household food insecurity, vitamin-A rich vegetables and fruits, flesh foods (meat, fish, poultry and liver/organ meats) consumption were higher during the pre-harvest season, while household dietary diversity, egg, and legume consumption were higher during the post-harvest season.

Table 5.1. Association between seasons and selected exposure variables in southwest Ethiopia, 2014-15

Variables	**Post-harvest season (N=1,253)**	**Pre-harvest season (N=1,354)**	**P[1]**
Household food insecurity, Mean (SD)	5.4(6.1)	6.8(6.6)	0.001
Household dietary diversity, Mean(SD)	3.9 (1.5)	3.7 (1.4)	0.001
Cereal intake,%	48.3	51.7	0.63
Vitamin A rich vegetables and fruits intake, %	42.3	57.7	0.001
Flesh food intake,%	25.2	74.8	0.001
Egg intake, %	63.4	36.6	0.001
Dairy intake, %	50.4	49.6	0.19
Legume intake,%	51.4	48.6	0.001
Other fruit and vegetables intake,%	48.9	51.1	0.46
Child dietary diversity score, Mean (SD)	2.9(1.3)	2.8 (1.2)	0.77

[1] bivariate association was assessed using a Chi-square test.

Table 5.2 shows the association between seasons and child growth deficit (linear growth and weight gain). The absolute mean height of children increased on average 3.3 cm per year in pre-harvest season compared to the post-harvest season. Similarly, the absolute mean weight of children increased by 1.0 kg per year in pre-harvest season compared to the post-harvest season.

Table-5.2. Associations of season and child growth deficits over a 2-year follow-up period in Southwest Ethiopia, 2014-15

		Model 1: Height		**Model 2: Weight**	
		Estimate (95%CI)	**SE**	**Estimate (95%CI)**	**SE**
Fixed effects					
Intercept		86.93(86.10,87.76)**	0.42	11.55(11.34,11.75)**	0.10
Seasons	Post-harvest (ref)				
	Pre-harvest	3.34(2.94,3.73)**	0.20	1.01 (0.91,1.11)**	0.05
Random-effects					
Variance of random intercept		10.34 (3.94,4.53)**	0.30	2.54 (2.34, 2.69)**	0.07
Variance of measurement errors (residuals)		5.09 (2.57, 2.90)**	0.08	1.27 (1.23, 1.31)**	0.021

*** Significant at p<0.001, CI=confidence interval, SE = standard error*

Child linear growth had similar determinants in post and pre-harvest seasons (Table 5.3). Children with a low dietary diversity and born during the lean season had lower linear growth in both seasons. Age of the child was positively associated with child linear growth in both seasons. Having experienced no illness during the past two weeks and severely food insecure household on the other hand was positively associated with child linear growth in post-harvest season.

Factors associated with child weight gain were similar in post and pre-harvest seasons (Table 5.4). Having a low dietary diversity was negatively associated with child weight gain in both seasons. However, being part of a severely food insecure household was negatively associated with child weight gain in the pre-harvest season. Age of the child, being male and no reported illness experience during the past two weeks was positively associated with child weight gain in both seasons.

Table 5.3. Linear growth deficit in the post-and pre-harvest seasons over a 2-year follow-up period in Southwest Ethiopia, 2014-15

		Model 1 Post-harvest		Model 2 Pre-harvest	
		Estimate(95%CI)	**SE**	**Estimate(95%CI)**	**SE**
Fixed effects					
Intercept		66.59(65.51, 67.68)**	0.55	67.79(66.49,69.09)**	0.66
Season of child birth	Autumn (ref)				
	Spring	0.35 (-0.62,1.32)	0.50	0.31(-0.73, 1.35)	0.53
	Summer	-0.99 (-1.93,-.04)*	0.48	-1.06(-2.07, -.04)*	0.52
	Winter	-0.35 (-1.42,0.71)	0.54	-0.25(-1.39, 0.89)	0.58
Age of the child (months)		0.60(0.58, 0.62)**	0.01	0.58(0.56,0.60)**	0.01
Sex of the child	Female(ref)				
	Male	0.41 (-0.25, 1.07)	0.34	0.67(-0.07,1.40)	0.38
Any illness in the past two weeks	Yes(ref)				
	No	0.54 (0.03,1.06)*	0.26	0.23 (-0.39, 0.86)	0.32
Child Dietary Diversity	High(ref)				
	Medium	-0.39 (-0.94, 0.15)	0.28	-0.31(-0.93,0.31)	0.32
	Low	-1.21(-1.80,-0.61)**	0.31	-1.44(-2.12, -0.76)**	0.35
Household food insecurity	Food Secure(ref)				
	Moderately food insecure	0.40(-0.17,0.96)	0.29	-0.17(-0.84,0.50)	0.34
	Severely food insecure	0.68(0.06,1.30)*	0.32	-0.38(-1.11,0.36)	0.38
Random-effects					
Variance of random intercept		4.23(3.94,4.53)	0.15	4.41 (4.10,4.75)	0.17
Variance of measurement errors (residuals)		2.73(2.57, 2.90)	0.09	3.443(3.26, 3.64)	0.10

** Significant at p<0.05, ref= Reference category, SE = standard Error*
*** Significant at p<0.001, CI=confidence interval*

Table 5.4. Child weight gain in the post and pre-harvest seasons over a 2-year follow up period in Southwest Ethiopia, 2014-15

		Model 1 Post-harvest		Model 2 Pre-harvest	
Fixed effects		**Estimate(95%CI)**	**SE**	**Estimate(95%CI)**	**SE**
Intercept		6.99 (6.65,7.33)**	0.170	7.24 (6.88, 7.61)**	0.19
Seasons of child birth	Autumn (Ref)				
	Spring	-0.02 (-0.31,0.29)	0.15	0.01 (-0.31, 0.32)	0.16
	Summer	-0.35 (-0.64,-0.06)*	0.15	-0.25 (-0.56,0.05)	0.16
	Winter	-0.19(-0.51,0.14)	0.17	-0.11, (-0.45, 0.23)	0.18
Age of the child (months)		0.13(0.13,0.14)**	0.003	0.14(0.13,0.14)**	0.003
Sex of the child	Female (ref)				
	Male	0.44 (0.24, 0.65)**	0.11	0.43 (0.22, 0.65)**	0.11
Any illness in the past two weeks	Yes (ref)				
	No	0.20 (0.04, 0.37)*	0.09	0.19 (0.02, 0.35)*	0.08
Child dietary diversity	High (ref)				
	Medium	-0.15 (-0.33, 0.03)	0.09	-0.13 (-0.29,0.04)	0.08
	Low	0.30(-0.50,-0.11)**	0.10	-0.39 (-0.58,-0.21)**	0.09
Household food insecurity	Food secure (ref)				
	Moderately food insecure	0.06 (-0.12, ,0.25)	0.09	-0.15 (-0.33,0.02)	0.09
	Severely food insecure	-0.08 (-0.28, 0.12)	0.10	-0.23 (-0.43, -0.03)*	0.10
Random-effects					
Variance of Random Intercept		1.28 (1.18, 1.37)	0.05	1.39 (1.30,1.48)	0.05
Variance of measurement errors (residuals)		0.91 (0.86, 0.97)	0.03	0.87 (0.83, 0.92)	0.03

*** Significant at p<0.001,* *Ref= Reference category, SE = standard Error*
** Significant at p<0.05,* *CI=confidence interval*

5.4. Discussion

Children in low-and middle-income countries suffer from sub-optimal growth due to seasonality of food production, insufficient dietary intake, food insecurity, morbidity, low use of agricultural technology and poor market access (135–137). To date however, only a few and mostly outdated studies have addressed seasonality of child growth (140,141). This study determined seasonality and determinants of child growth velocity and growth deficit in rural southwest Ethiopia.

In the present study, the child growth velocity sharply decreased between one to two years of age. The highest length and weight velocity were observed in the pre-harvest season. This finding is similar to a study conducted in northwestern Iran where a sharp decrease in the velocity growth charts from birth to 2 years of age was observed. These charts have remained relatively stable up to 4 years for both sexes (151).

Similarly to Australian findings (152), the present study showed a higher growth velocity in the pre-harvest season compared to the post-harvest season. In the present study however, the majority of pre-harvest data were collected during a period where some farmers had started to harvest crops. This is not unusual in Ethiopia as the majority of vegetables, fruits and some cereals are harvested early during the harvest season (143,144).

In addition, the present study estimated that vitamin A-rich vegetables and fruits, meat, fish, poultry and liver/organ meats are consumed more in pre-harvest season than post-harvest season. Contrary to our findings, other studies have shown that child growth velocity was lowest in pre-harvest season. Authors have attributed this to distance to food source, food insecurity, health service utilization and child feeding practice (153–156). In the present study, the data collection period might not have been totally reflecting the pre-harvest season. Most of the data were collected early during the harvest season during which the most cereals were being harvested.

Female children had a higher length velocity but a lower weight velocity than male children in both seasons. A study from Taiwan showed that female children had lower length velocity than male children (157). This difference was attributed to gender differences in child feeding, geographical factors. Therefore, appropriate childhood interventions should be considered to prevent childhood obesity and chronic disease development.

This study estimated that children were more likely to increase their height and weight in pre-harvest compared to the post-harvest season. As described earlier, pre-harvest data was partly collected early in the harvest season (143,144) and children might have had some access to cereals and other crops required for child growth.

Belonging to a highly food insecure household was a significant risk factor for lower child weight gain and a protective factor for increased linear growth in pre-harvest and post-harvest seasons, respectively. Families might have protected children during though shortages of food in the household. During food insecure seasons, families give priority to children and feed them first before the other household members. Previous evidence strongly supports the inverse association of child growth, food insecurity and household dietary diversity (139,140,152,155,158–160).

Children born during the lean season and with a low dietary diversity had a lower linear growth in post-harvest season compared to the pre-harvest season. Due to seasonal variation in food insecurity and dietary intake in developing countries, the season of childbirth affects linear growth of children. Not only the season of childbirth but also season of preconception and pregnancy is associated with child growth later in life. A study conducted in rural Burkina Faso showed that birth weight, birth length, intrauterine growth retardation, and preterm birth showed significant seasonal variations. Birth weights and birth lengths peaked at the end of the dry season, more precisely in April and May (161).

A study conducted in the UK and Gambia showed that season of birth was associated with birth weight, childhood growth and development, educational attainment and puberty timing in women (162,163). Therefore, adequate nutrition of the mother and the child should consider seasonality of child growth. The latter can have a profound impact on the child's growth and development and reduced disease risk, as well as on the protection of maternal health (164). Undernutrition during pregnancy, affecting fetal growth, is a major determinant of stunting and can lead to consequences such as obesity and nutrition-related non-communicable diseases in adulthood (25).

Age of the child and reporting no illness experience in past two weeks was positively associated with linear growth and weight again in post-harvest season and the pre-harvest season. It was also observed that being male had positive effect on weight again in post and pre-harvest seasons. Previous evidence showed that age and sex of the child and illness

experience in the past two weeks were determinants of weight again and linear growth (153,158,165).

Even though dietary diversity was significantly associated with stunting in all age groups, the association of dietary diversity with linear growth was as observed as age of the child increased (86). Therefore, dietary diversity and food frequency should consider the age of the child. Similarly, developing countries should consider seasonality of child growth in designing nutrition interventions to reduce the child growth faltering. Children in such settings are still vulnerable to seasonal food shortages due to rain-fed subsistence farming. Seasonality of food availability increases exposure to food shortages affects health of millions of the poor communities worldwide (31).

The strength of the study was its focus on seasonality of growth. Estimates on seasonality of growth and it determinants among rural southwest Ethiopia can guide planning, implementation and evaluation of integrated promotion of complementary feeding and health seeking behavior and household income generating activities options. Such knowledge can also strengthen partnership between nutrition and agriculture to reduce vulnerability to seasonal food shortages. However, the study did not have data from all four seasons. In addition, we were unable to collect data from the peak of the lean season. A comparison of the lean season and post-harvest season may have shown different and more pronounced results. Increased seasonal nutrition surveillance, which includes all four seasons, should be conducted to understand the seasonality of child growth velocity and deficits.

5.5. Conclusion

The study examined seasonality and determinants of child growth velocity and growth deficit in rural southwest Ethiopia. Child growth velocities were higher in the pre-harvest season than post-harvest season. Children had a higher child growth deficit in the post-harvest season than pre-harvest season corresponding to WHO reference. Child growth deficits had almost similar determinants in post and pre-harvest seasons. Being born during the lean season, a low dietary diversity, belonging to a highly food insecure household and reporting illness experienced during the past two weeks were negatively associated with child linear growth and weight gain in rural southwest Ethiopia. Complementary feeding and early health seeking education and household income generating activities options should be design to solve seasonality of child growth velocity and deficit in rural communities in low-and middle-income countries.

6

Chapter 6
General discussion, conclusions and recommendations

6.1. General discussion

Malnutrition is an urgent global public health concern in developing countries (4,46,166). By 2020, developing countries will bear the highest prevalence of malnourished children (166,167). Although tangible progress is being made, it is expected that the reduction in child malnutrition will be small in sub-Saharan Africa (4,166). In Africa, undernutrition and micronutrient deficiency have not declined at satisfactory rates while overweight and obesity are rising (168). Therefore, a comprehensive strategy must be designed to address child malnutrition effectively.

The present research was conducted to generate evidence on child malnutrition in rural southwest Ethiopia through a comprehensive assessment of child caring practices, seasonality of malnutrition, and determinants to support national nutrition policy, strategies and programs.

In the present research, 91% of the children had poor child feeding or preventive behavior. Of those children, almost half of the children suffered from poor child caring practices. Household dietary diversity, household food insecurity, age of the child, and age of the caretaker were predictors of concordance of poor child feeding and preventive behavior. Comprehensive interventions are needed to address child feeding and preventive behavior to decrease the high level of stunting in rural Ethiopia (Chapter 3).

Almost half of the children suffered from undernutrition in our sample. A composite index of anthropometrical failure estimated a higher proportion of undernutrition in the population compared with the conventional indices such as stunting, wasting, and underweight. Children were more likely to develop multiple anthropometrical failures compared with stunting or wasting. The presence of multiple anthropometrical failures was also associated with increased child morbidity, while this was not the case for conventional indices such as stunting, wasting, and underweight. Children with multiple anthropometric failures are hence at high risk for developing child morbidities and should be targeted accordingly for nutrition intervention to reduce child morbidities (Chapter 4).

Child growth velocity was higher in the pre-harvest season than post-harvest season. Children had a higher child growth deficit in the post-harvest season than pre-harvest season. The determinants of growth deficits were similar in the post and pre-harvest seasons. Being born during the lean season, having a low dietary diversity, and belonging to a highly food

insecure household and reporting illness experienced during the past two weeks were negatively associated with linear growth and weight gain in the sample. Complementary feeding and awareness to promote care seeking early and household income generating activities options should be designed to solve seasonality of child growth velocity and deficits in (Chapter 5).

In brief, the present research indicates that children in rural southwest Ethiopia suffer from poor child caring practices, multiple anthropometric failures, morbidities and seasonality of growth deficits.

6.2. Implication of the findings

6.2.1. Implication of child caring practices on malnutrition

Child caring practices encompass child feeding, promotion of a safe and healthy environment, provision of adequate health care, psychosocial connections and emotional support (91). Poor breastfeeding practices, inappropriate complementary feeding, poor hygiene, and low health service provision are directly correlated with occurrence of malnutrition and morbidities and undernourishment decrease chances of survival substantially (32). The present findings confirm that poor caring practices are directly associated with malnutrition (Chapter 4). Appropriate child care practices are key to ensure child survival, optimal growth, and development (92). When the caring practices are disrupted, the children are undergoing poor dietary intake and suffer from increased infections (23).

Child feeding and water, sanitation and hygiene are major contributing factors for child malnutrition and diarrhea episodes in developing countries (69,169–173). Water and sanitation interventions can hence contribute substantially to improve child caring and sanitation in developing countries (174).

Earlier evidence indicates that child caring practices have an impact on child nutrition and morbidities in developing countries (69,169–172,175). Poor caring practices of children is strongly associated with child undernutrition such as stunting, wasting and underweight and frequent morbidities like diarrhea and acute respiratory infections (175–179). Globally, only 60% of children aged six to eight months receive solid, semi-solid or soft foods (4). Promotion of breastfeeding and complementary feeding, provision of food supplements,

micronutrient interventions are cornerstones of interventions to eliminate malnutrition in the longer term (64,180,181,182).

In our sample, almost no children under age of five slept under a bed net during the night before the interview but one fourth of them reported an illness in the past 2 weeks (Chapter 3-4).Recurrent infections, which increase the requirements and constrains nutrient absorption contributes to undernutrition (1,23). In low-and middle-income countries, poor child caring practices are significant risk factors for undernutrition and morbidities among under-fives (183,184). There is a need for a genuine promotion and protection of optimal infant feeding practices to improve the nutritional status of children in developing countries like Ethiopia.

Child caring practices during childhood period have a positive impact on reduction of childhood malnutrition and mortality (98,101,112,113). However, many children experience poor caring practices due to a high adherence to local cultural norms (23,185). Socio-cultural conditions are hence important determinants for child caring practices, child growth, development and survival in Africa (23,186).

Research on food culture and taboos has focused on use of animal source foods by women and children and breastfeeding (187,188). Intra-household food allocation takes into account the household hierarchical structure and gives priority to the head of the family in allocating food. Finally, mothers and children receive a smaller share of the family's food (187). Therefore, integral family-oriented approaches are mandatory to create an enabling socio-cultural environment to improve nutrition in households and communities (188).

Culture and traditional knowledge play a major role to shape food preferences, intra-household food allocation, child caring practices, food processing, and preparation (189,190). In Ethiopia, the majority of universities started to give health science and nutrition program with limited professionals and they lack cultural competence. Cultural competence is social medicine the ability of providers and organizations to effectively deliver health care services that meet the social, cultural, and linguistic needs of patients. The study conducted in Ethiopia confirmed the overall cultural competence of health workers was low. The clients were not satisfied for the services and the interactions due to socio-cultural difference (191,192).

From personal experience lecturing in biomedical sciences, public health and nutrition programs are not well geared to address socio-cultural dimensions of public health nutrition in Ethiopia. Therefore, including socio-cultural dimensions in training efforts in biomedical sciences, public health, and nutrition profession increase their competencies to encourage beneficial practices and discourage harmful practices. In addition to basic cultural education aspects, insight in traditional food knowledge and socio-cultural aspects can be instrumental to promote food and nutrition security at the community level (189,190).

6.2.2. Implication of multiple anthropometric failures on morbidities and mortality

Compared to those with only single anthropometrical failure (51), children with more than anthropometrical failure are more likely to have diarrhea and suffer from increased morbidity and mortality. To date, only a few studies have addressed multiple anthropometrical failures and their effect on health and morbidity (51–53). Lack of an integrated approach to understand and address undernutrition in children has contributed to the fragmentation of efforts to address malnutrition, resource allocation and development of interventions (54). Identifying children with multiple anthropometric failures may therefore help prioritize and guide interventions towards the most vulnerable groups (55–58).

In the present research, almost half of the children had at least one anthropometrical failure while one-third experienced two or more anthropometrical failures (Chapter 4). Malnutrition has remained high and ongoing interventions have not yet yielded anticipated outcomes. Therefore, we have to investigate the reason why malnutrition still remains very high in the area, even though, there is nutrition intervention in different sectors. And then more and better-targeted efforts are needed for nutrition intervention programs to address the most vulnerable segment of the population.

In the present study, children with multiple anthropometrical failures were more likely to report child morbidities. None of the conventional indices such as stunting, wasting and underweight was associated with any of the reported child morbidities (Chapter 4). This finding implies that multiple anthropometric failures are strong drivers for child morbidity and mortality in developing countries.

Although, considerable attention has been devoted to the evaluation of conventional indices (stunting wasting and underweight), few studies have assessed the correlation between multiple anthropometrical failures and child morbidities and mortality. A large body of

evidence recognizes the correlation between conventional indices and child morbidities (193–199), vulnerable to hospital-acquired infections, admitted to an intensive care unit, long hospital admission and mortality (200).

Furthermore, research using conventional indices indicates that malnutrition is the underlying cause of 45 % of all child deaths, 11% of their domestic product lost and low school performance and chronic diseases (33,201–206), severe acute malnutrition and child mortality in developing countries (207,208). The overall effect of malnutrition by using a composite index measure of malnutrition has not been provided.

The correlation between multiple anthropometrical failures and child morbidities and mortality is poorly documented. The present research brings an important research area to fore on how children with multiple anthropometrical failures suffer from morbidities and mortality.

Conventional indices underestimate the overall prevalence of undernutrition due to overlap of stunting, wasting and underweight measures (51,52,209). Having a high prevalence of undernutrition in developing countries creates a high overlap of stunting, wasting and underweight in given population and might underestimate the overall prevalence of undernutrition (210–213).

The lack of a comprehensive estimator of undernutrition has directed nutrition interventions towards one component of malnutrition in developing countries (54,211–213). In the present document, a composite index is proposed to measure aggregated overall prevalence of undernutrition to reduce the problem and fragmented interventions in resource limited countries (51,52,209–214) (Chapter four).

A single aggregated indicator for overall prevalence of the undernutrion is promising to reduce undernutrition comprehensively in developing countries. A composite index measure is a new concept and recently applied in different settings. Further studies with adequate power and design are needed to validate the composite index measure in a different setting with different outcomes of interests.

The likelihood of having multiple anthropometric failures at 12 months of age was six times more likely than at six months. The underlying factors for children suffering from multiple anthropometric failures are unsafe and inappropriate complementary foods, lack of right

frequency and quality food (13,64,88,126,215). Existing evidence also shows that age of the child and socioeconomic statuses are predictors of malnutrition in various countries in sub-Saharan Africa (216,217).

This PhD thesis confirmed that female children suffering more from multiple anthropometric failures compared to male children. Malnutrition caused by gender discrimination in food distribution, remains a challenge in many developing countries (127). Parents discriminates against female children in terms of health seeking behavior, and female children received less treatment for various infections (128). This presents additional challenges to address eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality and empower women and reduce child mortality.

The PhD thesis showed that being under five years of age in the household was negatively associated with nutritional status of the index child (Chapter 4), implying the negative impact of family size on nutritional status of children. As the African population grows exponentially, the amount of food needed to feed population needs to increase considerably. Women in Africa have on average 5.1 children and 40% of sub-Saharan Africa's population is in the reproductive age group, which leads to population momentum for some time regardless of efforts regarding family planning. Investments in agriculture, education, health and accessing family planning and women empowerment are key actions for ensure future food demands and food security in sub-Saharan Africa (218).

According to UN population projections, the world's population will reach 9.15 billion by 2050 with a large share of the growth in Africa. Sub-Saharan Africa faces serious food insecurity challenges due to high population growth, limited natural resources and climate change. In addition, these countries confronted with a double burden of malnutrition, which present specific challenges for the health systems (219). Sub-Saharan Africa will hence have faced the burden of balancing food supply to population fast population growth to prevent malnutrition. To deal with the increasing demand, food production should increase by double in developing countries like Africa by 2050 (220).

6.2.3. Implication of seasonality of growth velocity and growth deficit

This PhD work reports a higher growth velocity in the pre-harvest season compared to the post-harvest season. Similarly, a higher linear growth and weight gain was observed in the pre-harvest season compared to the post-harvest season. The reason why linear growth was

higher in the pre-harvest season is possibly that the pre-harvest season was not totally reflecting the pre-harvest season. The majority of the study areas were entered into an early harvest season. Majorities of cereals were being harvested and harvested at an early harvest season (143,144), indicating that children had better access to diversified diet during this season and hence better growth. Additionally, vitamin A-rich vegetables and fruits, meat, fish, poultry and liver/organ meats are consumed in pre-harvest season than post-harvest season. Due to seasonal variability of food production, dietary intake, food security and morbidity in the developing world, many children suffer from impaired linear growth (29,30).

Child growth also varies by season due to distance to the food source, food insecurity, health service utilization and child feeding practices (151,153–156). The domestic staple food productions and prices are persistently seasonal in developing countries due to low-input low-output rain-fed agriculture. These factors are important drivers for child malnutrition (42,221).

Evidences showed that climate change in developing countries like in sub-Saharan Africa is the major threat due to the climate sensitive nature of the agriculture. It changes the agriculture production and creates imbalances of supply and demand. These build an opportunity for market price increment and determine the ability of consumers to pay and individual's consumption. The main reasons why developing countries affected are low adaptive capacities; poverty; governance; limited access to capital like markets, infrastructure and technology; disasters and conflicts. What the evidence indicating, although, the cause of undernutrition is multifaceted, climate change takes the largest share in developing countries (135–137).

During periods of food shortage and household food insecurity, women are particularly vulnerable to nutrient inadequacies related to physiological vulnerability during childbearing and experience fatigue, which limits their ability to satisfy infant needs. This impairs child growth and cognitive development, which may persist into adulthood and transmit to the next generation (35).

Being born during the lean season was correlated with linear growth and weight gain in Ethiopia. Children being born during the lean season experienced higher linear growth deficits and lower weight gain than children being born during the autumn season. In rural Burkina Faso, birth weight, birth length, and small for gestational age showed significant seasonal variations (161). Birth weights and birth lengths peaked at the end of the dry season,

more precisely in April and May. Birth weights and birth lengths are the proxy indicators of future child growth. This indicates that the seasonality of maternal nutrition is the major determinant of low birth weight and length in developing countries like Ethiopia.

In the UK, Gambia, Nepal, and Indonesia, season of birth was associated with birth weight, birth outcomes, childhood growth and development (162,163,222,223). The study conducted in the UK stated that vitamin-D exposure variation is the underlying cause of seasonality of child growth. Whereas, the study conducted Gambia, Nepal, and Indonesia stated that limited market access, low infrastructure, limited micro-finance, shortage of food availability and infectious disease burden are the major determinant of seasonality of birth weight, birth outcomes, health, and child growth. The present findings confirm that seasonal differences in food insecurity, dietary intake and season of childbirth are directly associated with the seasonality of child growth (Chapter 5). This implies that the determinant of seasonality of child growth is different across the region. Moreover, the time and season of preconception and pregnancy are also predictor of child growth later in life (163,224).

Reporting illness during the past two weeks was negatively associated with seasonality of child linear growth and weight gain in rural southwest Ethiopia. Malnutrition and infections interact synergistically in developing countries (206). Children in developing countries experience malnutrition and micronutrient deficiency seasonally with infections like malaria, HIV, intestinal parasite and diarrhea episodes (225–235).

Seasonality was also directly associated with household food insecurity, household dietary diversity, climate change and infection. Seasonality of child growth occurred due to food price variation across seasons (221,236), burden due to infectious diseases (237), food availability, stability and utilization, climate change and rainfall vary across seasons (238–240). Likewise, energy intake and energy expenditure (224,241,242) and exclusive breastfeeding had shown seasonal variability (243).

Season not only affects the child growth but also body composition (244), maternal anxiety and depression (245) and child mortality (246,247). Differences in season and climate are hence key factors of child growth, development and survival in developing countries like Africa. Therefore, seasonal effect of interventions on malnutrition needs to be considered.

Earlier studies also showed how the brain response i.e. attention and memory tasks, is strongly associated with season. The maximum brain responses for attention and memory tasks were situated during summer and autumn months respectively, whereas minimum brain responses for attention and memory tasks were observed during winter and spring respectively (248).

6.2.4. Implication of common determinants on child caring, seasonality and nutrition

Throughout the various chapters in this study, dietary diversity and food insecurity emerged as common determinants of poor child caring practices, multiple anthropometric failures, morbidities and seasonality of child growth deficits in Ethiopia (Chapter 3-5). Dietary diversity and food insecurity are the proxy indicators of dietary adequacy, dietary quality, food availability and access which has influence on child malnutrition (249–251).

Household food insecurity is increasing in Africa due to low production by rain-fed agriculture. As such, African agriculture faces difficulty to achieve its primary objective, of feeding the population (252). Market-oriented agricultural activities play a more important role in determining food prices and incomes in rural area. Market-oriented food production and consumption has bidirectional links with agriculture and nutrition (253).

Therefore, agriculture must contribute more to improve dietary diversity and food insecurity. Agriculture needs to nourish instead of simply feeding populations of low-and middle-income countries. Moreover, agriculture is a source of food and income, a driver of food prices, empower women, ensure food and nutrition security in developing countries (254,255).

Increased agricultural production can also improve the storage food and create multiple benefits for producers and consumers. For this purpose, agricultural production needs to be diversified and include more nutrient-dense foods, which help to improve the household dietary and micronutrient intake. On the other hand, more attention should focus on research and innovation to reduce losses of nutrients and increasing the nutrient content of a variety of foods to improve nutrition and food insecurity (81).

Rain-fed agriculture must be replaced by sustainable agriculture, which brings food security in developing countries (256). Sustainable agriculture is the efficient production of safe, high quality agricultural products that protect and improve the natural environment, the social and economic conditions of farmers, their employees and local communities, and safeguards the health and welfare of all farmed species (257,258).

African agriculture should focus on business models for smallholder agriculture. Small farms that rely mainly on family labor and rural development and empower women (256). The policy options should focus on promoting context-specific farm-size policies, establish productive social safety nets, improve risk mitigation and adaptation strategies, link agriculture, nutrition, and health, promote pro-smallholder value chains, and ensure smallholder-friendly financing and investment to strengthen smallholder farmers (259). Resource mobilization and political commitment, scaling-up nutrition-sensitive interventions, increase evidence of agriculture and nutrition are key strategies to forge agriculture-nutrition linkages in developing countries (255).

On the other hand, due to unfair distribution food resource in the countries due to limited infrastructure and absence of functional food market structures, children have inadequate access to meet their energy and nutrient requirements (253). Children with monotonous and cereal-based diets experience multiple micronutrient deficiency (260), indicating dietary diversity score is a useful indicator of micronutrient intake.

As a final remark, to end malnutrition in developing countries, designing a strong national policy and tracking commitments and effectiveness is essential. Comprehensive monitoring and evaluation systems are needed to assess what works to determine cost-effective and acceptable nutrition intervention in the developing countries (81).

6.3. Future opportunities for reduction of malnutrition

The World Health Assembly reached an agreement on the need for rapid global action on nutrition. Six global nutrition targets were identified by 2025 and include reducing stunting by 40%, anemia in women of reproductive age by 50%, low birth weight 30%, no increase in child overweight, wasting to less than 5% and increase exclusive breastfeeding by 50% (72).

In 2014, the African Union passed three declarations with specific commitments of ending hunger by 2025, improving nutritional status, reducing child stunting to 10% and underweight to 5% by 2025, and accelerating progress on preventing child and maternal deaths (81,261).

To achieve the agenda by 2063, African leaders endorsed multiple declarations and agreements including reducing hunger and malnutrition and improving the diets of their populations and to ensuring sustainable growth and prosperity for Africa (81). A multi-sectoral nutrition strategy 2014-2025 was established with the aims of decreasing chronic malnutrition by 20% and maintaining global acute malnutrition below the emergency threshold of 15% (78).

The European Commission and African countries established a new partnership with the aim of reducing chronically undernourished by seven million by 2025 (79). The Ethiopian government launched an ambitious initiative named ‘Sekota Declaration’ to end hunger and under nutrition by 2030 with the goal of improving nutrition to save lives, build resilience, increase economic productivity, and advance development (44). Furthermore, the Ethiopian government launched national nutrition program II 2016-2020 with the aim of eradicating chronic malnutrition by 2030. The new national nutrition program aimed to reduce stunting from 40% to 26%, underweight from 25% to 13% and wasting from 9% to 4.9% (82,83).

6.4. Way forward

Different scholars propose different strategies to end hunger and disease in Africa. Improving government policy, increasing political commitment and application strategies to be adapted by the community-in tackling malnutrition are fundamental. Improvement in the transport system and market access to sell local produce and raise rural incomes is important. Different actors in health, education, agriculture, environment, universities, research institutes and non-governmental organizations must work together to deliver on nutrition outcomes (262,263).

To build capacity in nutrition-sensitive agriculture in Africa, interventions should focus on creating a supporting environment of agriculture for nutrition and health research. This helps to build participation of stakeholders in determining research priorities, communicating research outcomes to stakeholders and building capacity of local organizations and researchers. Alignment of research agendas and collaborative research between better-resource countries and less resource ones provides opportunities to rationalize resources and ensure build-up of capacity and transfer of knowledge (264,265).

Efforts to build capacity in Africa should consider consolidating networks for effective coordination and knowledge dissemination. Additionally, agriculture and nutrition professionals in Africa lead African research and ensure a sustained contribution of African expertise to addressing agriculture related nutrition and health issues (265). Promising strategies for Africa in this regards are advocating better nutrition position at higher level, establishing local nutrition research fund, mapping and creating nutrition research training opportunity (266) and developing multi- sectoral collaborative research with well-equipped professionals from abroad.

African agriculture and nutrition researchers need to generate evidence to reduce malnutrition taking into account the complexity of cross-sectoral coordination, lack of political commitment, limited financial resources, absence of a policy framework and low institutional capacity, recurrent conflicts and natural disasters and abandonment of traditional diets (185,267).

To ensure sustainable improvement in nutrition, a broader ‘systemic thinking’ is needed. Systemic thinking is enabling people to become aware of unpredictable interactions of actors, sectors, disciplines, and determinants of malnutrition. And this results new ways of forthcoming, examining, and solving the challenges through policy development, program

design, implementation and research (268). A conceptual framework of malnutrition using the social-ecological model was developed that integrates the findings of the present research and current evidence (269). The proposed framework helps to build a comprehensive understanding of malnutrition for better intervention (Figure 6.1).

We used socio-ecological model for this purpose as it considers multi-level of influence of malnutrition from policy up to individual factors to bring the desired behavior change (269). This model describes why people suffered from malnutrition, what one needs to know before developing and organizing malnutrition intervention, how to shape malnutrition program strategies to reach people and organizations and make an impact on them and what should be monitored and evaluated (269–272).

In the present research, we identified child caring practices, nutrition knowledge, women empowerment, women dietary diversity, morbidities and socio-demographic characteristics as individual factors; socio-cultural domain, wealth index, household food insecurity, household dietary diversity and household health services as interpersonal factors and seasonality as structure and systemic factors.

From the literature review, we identified policy (i.e. nutrition, agriculture, population growth, economic and health), globalization-urbanization, food system, education and training system, transportation system and government politics as structure and system factors; media promotion, workplace and school food environment, out eating habits, health and nutrition education curriculum and community nutrition value as community and institutional factors and finally community social network and community social support as interpersonal factors.

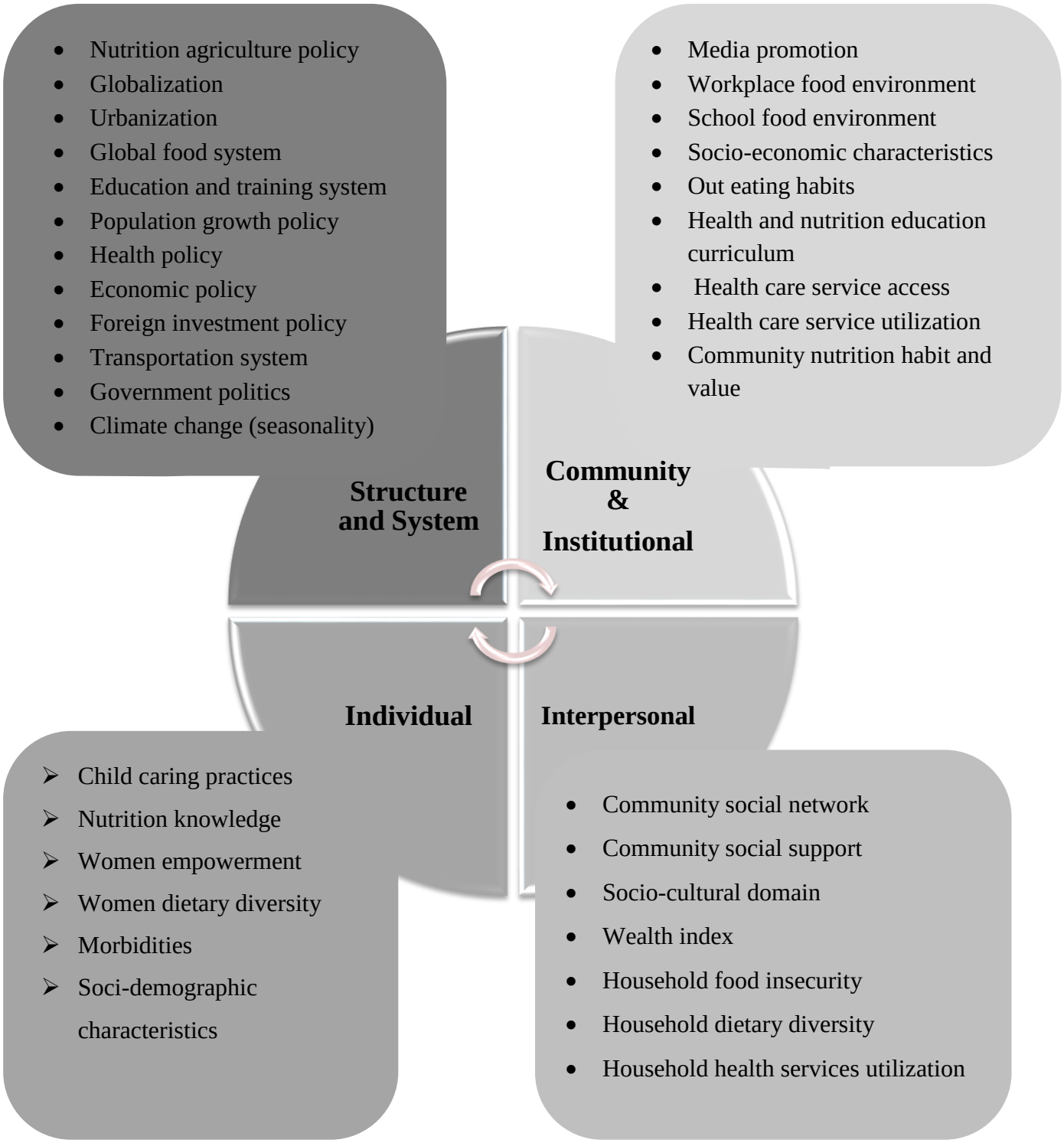

Figure 6.1. Proposed conceptual framework of malnutrition determinants using social – ecological model

6.5. Limitations and methodological considerations

6.5.1. Limitations

This study is not free of limitations. Limitations to the studies were added to the respective Chapters. Here, we describe the general limitations of this research.

Our project sample excluded the most remote rural areas, which were difficult to access and presented additional logistical challenges. Therefore, our sample may not fully represent the rural areas of southwest Ethiopia. Child caring practices were feeding, preventive behavior and psycho-social stimulation support components (92). Due to absence of psychosocial stimulation support empirical data in our study, we used feeding and preventive behavior to measure child feeding and preventive practices. Additionally, due to lack of empirical data regarding child preventive behavior from this study, we used caretaker's preventive behavior alone for children age greater than 36 months.

Our panel study collected data twice per year in pre- and post-harvest seasons. Due to lack of empirical data from four seasons and 12 months, it cannot be established whether the previous season or dietary intake over the last month had an effect of child growth or not. Such information would have improved the assessment of multiple anthropometric failures with morbidity and mortality. But, due to absence such information, we were unable to link multiple anthropometric failures with mortality outcomes.

Finally, the PhD thesis assessed gender differences, socio-cultural factors and child caring practices that were associated with malnutrition. Questions regarding gender differences, socio-cultural influence due to social cultural value, low literacy and political issues related to gender are challenging for rural respondents. Collected responses may hence under or over estimate, the effect of gender difference and socio-cultural influence on child caring practices.

To date, nutrition research in Ethiopia is in its infancy and requires care and support. To date, the majorities of the studies are descriptive and provide poor guidance for decision-making, planning, and implementation of interventions. Multi-sectoral collaboration in nutrition research in Ethiopia is virtually non-existent due to limited nutrition professionals at all levels of the government system, absence of research agenda in the area of nutrition. There are also very few trained nutrition professionals at university and research institutes with limited research resources.

To achieve nutrition capacity in Ethiopia, a supporting environment for nutrition research needs to be created with build-up of capacity at local organizations. Integration and pooling of knowledge and efforts can contribute to develop a nutrition research agenda with better-resource countries and less resource ones (264,265).

6.5.2. Strength of the study

As a strength of the study, a protocol was prepared before data collection and implemented as planned. Our study population was sampled from different agro-ecological zones of southwest Ethiopia with different crop cultivation, harvesting, food availability, and variation in morbidity characteristics. The consideration of different agro-ecological zones to understand child malnutrition in Ethiopia and comprehensive analysis of child caring practices, seasons and nutrition, are some of the strengths of this study.

The project was carried out in collaboration with different institutes in Ethiopia and abroad. This collaboration creates an opportunity to share their experiences and ensure quality of the data. The project adopted most rigorous operational research to address seasonality of agricultural activities, food availability, household food consumptions, optimal maternal and infant young child feeding practices and dietary diversity and maternal and child nutrition status.

6.6. Conclusion

Malnutrition is an urgent global public health concern in developing countries. Despite some positive developments, undernutrition is still a global concern (4,166). African agriculture and nutrition revolution is needed with multi-sectoral coordination, political stability and commitment, adequate financial resources, policy framework and institutional capacity are needed to reduce malnutrition in Africa (185,267).

Malnutrition in Ethiopia has been persistently high for the last decades due to insufficient food availability, inadequate provision of poor water, sanitation and hygiene, poor maternal and child nutrition, low women's decision-making power and resource control and political economy factors (95).

The present study has generated evidence on child malnutrition in Ethiopia through a comprehensive analysis of child caring practices, seasons and nutrition, and their determinants in southwest rural Ethiopia. The following conclusions are provided based on the findings:

- The majority of children suffer from a poor child caring practice, multiple anthropometrical failures, morbidities, and linear growth deficits;
- Age of the child, the sex of the child, dietary diversity, food insecurity and reporting illness experienced during the past two weeks were key determinant factors for the poor child caring practices, multiple anthropometrical failures, and growth deficits;
- Children with multiple anthropometric failures experience frequent morbidities;
- The conventional indices such as stunting, wasting and underweight underestimate the overall prevalence of undernutrition in the population as compared to multiple anthropometric failures estimated. The observed differences between the conventional and anthropometrical failures persist over time;
- Season was a major influencing factor for child linear growth and weight gain;
- Children suffer from poor child caring practices, multiple anthropometric failures and growth deficits in Ethiopia due to inappropriate complementary feeding practices;
- Child caring practices are poor, and there is high multiple anthropometrical failure and growth deficits in Ethiopia;
- National household consumption, expenditure, and demographic health surveys have not considered seasonality of child growth, food availability variation while collecting

nutrition related data. So, data generated by the present study are invaluable inputs to policy development and program planning, and

- Although the Ethiopian government has developed considerable effort to reduce malnutrition, a high prevalence of malnutrition is still observed during the first 1000 days. More and better-targeted efforts are needed for nutrition intervention programs to address the most vulnerable segment of the population.

6.7. Recommendation and future research perspectives

6.7.1. Recommendation for policy

To address poor child caring practice, multiple anthropometric failures, morbidities and linear growth deficit in Ethiopia, the following policy recommendation should be taken to account:

- A composite (comprehensive) index measure should be used to estimate undernutrition and a proxy predictor of child morbidity and mortality risk;
- Growth monitoring and promotion including community child health days should focus on seasons with a high likelihood of growth deficit;
- Behaviors such as poor child feeding and poor preventive behavior cluster. Negative deviant mothers (negative deviant: mothers who showed both poor child feeding and preventive behavior compared to the others in the same environmental setting) should be targeted for both behaviors in a more comprehensive way rather than in a fragmented manner;
- Due to an increased demand for nutrition interventions, fragmented nutrition work should be pooled into one national comprehensive work and give tasks for each stakeholder according to national aim. This will avoid duplication of effort and rationalize resources;
- Management of children suffering from multiple anthropometric failures in the existing health care services should be scaled-up. Differences in burden due to malnutrition and vulnerability to disease and mortality need to be assessed, and
- Health extension workers and agricultural development agents are overloaded by different other duties and responsibilities. Adequate supervision, support and in-service training on nutrition are mandatory to monitor and to fill the existing knowledge, attitude and practice gap.

6.7.2. Recommendation for nutrition service providers

- At the short-term, nutritional interventions should be designed that target poor child caring practice, multiple anthropometric failures, morbidities and the seasonality of child growth in Ethiopia. This intervention should consider age, gender, dietary diversity, food insecurity, and reporting illness experienced during the past two weeks as driving factors for undernutrition while designing and implementing the intervention;
- Children suffered from poor child caring practices, multiple anthropometric failures, and growth deficits due to inappropriate complementary feeding practices. Evidence-based and socio-culturally appropriate nutrition education packages should be designed on complementary feeding practices to reduce the prevalence undernutrition;
- For long-term interventions, multi-sectoral nutrition intervention focusing on nutrition-specific and nutrition-sensitive interventions should design to end malnutrition in Ethiopia. The proposed framework will help to think and understand more about malnutrition determinant dimension for long-term intervention, and
- Additionally, in the long-term, nutrition intervention and improvement should rely on individual, family and community action. However, this required extensive research and take the time to empower individual, family, and community with knowledge and available basic necessary services.

6.7.3. Recommendation for future research

- National household consumption and Expenditure survey should consider seasonality of child growth, food availability variation while collecting nutrition related data;
- National Demographic Health Survey should consider seasonality of child growth, food availability variation while collecting nutrition related data;
- A longitudinal study should be conducted to understand the effect of season on child growth by considering four Ethiopian seasons and 12 months;
- A high prevalence of undernutrition, poor caring practices, and morbidities was observed in the high agricultural production area. The reason why high rate undernutrition occurred in high agricultural productive area and women's empowerment on agricultural activities and household control of assets and undernutrition should be investigated;

- Community based intervention studies are needed to assess the effect gender-based positive deviance behavior on complementary feeding practices. Positive deviance is a development approach that is based on the premise that solutions to community problems already exist within the community. This will help to scale up existing indigenous knowledge in the community to react to malnutrition problem;
- A qualitative study should be conducted to explore why children are suffering from the concordance of poor child feeding and preventive behavior;
- An observational longitudinal study should be conducted on the effect of multiple anthropometric failures on mortality and sensitivity of multiple anthropometric failures to detect child morbidity and mortality;
- Future experimental studies should be conducted to assess the effectiveness and efficacy of specific nutrition and nutrition-sensitive intervention in rural Ethiopia, and
- Cost–effectiveness and efficacy of nutrition intervention in Ethiopia should be investigated to scale-up or fine tune existing nutrition interventions.

Future plans

Following studies will be conducted in the aftermath of this PhD research and address a number of knowledge gaps identified.

Seasonality was a major determinant of child growth in Ethiopia influencing food access, dietary quality, and infectious disease burden. The effect of seasonal intervention on malnutrition need to be established through a systematic review.

Poor caring practices are a major concern in rural Ethiopia. Within the community however, successful families were found that had good child caring practices while living in similar socio-economic status, food security and sharing the same socio-cultural factors. A community based nutrition intervention using gender-based positive deviance behavioral approaches to assess the effect of child caring practices. The positive deviance approach is one the target approach of the new launched Ethiopian national nutrition program II. This creates an opportunity to scale up the outcome of this intervention to nationwide to react to malnutrition problem.

Lesson learned from ENGINE Project

In Ethiopia, there was a big divide between non-governmental organization, higher education and research institutes to work together for last many years. The ENGINE project has broken down these boundaries and created a model for collaboration between non-governmental organization, higher education and research institutes how they work together for a common goal in Ethiopia.

The project also created an opportunity to share experiences from local higher education and research institutes in Ethiopia and abroad from Tuft University, USA. It was also an opportunity for capacity building opportunity with local institutes in Ethiopia. As a result, eight PhD students from local institutions pursued PhD degrees in Jimma and European Universities like Belgium, Ghent University; Denmark, Copenhagen University; Germany, Hohenheim University and Netherlands, Wageningen University. This is a significant contribution by a single project to build capacity in nutrition in Ethiopia.

When developing a capacity-building component however, future efforts can identify early on when and where how the students are pursuing their studies. Master data sets were access by few individuals and students were not allowed to access their data from master data sets. The students did not get a chance of timely access of their data to check the quality and give immediate feedback while conducting the data in the field. Therefore, restrictions to data access need to be resolved. PhD students need to hold the responsibility of research data on a continuous level and obtain frequent data access while conducting the data in the field, given appropriate procedures for data quality and purposes for use.

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Curriculum Vitae

Personal information

First name	Netsanet Fentahun
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Place of birth	Merawi, West Gojjam
Nationality	Ethiopian
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Number of children	Two
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Working place	Jimma University

Education

Jan 2014-	PhD student in human Nutrition at Jimma University
Jan 2017-	PhD student in doctorate in Applied Biological Sciences: Food Science and Nutrition at Ghent University
2009-2011	Master of public health in health education and promotion at Jimma University
2005 -2007	BSC in Health Education and Promotion at Jimma University
2001-2004	Secondary and preparatory school
1994-2000	Primary school

Nutrition course attended

1. The Anthropology of Food, Nutrition and Agriculture at Jimma University
2. Introduction to Food & Health at Stanford University (online course)
3. Food and Nutrition Policy and Program Planning and intervention at Jimma University
4. Nutritional Epidemiology at Jimma University
5. Nutritional Assessment at Jimma University

Training attended

1. Training on Research Ethic (partI and II) from Nov 03-07, 2014 organized by university of Oslo and Jimma University through NORHED/SACCADE project.
2. Training on Statistical Analysis with STATA and SAS at Jimma University for 15 day,2014
3. Training of Hierarchical Linear and non-linear modeling from Dec 9-13/12/2013 Organized by The Ohio State and Jimma University
4. Training on statistical analysis from Sept 17-26/2013 organized by Tufts and Jimma University
5. National Workshop on design of experiment for statistician and practioner from March 25-29,2013 organized by JU, VLIR and NSS
6. Training on systematic review at Jimma University from Dec 24-28,2012 organized by Joanna Briggs Institute, the University of Adelaide
7. Training on Manuscript Review for publication
8. Training on qualitative method and analysis through Atlas.ti Software
9. Training on community mobilization at Jimma University
10. Training on Infection Prevention and Patient Safety Organized by Jimma University, USAID and AID STAR-One
11. Training on Communication Materials Development
12. Training on Instructional Skill at Jimma University, from July-10 2008 organized by Jimma University
13. Training on Teaching Methodology
14. Training on Curriculum Development

Scientific contribution

International A1-Journals

1. Habtamu Wondiye, Netsanet Fentahun, Rupali J. Limaye, Mesfin Kote, Eshetu Girma. Barriers and facilitators of ART adherence in Hawassa town, Southern Ethiopia: A grounded theory approach.***Ethiop. J. Health Dev. 2016; 30(2):66-77***.
2. Netsanet Fentahun, Carl Lachat, Tefera Belachew. Concordance of poor child feeding and preventive behavior and its predictors in southwest rural Ethiopia. ***Food & Nutrition Research 2016, 60: 32207***.
3. Netsanet Fentahun, Tefera Belachew, Carl Lachat. Determinants and morbidities of multiple anthropometric deficits in southwest rural Ethiopia. ***Nutrition Journal 2016,***

Volume 32(11-12):1243–1249.

4. Urgessa Soressa, Desta Hiko, Abebe Mamo, Netsanet Fentahun. Prevalence, Causes and Management Outcome of Intestinal Obstruction in Adama Hospital Medical College, Ethiopia. ***BMC Surgery 2016;* 16:38**.
5. Eshetu Seyom, Million Tesfaye, Mubarak Abera, Netsanet Fentahun. Maternal and Fetal Outcome of Pregnancy Related Hypertension in Mettu Karl Referral Hospital, Ethiopia.***BMC Journal of Ovarian Research 2015; 8:10***.
6. Netsanet Fentahun, Ashagre Molla, Beyene Wondafrash. Self-efficacy analysis among HIV positive patients in Jimma University Specialized Hospital: a cross-sectional study. ***Asian Pac J Trop Biomed 2014; 4(2): S597-S60.***
7. Abebe Mamo, Tsion Assefa, Netsanet Fentahun. Living with parents and risky sexual behaviors among preparatory school students in Jimma zone, south west Ethiopia. ***Journal of African Health Sciences 2013; 13(2): 498 – 506.***

Peer Reviewed Non-A1 Publications

1. Tigist Endale, Netsanet Fentahun, Desta Hiko, Manusha Amana. Maternal and Fetal Outcome in Term Premature Rupture of Membrane in Mizan Aman General Hospital, SNNPR, South West Ethiopia. ***World J Emerg Med. 2016; 7(2): 147–152***.
2. Ashagre Molla, Netsanet Fentahun. Predictors of Willingness to Participate in Health insurance Services among the community of Jimma town, Southwest Ethiopia. ***Health Services Insights 2014; 7: 31–37.***
3. Netsanet Fentahun, Abebe Mamo. Risky Sexual Behaviors and Associated Factors among Male and Female Students in Jimma Zone Preparatory Schools, South West Ethiopia. ***Ethiopian Journal of health sciences 2014; Vol. 24(1):59-68.***
4. Adisu Aleme, Eshetu Girma, Netsanet Fentahun. Willingness to pay for Insecticide-Treated Nets in Berehet District, Amhara Region, Northern Ethiopia: Implication of Social Marketing. ***Ethiopian Journal of health sciences 2014; Vol. 24(1):75-84***.
5. Netsanet Fentahun, Ashagre Molla. Determinants of and opportunities for continuing education among health care professionals in public health care institutions in Jimma township, Southwest Ethiopia. ***Advances in Medical Education and Practice 2012, Vol. 3:89-96.***
6. Netsanet Fentahun, Tsion Assefa, Fessahaye Alemseged, Fentie Ambaw. Parents' Perception, Students' and Teachers' Attitude towards School Sex Education. ***Ethiopian Journal of health sciences 2012, Vol. 22(2):99-106***

7. Mekuanint Taddele, Lakew Abebe, Netsanet Fentahun. Exclusive Breastfeeding and Maternal Employment in Ethiopia: A Comparative Cross- Sectional Study. ***International Journal of Nutrition and Food Sciences 2014; Vol. 3(6): 497-503.***
8. Yohannes Abuhay, Lakew Abebe, Netsanet Fentahun. Male Involvement in Prevention of Mother to Child Transmission of HIV and Associated Factors among Males in Addis Ababa, Ethiopia. ***American Journal of Health Research 2014; Vol. 2(6): 338-343.***
9. Yeshiwork Amogne Mekonnen, Lakew Abebe, Netsanet Fentahun, Shegaw Alemu Belay, Addisu Workineh Kassa. Delay for First Consultation and Associated Factors among Tuberculosis Patients in Bahir Dar Town Administration, North West Ethiopia. ***American Journal of Health Research 2014; Vol. 2(4):140-145.***
10. Abebe Mamo Gebretsadik, Netsanet Fentahun Babbel. Family Environment and Sexual Behaviors in Jimma Zone, South West Ethiopia. ***Science Journal of Public Health 2014; Vol. 2(6): 539-545.***
11. Zinabu Ayenew, Abraham Tamirat, Desta Workneh, Netsanet Fentahun. Outcome of Non-Traumatic Surgical Acute Abdomen in Nekemte Referral Hospital Southwest Ethiopia: A Retrospective Cross-Sectional Study. **Surgery Curr Res 2016, 7(1):282.**

Published National report

1. Shibani Ghosh, Devika Suri, Desta Hiko, Netsanet Fentahun, Jeffrey K. Griffiths. Factors associated with stunting in Ethiopian children under five: An analysis of DHS data from 2000-2011.

Accepted Manuscript

1. Netsanet Fentahun, Tefera Belachew, Jennifer Coates, Carl Lachat. Seasonality and determinants of child growth velocity and growth deficit in rural southwest Ethiopia. ***BMC: Pediatrics*.**

   Under review manuscript
2. Nakachew Mekonnen, Shifera Asfaw, Abebe Mamo, Yared Mulu, **Netsanet Fentahun**. Explore child-feeding practices in Gozamin district, northwest of Ethiopia: A qualitative study. BMC: Nutrition, 2017
3. **Netsanet Fentahun**, Solomon Ali , Melkamu Berhane, Sisay Bekele, Gebre Kibru, Lule Teshager, Yonas Yilma, Yesuf Ahmed, Henok Assefa, Esayas Kebede Gudina, Mulatu Gashaw. Key informants perspective of infection prevention and patient safety practices at Jimma university medical center***: A qualitative study***. Journal of Infection prevention, 2017
4. Solomon Ali, Melkamu Berhane, Sisay Bekele, Gebre Kibru, Lule Teshager, Yonas Yilma,

Yesuf Ahmed, **Netsanet Fentahun**, Henok Assefa, Mulatu Gashaw, Esayas Kebede Gudina. Healthcare associated infection and associated factors among patients admitted to a tertiary hospital in Ethiopia: longitudinal study. BMC: Antimicrobial Resistance & Infection Control, 2017

International collaboration projected delivered

1. Effectiveness of direct and indirect interventions targeting maternal and child nutrition and health outcomes: a quasi-experimental observational birth cohort study. Tufts University in collaboration with Jimma University, Hawassa University and Ethiopian public health institute by USAID- ENGINE program
2. Evaluating Multisectoral Strategies for Improved Nutrition and Food Security in Ethiopia: Agricultural-nutrition panel study. Tufts University in collaboration with Jimma University, Hawassa University and Ethiopian public health institute for USAID-ENGINE Program
3. Maternal and Child Health Service Provision Assessment in Jimma Zone Public Facilities: the AFRICA HUB funded by Department for International Development, UK

Oral and poster presented articles

4. Determinants of and opportunities for continuing education among health care professionals in public health care institutions in Jimma township, Southwest Ethiopia.26 annual conference of Ethiopian public health association, 2015
5. Determinants of and opportunities for continuing education among health care professionals in public health care institutions in Jimma township, Southwest Ethiopia. Annual conference of African school of public health in Africa, Accra, Ghana
6. Parents' Perception, Students' and Teachers' Attitude towards School Sex Education. 23 annual conference of Ethiopian public health association, 2013
7. Factors associated with stunting in Ethiopian children under five: An analysis of DHS data from 2000-2011. USAID-ENGINE operational research and dissemination workshop March, 2015
8. Concordance of poor child feeding and preventive behavior and its predictors in southwest rural Ethiopia. USAID-ENGINE research symposium June 2016.
9. Determinants and morbidities of multiple anthropometric deficits in southwest rural Ethiopia. USAID-ENGINE research symposium June 2016.

Research undertaking

1. Supply and demand side factors influencing utilization of infant and young child Feeding
2. Magnitude and determinants of nosocomial infection among inpatients of Jimma University Specialized Hospital, Jimma, Southwest Ethiopia

Membership in Professional Associations

- Ethiopian Public Health Association
- Association of Schools of Public Health in Africa, Country Representative
- Agriculture-Nutrition Community of Practice Ethiopian sub-group

Annex: Questionnaires

Mother/Caretaker Questionnaire

Section 1: Interview Information

Table 1.1

Number	Question	Response	Variable
1.1.1.	Date of interview	☐☐/☐☐/☐☐☐☐	HDATEINT
1.1.2.	Survey Round (1-5)	☐☐	HDTIMEPT
1.1.3.	Household ID	☐☐☐☐☐☐☐☐	HHID
1.1.4.	Woreda	*drop list:*	HWOREDA
1.1.5.	Kebele	*drop list:*	HKEBELE
1.1.6.	Gote / Gere	*drop list:*	HGOTE
1.1.7.	GPS	"Get GPS Coordinates" (button)	HHGPS
1.1.8.	Interviewer's ID 1	☐☐☐	HID1
1.1.9.	Interviewer's ID 2	☐☐☐	HID2
1.1.10.	Supervisor's ID	☐☐☐	HSID
1.1.11.	Caretaker Roster ID	☐☐	RESPID
1.1.12.	Child Roster ID	☐☐	CHLDID

Module 1: Child Health Status

Section 2: Child Illnesses and Symptoms

	Question	Responses	Variable name
7.2.1.	Did the index child sleep under a bed net last night?	☐ 1=Yes ☐ 0=No ☐ 98=Don't Know	MNETCHILD
7.2.2.	Has the child had any illness in the past two weeks?	☐ 1=Yes ☐ 0=No ☐ 98=Don't Know ***If yes, continue below. Otherwise, skip to the next section.***	CILL
7.2.3.	Which illnesses or symptoms has the child had in the past two weeks? *Do not read the list below; allow the caregiver to answer,*	For how many days in the past two weeks (14 days), has the child experienced the symptom? (*0 if child has not experienced*	

	then complete all questions.	*the symptom) 98 = don't know*	
7.2.4.	Cough☐ 1=Yes ☐ 0=No	☐☐ days	CCOUGH/CCOUGHDAY
7.2.5.	Difficult or fast breathing ☐ 1=Yes ☐ 0=No	☐☐ days	CFASTBRTH/CFASTBRTHDAY
7.2.6.	Fever☐ 1=Yes ☐ 0=No	☐☐ days	CFEVER/CFEVERDAY
7.2.7.	Diarrhea without blood ☐ 1=Yes ☐ 0=No	☐☐ days	CDIARRH/CDIARRHDAY
7.2.8.	Diarrhea with blood ☐ 1=Yes ☐ 0=No	☐☐ days	CBLOODIARRH/CBLDDIADAY
7.2.9.	Measles☐ 1=Yes ☐ 0=No	☐☐ days	CMEASLES/CMEASDAY
7.2.14.	If the child had diarrhea, did you give them any liquids?	1=yes 0=no 98=Don't Know	CDIARRLIQG
7.2.15.	If yes, what liquids did you give to the child?	1. Water 2. Sugar water 3. ORS (Lemlem) 4. Other (specify)	CDIARRLIQD CDIARRLIQO
7.2.16.	If your child had any illness or symptoms, did you seek any help outside the home?	☐ 1=Yes ☐ 0=No	CTREAT
7.2.17.	If yes, where did you seek help? *Select all that apply*	1. =Traditional healer 2. = Holy Water 3. = Witchcraft 4. =Health extension worker 5. =Drug shop or private pharmacy 6. =Private clinic 7. =Not-for-profit health facility 8. =Public health facility (HC, Hospital)	CTREATWHERE
7.2.18.	(If health facility was selected) Did you have to remain in the health facility for more than one day? If yes, how	1=Yes 0=No ____days	CTREATSTY CTREATDYS

	many days?		
7.2.19.	How much did it cost to receive this treatment? In Birr (Enter 0 if free)	_____	CTREATCST
7.2.20.	Did the child recover after receiving this treatment?	1=Yes 0=No	CTREATRVR

Module 2: Child Feeding

Section 1: Index Child Breast Feeding and Complementary Feeding

To Enumerator: This section is to be administered to the caregiver of the index child, regarding herself and the index child. Note "breastfeeding" includes both feeding from the breast and bottle-feeding expressed breast milk

(Q. No)	**(Questions)**	**(Response)**	**(variable)**
2.1.1	Did you ever breastfeed (NAME)?	1.(Yes) 0.(No) -> Skip to 2.1.11 98 = don't know	CBREAST
2.1.2	How long after birth did you first put (NAME) to the breast?	1.(Immediately/within first hour after birth) 2.(After first hour) 3.(After one day) 98. (Don't remember/don't know)	CBRAFBIR
2.1.3	Did the HEW tell you when to put the baby to the breast?	1. (Yes) 0. (No) 98. (Don't know/Don't remember)	CBRHEW
2.1.4	During the first three days after delivery, did you give (NAME) the liquid that came from your breasts?	1. (Yes) 0. (No) 98. (Don't know)	CBRCOLL
2.1.5	During the first three days after delivery, did you give (NAME) anything else to eat or drink before feeding him/her breast milk?	1. (Yes) 0. (No) 98. (Don't know)	CBRBEFBM
2.1.6	If Yes, what did you give (NAME)? (DO NOT READ THE LIST)	1. (Milk (other than breast milk) 2. (Butter) 3. (Plain water)	CBBEFBML

	RECORD ALL MENTIONED BY CIRCLING FOR EACH ITEM MENTIONED	4. (Water with sugar and/or salt) 5. (Fruit juice) 6. (Tea/coffee infusions) 7. Infant formula 8. Other (Specify) _____ _____	
2.1.7	Are you currently breastfeeding (NAME)?	1. (Yes) – Skip to 2.1.10 0. (No)	CCURBF
2.1.8	If no, for how long did you breastfeed (NAME)?	(Months)_____ _ (IF LESS THAN ONE MONTH, RECORD "00" MONTHS VALID range: (0-60) 98 = don't know	CBFDUR
2.1.9	Why did you stop breastfeeding? (Main reason)	1. (Mother pregnant) 2. (Mother sick) 3. (Mother tired of breast feeding/wants to stop) 4. (Introduced solids) 5. (Breast milk making child sick) 6. (Not enough milk) 7. Mother died or left 8. Religious reasons 9. Child stopped 10. Other (specify)_____	CBFWHYST
2.1.10	If you are currently breast feeding, how many times in the last 24 hrs including day and night did you breastfeed?	_____ times Valid range: (0-24) 98=Don't Know	CBFTIMES
2.1.11	Did (NAME) drink anything from a bottle with a nipple yesterday or last night?	1. (Yes) 0. (No) 98 (DON'T KNOW)	CBFNIPP
2.1.12	Are you giving your infant any **foods** other than breast milk?	1. (Yes) 0. (No) 98 = don't know	CBFFOOD
2.1.13	How old was the child when you first gave them any food or liquid	____ months Valid range (0-36) If less than one month, enter "0"	CBFAGE

	other than breast milk?		
2.1.14	How many times did (NAME) eat any food other than liquids yesterday during the day and at night?	1.(Number of times)_____ 98 .(Don't know) Valid Range (0-20)	CTIMFOOD
(Use probing questions to help the respondent remember all the times the child ate yesterday)			
2.1.15	Which of these foods do mothers say should NOT be fed to infants at this age (PROBE)? *Multiple Answers are possible*	1. (corn porridge) 2. (other porridge) 3. (corn bread) 4. (bulla) 5. (enjera) 6. (beans) 7. (biscuits) 8. (vegetables) 9. (fruits) 10. (potatoes) 11. (egg) 12. (fish) 13. (meat) 14. (soft cheese) 15. Nothing	CNOCORN CNOPORR CNOCORNB CNOBULLA CNOENJERA CNOBEANS CNOBISCUT CNOVEG CNOFRUIT CNOPOTA CNOEGG CNOFISH CNOMEAT CNOSFCHEES
2.1.16	Do you give special foods to your child when (Name) is ill?	1. Yes 0. No If Yes, Specify_____	CSPECFOOD CSPECFDS
2.1.17	Do you withhold food from your child when (Name) is ill?	1. (Yes) 0. (No) (If yes, Specify)_____	CILLNOFD CILLNOFDS
2.1.18	How often do you feed your child when they are ill? (times per day)	_____	CIILFREQ
2.1.19	Do you give special food to your child after illness?	1. (Yes) 0. (No) (If yes, Specify)_____	CFDAFTILL CFDAFTILS

		—	
2.1.20	How often do you feed your child after an illness? (times per day)	_____	CRECVFR

Section 2: Child Diet Recall

Enumerator: Only administer this section if the index child is between 6 and 59 months, otherwise skip to the next section.

First ask the mother/caretaker of the index child to recall all liquids and foods listed below that the child drank or ate in the previous day. If she has another child between 6 and 59 months of the opposite sex, collect the information again regarding the second child's diet. If she has no other child between 6 and 59 months of the opposite sex, place a "99" in the column below "2nd Child and continue to the next section."

		Index Child	2nd Child
	Household Roster ID		"99" if none
	Sex of child (Only allow one of each sex)	1 = female 0 = male	1 = female 0 = male

Now I would like to ask about the type of liquids (NAME) drank yesterday during the day and night)

	Did (NAME) drink any of the following liquids yesterday during the day or night?	**Consumed (1=Yes, 0=No, 98=Don't know)**	
		INDEX CHILD	**2ND CHILD**
2.1.21	Breast milk		
2.1.22	Plain water		
2.1.23	Abishwuha		
2.1.24	Any other milk such as tinned, powdered, or fresh animal milk		
2.1.25	Fruit juice		
2.1.26	Coffee		

2.1.27	Tea		
2.1.28	Any other liquids such as sugar water, soup broth		

Now I would like to ask about the type of foods (NAME) ate yesterday during the day and night)

	Did (NAME) eat any of the following foods yesterday during the day or night?		
2.1.27	Porridge or gruel prepared from cereal grains (e.g. made with maize, sorghum, millet, wheat, barley, teff)? If yes, specify cereals:		
2.1.28	Corn bread		
2.1.29	Enset foods (specify,kotcho and bulla		
2.1.30	Enjera prepared from cereals specify cereals		
2.1.31	Any foods made from beans (for example kidney beans, haricot beans, field peas, cowpeas, chick peas or others		
2.1.32	Pumpkin or yellow/orange-fleshed squash, carrots, or yellow/orange-fleshed sweet potatoes		
2.1.33	Any other food made from roots or tubers other than enset. For example, white potatoes, white yams, cassava, Boyna		
2.1.34	Any dark green leafy vegetables (for example, cassava leaves, pumpkin leaves, kale, amaranth leaves, or other dark green leaves)		
2.1.35	Other vegetables (onion, etc.)		
2.1.36	Vitamin A rich fruits (papaya, mango, etc.)		
2.1.37	Other fruits (banana, etc.)		
2.1.38	Any beef, pork, lamb, goat, or rabbit		

2.1.39	Any chicken, duck, or other birds (for example, guinea hen, others)?)		
2.1.40	Any fresh or dried fish		
2.1.41	Any eggs		
2.1.42	Any groundnuts/peanuts, or any nuts		
2.1.43	Any cheese or yogurt		
2.1.44	Any food with oil, fat, or butter		

Section 3: Handwashing

Enumerator: Ask the mother/caretaker if the index children feed themselves. If yes, ask the **child** the following question:

2.3.1	Do the index children feed themselves?	1 = always 2 = sometimes 3 = never	*If "3", skip to Module 6*
Under what circumstances do you wash your hands? (Do not read the responses below. Allow respondent to answer, then fill each item below.)			
2.3.2	Not at all	☐ 1=Yes ☐ 0=No	WNIL
2.3.3	When dirt is visible	☐ 1=Yes ☐ 0=No	WDIRT
2.3.4	After toilet use/defecation/urination	☐ 1=Yes ☐ 0=No	WTOILETUSE
2.3.5	Before eating	☐ 1=Yes ☐ 0=No	WEAT
2.3.6	When I am reminded to do so	☐ 1=Yes ☐ 0=No	WREMIND

Module 3: Index Woman Health Status

Section 1: Health Status Assessment

I am going to ask you about your health. Please respond to the following questions about you yourself.

	Question	**Responses**	**Variable name**
6.1.1.	In the past two weeks, have you had any illness? (if no, skip to Module 4)	☐ 1=Yes ☐ 0=No ☐ 98= Don't know	MANYILL
6.1.2.	If yes, how many days in the past two weeks were you unable to do your daily work because of illness?	___days (allow partial days)	MDAYS

Module 4: Nutrition Knowledge Assessment

To the Enumerator: Read each question and if the respondent gives the correct answer, select 0=Correct. If she does not give the correct answer, select 1 = Incorrect. Enter 99 if she refuses to answer.

#	Question	Respondent answer is Correct	Respondent answer is Incorrect	DK
	Is a meal of injera and shiro every day a good example of a diversified diet? ANSWER: NO.	1	0	98
	Is eating three times a day during pregnancy an adequate frequency for the proper growth and development of the fetus? ANSWER: NO.	1	0	98
	Which is better- to begin breastfeeding within12 hours after giving birth OR within 1 hour after giving birth? ANSWER: Within 1 hour	1	0	98
	Does breastmilk alone have all of the necessary nutrients and water that a baby needs until the end of the first year of life? ANSWER: No	1	0	98
	At what age should a mother begin giving foods other than breast milk to her babies? ANSWER: Six months	1	0	98

Module 5: Anthropometric Measurements

Section 1: Mother/Caretaker Anthropometry

	Question	Response	Var. name
15.1.1	Respondent's HH roster ID	☐☐	AMROSID
15.1.2	Age in years	☐☐	AMYRS
15.1.3	Pregnant	1=Yes 0=No 98.	AMPREG

		Don't Know	
15.1.4	Weight 1	☐☐☐.☐ kg	AMWT1
15.1.5	Weight 2	☐☐☐.☐ kg	AMWT2
15.1.6	Weight 3	☐☐☐.☐ kg	AMWT3
15.1.7	Height 1	☐☐☐.☐ cm	AMHT1
15.1.8	Height 2	☐☐☐.☐ cm	AMHT2
15.1.9	Height 3	☐☐☐.☐ cm	AMHT3

Section 2: Children Anthropometry

Enumerator: Take anthropometric measurements of all children under age 5 of the adult respondents that gave consent.

	Question	**Index child**	**2nd child (up to 4 children)**
			☐ twin?
15.3.1	Child's HH Roster ID	☐☐	☐☐
15.3.2	Sex	☐ M ☐F ACSEX1	☐ M ☐F ACSEX2
15.3.3	Date of birth (dd/mm/yyyy)	☐☐/☐☐/☐☐☐☐ ACDOB1	☐☐/☐☐/☐☐☐☐ ACDOB2
15.3.4	Age	☐☐☐ ACAGEY1 ACAGEM1	☐☐☐ ACAGEY2 ACAGEM2
15.3.5	Weight 1	☐☐.☐ kg ACWT11	☐☐.☐ kg ACWT12
15.3.6	Weight 2	☐☐.☐ kg ACWT21	☐☐.☐ kg ACWT22
15.3.7	Length/height 1	☐☐☐.☐ cm (ACLEG11)	☐☐☐.☐ cm (ACLEG12)
15.3.8	Length/height 2	☐☐☐.☐ cm (ACLEG21)	☐☐☐.☐ cm (ACLEG22)
15.3.9	Measurement taken:	☐1=length ☐ 2=height ACMEA1	☐1=length ☐ 2=height ACMEA2
15.3.10	Edema	☐ 1=Yes ☐ 0=No ACEDEMA1	☐ 1=Yes ☐ 0=No ACEDEMA2

Module 6: Interview Outcome

19.	Outcome of Interview	1. completed 2. incomplete	HINTOUT

19b.	If incomplete, why?	1. Unable to locate Caretaker or Child to complete 2. Stopped Interview 3. Other (specify)	HINTOUTSP

Adult Female Questionnaires

Module 1: Household Information& Characteristics

Section 1: Interview Information

Table 1.1

Number	Question	Response	Variable
1.1.13.	Date of interview	☐☐/☐☐/☐☐☐☐	HDATEINT
1.1.14.	SurveyRound (1-5)	☐☐	HDTIMEPT
1.1.15.	Household ID	☐☐☐☐☐☐☐☐	HHID
1.1.16.	Woreda	*drop list:*	HWOREDA
1.1.17.	Kebele	*drop list:*	HKEBELE
1.1.18.	Gote / Gere	*drop list:*	HGOTE
1.1.19.	GPS	"Get GPS Coordinates" (button)	HHGPS
1.1.20.	Interviewer's ID 1	☐☐☐	HID1
1.1.21.	Interviewer's ID 2	☐☐☐	HID2
1.1.22.	Supervisor's ID	☐☐☐	HSID
1.1.23.	Outcome of Interview	1. absent/could not locate 2. refused 3. relocated 4. conducted	HINTOUT
1.1.24.	Number of Visits to Complete Interview	☐	HNUMVIS

Section 2: Household Information

I am going to start by asking you questions about yourself and your household.

Enumerator: Ask first about the head of household, thenthespouse, and any other household member.

House holdRoster ID Number (Start with head of household =1)	**Full Name** (First, Father's, Grandfather's)	**Relation to HH Head** 1 = HH Head 2 = Father 3 = Mother 4 = Wife 5 = Child 6 = Mother-in-law 7= Father-in-law 8=2nd wife 9= 3rd wife 10=4th wife 11=grandchild 12 = grandparent 13 = Sibling 14 = Uncle 15 = Aunt 16 = child of other adult 17 = adopted child 18 = other adult	**Does the person stay at home at least 3 days out of the week and eat from the family pot?** 1 = yes 0 = no 98 = don't know	**Sex** 1 = female 0 = male	**Age** (yrs) Enter Months if less than 2 years of age		**Marital Status** 1=married, monogamous; 2=married, polygamous; 3=cohabiting; 4=single; 5=widowed; 6=divorced; 7=separated	**Years of Completed Schooling** (yrs)	**Religion** 1. Orthodox 2. Catholic 3. Protestant 4. Muslim 5. Traditional 6. Pagan 7. Other	**Pregnant?** 1 = yes 0 = no 98 = don't know Only appears if female and over 12 yrs old
					Yrs	**Mos**				

Section 3: Socioeconomic Characteristics

I am going to ask you questions about the type of house you live in.

Table 1.4 Type of House

Number	**Question**	**Responses**	**Variable name**	**Did you Confirm?**
1.4.1	Main type of walls	1. Wood and mud 2. Mud bricks or burnt bricks 3. Concrete blocks 4. Wood 5. Grass/bamboo 6. Other (specify _____)	HWALL HWALLSPE	Yes/No HWALLCF
1.4.2	Main type of roof	1. Grass or leaf thatched 2. Corrugated iron sheets 3. Tiles 4. Other (specify _____)	HROOF HROOFSPE	Yes/No HROOFCF
1.4.3	Main type of floor	1.Mud or dirt 2. Brick/stones/cement 3. Tiles 4. Bamboo/grass/wood 5. Plastic 6. Other (specify_____)	HFLOOR HFLOORSPE	Yes/No HFLOORCF
1.4.4	Type of toilet used by the household most of the time:	1. None/bush/garden 2.Unimproved pit latrine 3. Improved pit latrine 4. Flush toilet 5. Community owned latrine 6. Other (specify _____)	HTOILET HTOILSPE	Yes/No HTOILETCF
1.4.5	Does your household have running water?	1=Yes, 0=No	HRWATER	Yes/No HRWATERCF
1.4.6	What is the most common source of energy for cooking in this household?	1. Wood 2. Charcoal 3. Gas or biogas 4. Electricity 5. Kerosene/Paraffin 6. Cows dung (“kubet”) 7. Other (specify_____)	HFUEL HFUELSPE	

1.4.7	What do you most commonly use for lighting your household?	1. Electricity 2. Solar 3. Lantern or fanos 4. Kuraz(tin kerosene lamp) 5. Torch/ Battery lamp 6. Firewood place 7. Other (specify_____)	HLIGHT HLIGHTSPE	

Module 2: Water, Hygiene and Sanitation

Section 1: Water Source & Use

Table 2.1

	Questions	**Responses**	**Var. name**
2.1.1	What is your household's most commonly used source of drinking water?	1=piped water, 2=public tap/bono, 3=tube well or borehole, 4=protected well 5 =protected spring, 6=unprotected well 7. Unprotected spring, 8=rainwater, 9=river/pond/lake, 10=bottled, 11=other (specify_____) 98 = don't know	WSOURCE WSOURSPE
2.1.2	What is your household's most commonly used source of other household water (non agri)?	1=piped water, 2=public tap/bono, 3=tube well or borehole, 4=protected well 5= protected spring, 6=unprotected well 7= unprotected spring, 8=rainwater, 9=river/pond/lake, 10=bottled, 11=other (specify_____) 98 = don't know	WSRCOTH WSROTHSPE
2.1.4	How much time does it take to bring water (one roundtrip, including waiting time, by usual means) from the furthest source?	_____minutes 98 = don't know	WTIME
2.1.5	Does the household do any rain water harvesting (for domestic use)?	0=No 1=Yes 98 = don't know	WRAIN

2.1.6	Do you usually do anything to your household water to purify it before drinking it?	0=No 1=Yes 98 = don't know	WPURIFY
2.1.6	If yes, what do you do to purify it before drinking it? *(allow multiple responses)*	1= boiling, 2=use traditional herbs, 3=use chemicals (water guard, Wuha Agar/Bishangari), 4=filter/sieve, 5=decant (sedimentation), 6=other (specify_____) 98 = don't know	WTREAT WTREATSPE
2.1.7	Do you store drinking water separately from your other household water?	1= yes 0= no 98 = don't know	WWATSTR
2.1.8	Where do you store your household drinking water?	1=Traditional pot with cover, 2=traditional pot without cover, 3=plastic or metal jerry can with cover, 4=plastic or metal jerry can without cover, 5=other (specify_____) 98 = don't know	WSTORE WSTORESPE
2.1.9	How much water does your household usually use in one day?	_____ Liters 98 = don't know	WLITERS

Section 2: Sanitation & Hygiene

Table 2.2

	How do you dispose of household rubbish? (Do not read the responses. Allow respondent to answer, then fill each item below.)		
2.2.1	Garbage pit	☐ 1=Yes ☐ 0=No	WPIT
2.2.2	Discard in garden and/or turn into	☐ 1=Yes ☐ 0=No	WGARDEN
2.2.3	Discard in bush	☐ 1=Yes ☐ 0=No	WBUSH
2.2.4	Open burning	☐ 1=Yes ☐ 0=No	WBURN
2.2.5	Other (specify_____)	☐ 1=Yes ☐ 0=No	WOTHER
2.2.6	How do you most commonly store prepared food? *(Do not read the responses. Allow respondent to answer, then fill in response appropriately.)*	1. Uncovered container or plate 2. Covered container or plate 3. On fire or hot ash 4. Other (specify_____) 98 = don't know	WFDSTORE WFDSTORESPE

2.2.7	Where do you most commonly store clean dishes? *(Do not read the responses. Allow respondent to answer, then fill in response appropriately.)*	1. Shelf, table, chair, bed 2. Floor 3. Hanging on wall 4. Covered Container 5. N/A 6. Other (specify) 98 = don't know	WDISHSTOR WDISHSOTH
Under what circumstances do you wash your hands? (Do not read the responses below. Allow respondent to answer, then fill each item below.)			
2.2.8	Not at all	☐ 1=Yes ☐ 0=No	WNIL
2.2.9	When dirt is visible	☐ 1=Yes ☐ 0=No	WDIRT
2.2.10	After toilet	☐ 1=Yes ☐ 0=No	WTOILETUSE
2.2.11	After cleaning child following	☐ 1=Yes ☐ 0=No	WCLEANCHILD
2.2.12	Before preparing the food	☐ 1=Yes ☐ 0=No	WFOOD
2.2.13	Before serving a meal	☐ 1=Yes ☐ 0=No	WMEAL
2.2.14	Before eating	☐ 1=Yes ☐ 0=No	WEATB
2.2.15	After eating	☐ 1=Yes ☐ 0=No	WEATA
2.2.16	Before feeding a child	☐ 1=Yes ☐ 0=No	WFEEDBABY
2.2.17	When I am reminded to do so	☐ 1=Yes ☐ 0=No	WREMIND

Module 3: Household Diet

Section 1: Individual Dietary Diversity

This section should be administered to the female respondent about her own consumption.		**In the past 7 days, did you personally eat:**	**If yes, how many total times in the past 7 days did you personally consume these foods?**
		Yes=1 No=0	*Write number of times*
3.2.1.	Any grain or any food made from grains: injera, teff, millet, sorghum, maize, rice, wheat, bread, biscuits, or any other grain product?		
3.2.2.	Vitamin A-rich roots or tubers? (,orange fleshed sweet potato, yams,)		
3.2.3.	White roots or tubers? (potato, white sweet potato, enset, godere,cassava, anchiote)		
3.2.4.	Any s, legumes, oil seeds (nuts,beans, lentils, peas)?		
3.2.5.	Any dark green leafy vegetables? (Spinach, kale, chard)		
3.2.6.	Any other vegetables?(green beans, tomatoes, cabbage etc.)		
3.2.7.	Any vitamin A rich fruits? (e, mangoes, papaya,)		
3.2.8.	Any other fruits avocado, Casmir, banana,)?		
3.2.9.	Any organ meat (Liver, Kidney, etc)		
3.2.10.	Any flesh meat? (chicken, goat, beef)		
3.2.11.	Any eggs?		
3.2.12.	Any fish or seafood?		
3.2.13.	Any dairy products - milk, cheese, yogurt (not including butter)?		
3.2.14.	Any sugar or honey?		
3.2.15.	Any oil, fats, or butter?		
3.2.16.	Any Miscellaneous?		

Section 2: Household Dietary Diversity

		A	B	C
		In the past 24 hours, did you or anyone in your household eat:	**In the past 7 days, did you or anyone in your household eat?**	**In the past 7 days, how many total daysdid you or anyone in your household consumes these foods?**
		Yes=1 No=0 (If Yes, Skip to column C)	Yes=1 No=0 (If No, skip to next food group)	*(Write number of days)*
3.3.1	Any food made from grains: teff, millet, sorghum, maize, rice, wheat, bread, biscuits, or any other grain product?			
3.3.2	Any food made from roots or tubers: potatoes, sweet potatoes, beets, carrots, or other roots or tubers?			
3.3.3	Any pulses, legumes, or nuts (beans, lentils, peas)?			
3.3.4	Any vegetables (green beans, tomatoes, cabbage etc.)?			
3.3.5	Any fruits (avocado, Casmir, banana,)??			
3.3.6	Any meat, fish, or eggs? (beef, lamb, goat, wild game, fish, chicken, or other birds, eggs, liver, kidney, or other organ meats?)			
3.3.7	If yes, was it meat, poultry, offal?			
3.3.8	If yes, did you consume any eggs?			
3.3.9	If yes, did you consume any fish or seafood?			
3.3.10	Any dairy products - milk, cheese, yogurt (not including butter)?			
3.3.11	Any sugar or honey?			
3.3.12	Any oil, fat, or butter?			
3.3.13	Any Miscellaneous?			

Section 3: Household 24 Hr Recall

Enumerator: Interview person who prepared the food the previous day, if different from female who responds to the rest of the questionnaire.

Number	Question	Answer	Variable
3.1	HH Roster ID number of respondent	__	HRECRID
3.2	Are you the person who prepared food yesterday?	1. Yes 2. No	HRECRFP
	If answer to Q 3.2 is Yes, continue. If no, STOP and seek out the person who did prepare food yesterday. Administer consent to this individual and begin this module again, recording the HH roster ID number.		
3.1.1	Does yesterday represent a normal eating day for your household? *If yes, skip to **3.1.4***	1. Yes 2. No 98. Refused	HRECNORM
3.1.2	If no, what was the reason?	1. Sickness 2. Festival 3. Holiday 4. Other	HRECREAS
3.1.3	Was the day **before** yesterday a normal eating day for your household? *If no, continue to 3.1.4* *If yes, skip to 3.1.6*	1. Yes 2. No	HRECPRVDAY
3.1.4	Was yesterday a fasting day for your household? *If no, skip to 3.1.8 and record "yesterday"* *If yes, continue to next question*	1. Yes 0. No 98. Refused	HRECFAST
3.1.5	If yes, was there any part of the day yesterday that your household abstained from all food? *skip to **3.1.8** and record "yesterday".*	1. Yes, until noon 2. Yes, until 3pm 3. Yes, until sundown 0. No 98. Refused	HRECFALL
3.1.6	Was the day before yesterday a fasting day for	1. Yes 0. No	HRECPRVFST

Number	Question	Answer	Variable
	your household?	1. 98. refused	
3.1.7	If yes, was there any part of the day before yesterday that your household abstained from all food? *Continue to**3.1.8** and record " day before yesterday".*	4. Yes, until noon 5. Yes, until 3pm 6. Yes, until sundown 1. No 2. 98. Refused	HRECFALL
3.1.8- 3.1.9	Enumerator: record "yesterday" or "day before yesterday" as directed by the skip pattern above. Also record which day of the week this refers to. If "yesterday", you should ask the respondent to recall all food and drink prepared for or eaten by any household members in the 24 hour period starting from the time the first member woke up to the time the last member went to sleep. If "day before yesterday", you should ask the respondent to recall all food and drink prepared for or eaten by any household members in the 24 hour period the day BEFORE yesterday, starting from the time the first member woke up to the time the last member went to sleep.	**3.1.7** 1. Yesterday 2. Day before yesterday **3.1.8** Record day of the week of the option entered above: 1. Sunday 2. Monday 3. Tuesday 4. Wednesday 5. Thursday 6. Friday 7. Saturday	HRECDAY HRECDWK

Module 4: Household Food Security

Section 1: Months of Adequate Household Food Provisioning

Now I would like to ask you about your household's food supply during different months of the year. When responding to these questions, please think back over the last 12 months, starting with the current month until the same time last year.

Table 4.1: Months of adequate household food provision

	Question	**Responses**	**Var. name**
4.1.1.	Were there month(s), in the past 12 months, in which you did not have enough food to meet your family's needs?	☐ 1=Yes ☐ 0=No ☐ 98=Don't Know	SGOOD
If yes, which were the months in the past 12 months during which you did <u>not</u> have enough food to meet your family's needs? If NO, skip to Section 2.			

To the Enumerator: This includes any kind of food from any source, such as own production, purchase or exchange, food aid, or borrowing. Do not read the list of months aloud. Use a seasonal calendar if needed to help respondent remember the different months. Probe to make sure the respondent has thought about the entire past 12 months.

	Month	**Response**	
4.1.2	January	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SJAN
4.1.3	February	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SFEB
4.1.4	March	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SMAR
4.1.5	April	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SAPR
4.1.6	May	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SMAY
4.1.7	June	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SJUN
4.1.8	July	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SJUL
4.1.9	August	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SAUG
4.1.10	September	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SEPT
4.1.11	October	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SOCT
4.1.12	November	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SNOV
4.1.13	December	☐ 1=Yes ☐ 0=No ☐ 98=Don't	SDEC

Section 2: Household Food Insecurity Access Scale

Now I am going to ask you questions about your household's food supply over the past four weeks. Food supply includes staples, sauces, and any other foods in your diet and the diets of all members of your household.

Table 4.2: Household Food Insecurity Access Scale

	Question	Response	Var name
4.2	In the past four weeks, did you worry that your household would not have enough food?	☐ 1=Yes ☐ 0=No	SWORRY
4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SWORRYFRQ
4.2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	☐ 1=Yes ☐ 0=No	SKIND
4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SKINDFRQ
4.2	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	☐ 1=Yes ☐ 0=No	SLIMITED
4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SLIMITEDFRQ
4.2	In the past four weeks, 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?	☐ 1=Yes ☐ 0=No	SDISLIKE
4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SDISLIKEFRQ
4.2	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	☐ 1=Yes ☐ 0=No	SMALL

4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SMALLFRQ
4.2	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?	☐ 1=Yes ☐ 0=No	SFEW
4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SFEWFRQ
4.2	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	☐ 1=Yes ☐ 0=No	SNOFOOD
4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SNOFOODFRQ
4.2	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	☐ 1=Yes ☐ 0=No	SLEEP
4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SLEEPFRQ
4.2	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	☐ 1=Yes ☐ 0=No	SNODAY
4.2	If yes, how often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (3 to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)	SNODAYFRQ

Module 5: Women's Empowerment in Agriculture

SECTION 1: Decision-making

Enumerator: The purpose of this module is to get additional information about decision making within households.

Enumerator: Ask G01 for all categories of activities before asking G02. If household does not engage in that particular activity, enter code for "Decision not made" and proceed to next activity.		When decisions are made regarding the following aspects of household life, who is it that normally takes the decision? If response = option 2 ["Main female or Wife] go to**next domain** Otherwise >>G02 **CODE 1↓**	To what extent do you feel you can make your own personal decisions regarding these aspects of household life if you want(ed) to? **CODE 2↓**
		G01	***G02***
A	Agricultural production?		
B	What inputs to buy for		
C	What types of crops to grow		
D	When or who would take		
E	Livestock raising?		
F	Non-farm business activity (For example: shop owner, animal trading, wood and		
G	Your own (singular) wage or		
H1	Major household expenditures? (such as livestock purchase, rent land)		
H2	Minor household expenditures? (suchas food for daily consumption)		
M	Whether or not to use family planning to space or limit births?		
N	Homestead gardening?		

CODE1: (G01) Decision making	CODE 2: (G02) Extent of participation in decision making
Main male or husband.....1 Main female or wife/ self.....2 Husband and wife jointly.....3 Someone else in the household....4 Jointly with others inside the household 5 Jointly with someone else outside the household .....6 Someone outside the household/other 7 Decision not made because not applicable 98	Not at all ……1 Small extent……..2 Medium extent……..3 To a high extent……4

Module 6: Cultural Norms on Gender Differences

	Question	Response	Variable name
10.1.1	In your area/culture Women cannot stand up for their own choice	1= strongly agree 2= Agree 3= disagree 4=strongly disagree	CTNRM1
10.1.2	In your area/culture female child is the internalization of the low value by society	1= strongly agree 2= Agree 3= disagree 4=strongly disagree	CTNRM2
10.1.3	In your area/culture female children are socialized to eat less	1= strongly agree 2= Agree 3= disagree 4=strongly disagree	CTNRM3
10.1.4	In your area/culture female children are socialized to eat last.	1= strongly agree 2= Agree 3= disagree 4=strongly disagree	CTNRM4
10.1.5	In your area/culture female children are socialized to eat leftovers.	1= strongly agree 2= Agree 3= disagree 4=strongly disagree	CTNRM5

Module 7: Anthropometric Measurements

	Question	Response	Var. name
15.1.10	Index woman's HH roster ID	☐☐	AMROSID
15.1.11	Age in years	☐☐	AMYRS
15.1.12	Pregnant	1=Yes 0=No 98. Don't Know	AMPREG
15.1.13	Weight 1	☐☐☐.☐ kg	AMWT1
15.1.14	Weight 2	☐☐☐.☐ kg	AMWT2
15.1.15	Weight 3	☐☐☐.☐ kg	AMWT3
15.1.16	Height 1	☐☐☐.☐ cm	AMHT1
15.1.17	Height 2	☐☐☐.☐ cm	AMHT2
15.1.18	Height 3	☐☐☐.☐ cm	AMHT3

Module 8: Final Interview Outcome

19.	Final outcome of Interview	1. completed 2. incomplete	HINTOUT
19b.	If incomplete, why?	1. Unable to locate 2. Stopped Interview 3. Other (specify)	HINTOUTSP