INEQUALITIES IN CHILD CARE PRACTICES AND HEALTH OUTCOMES IN ETHIOPIA

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ABSTRACT

Child health is one of the core components of the Sustainable Development Goals (SDGs), explicitly related to goal-3 “ensure healthy lives and promote well-being for all ages" which aims at reducing child health inequalities within and among countries by 2030. It particularly prioritizes reduction of the three most important child health outcomes: under five mortality, morbidity, and undernutrition. Evidence from developing countries indicates that three sets of childcare practices play leading roles in shaping these outcomes: child feeding, health service utilization and Water, Sanitation and Hygiene (WaSH). Ethiopia is one of the Sub-Saharan African countries with unacceptably high disparities in both child health outcomes and childcare practices/interventions. Research focusing on disparities in these subjects is relatively scarce in Ethiopia. The very few available studies on child health outcome and care practices were limited in addressing the risk factors of a single problem (such as undernutrition, child mortality; antenatal or postnatal care) and were based on a small sample size. Thus, this study was primarily aimed at examining the inequalities in key childcare practices/interventions and their effects on prominent child health outcomes (multiple nutritional deficiencies and child survival) in Ethiopia.

The study used data from 2016 Ethiopian Demographic and Health Survey (EDHS), a cross-sectional nationally representative survey conducted every five years. The sampling design for all the DHS surveys was a two-stage stratified cluster sampling. The study used the children’s file containing several sociodemographic and health related variables for 10641 under-five children. In the EDHS, mothers aged 15-49 were interviewed. The analysis presented in Chapters 4-8 employed a wide range of statistical analyses ranging from binary logistic regression (for binary outcome), proportional odds regression (for ordinal outcome) to mixed effect regression models. Purposeful model selection of explanatory variables was used for model building. All predictors with a p-value of <0.2 based on the bivariate analysis were subsequently included in the initial multivariable regression model. For all analyses conducted in Chapters 4-8, the model selection criterion was the Akaike Information Criterion (AIC), and the level of statistical error was set to be 5%.

The analysis began with examining the disparities in the three core childcare practices (Chapters 4-6). The findings indicated that Infant and Young Child Feeding (IYCF) practices are unacceptably poor, where about 80% of the children aged 6-23 months in Ethiopia did not adhere to the core WHO recommended feeding practices. The study indicated that the six components of health service utilization

used to form the outcome variable in Chapter 5, were very low by any standard, resulting in overall low utilization scores. For instance, two-third of the most recent pregnancies had not the minimum antenatal care (ANC) visits, only 26% of last births occurred in health facilities and only 12% received postnatal care services. The intake of micronutrients (Vitamin A, Iron) and deworming pills was also unacceptably low. The findings confirmed that more than half of the households have very poor or poor sanitation and hygiene status as defined by a composite score based on four indicators (access to water, hygiene, household pollution and access to toilet facilities). The three sets of childcare practices were determined by individual characteristics, household characteristics and community variables.

Given 28% of deaths of under five children in the country is caused by easily preventable childhood diseases, such as acute respiratory infection (ARI) and diarrhea, Chapter seven of this thesis examined the health seeking behavior of mothers for the two childhood diseases. The finding revealed that 55.6% and 72.6% of mothers did not seek health care during the episode of diarrhea and ARI, respectively. This might have contributed for poor childhood undernutrition reported in Chapters 8. In Chapter 8, it was noted that the proportion of children stunted, underweight and wasted were 38%, 25% and 9%, respectively. About 58% of the sample children were anemic. The prevalence of children concurrently stunted and anemic was 24.8%. The incidence rate for multiple nutritional problems was determined by a range of individual, household, and behavioral factors. The three proximate variables (hygiene and sanitation score, feeding practice and child health service utilization score) were found to exert a strong influence on the incidence rate of multiple nutritional deficiencies.

The overall findings of the study strongly suggest that future reductions in inadequacies in the key child health outcomes (under 5 mortality and undernutrition) would largely depend on the country's ability to significantly improve the desirable behaviors pertaining to the three core intermediate variables (child feeding practices, health service utilization and improving household Water, Sanitation and Hygiene (WASH) practices and indoor pollution. Therefore, more attention should be given to a child's living context (those living in rural areas, those living with parents of poor education or in households with mothers having poor autonomy).

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DEDICATION

To my wife (Tsigereda Getnet Beyene) and children (Yonathan, Kirubel and Barok) for their love, support, and prayers in all my difficult times

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LIST OF ABBREVIATIONS

ADRI	Agricultural Development Led Industrialization
AIC	Alkaline Information Criteria
ALD	Agriculture Led Development
ANC	Antenatal care
ARI	Acute Respiratory Infection
CAS	Concurrent Anemia and Stunting
CI	Confidence Interval
CSA	Central Statistics Authority
DDS	Diet Diversity Score
DHS	Demographic and Health Surveys
EDHS	Ethiopian Demographic and Health Survey
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
HEW	Health Extension Worker
IFAD	International Food and Agricultural Fund
IPV	Intimate Partners Violence
RR	Rate Ratio
IYCF	Infant and Young Child Feeding
MMF	Minimum Meal Frequency
OR	Odds Ratio
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
SD	Standard Deviation
SDG	Sustainable Development Goals
SDRP	Sustainable Development and Poverty Reduction Program
SES	Socio Economic Status
UNDP	United Nations Development Program
U5M	Under Five Mortality
UN	United Nations
UNICEF	The United Nations Children's Fund
VIF	Variance Inflation Factor
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background

Child health was one of the core components of the eight Millennium Development Goals (MDGs)[1], which recently transformed into Sustainable Development Goals (SDGs)[2]. The SDG-3 explicitly relates to health—to "ensure healthy lives and promote well-being for all ages." This goal is translated into 13 targets, including three targets related to reproductive and child health[3]. The SDG for child health specifically targets improving child health outcomes and interventions and reducing inequality within and among countries by 2030[4].

The two most commonly used child health outcome indicators are under-5 mortality and undernutrition/ stunting [5–7]. Reducing under-5 mortality (including infant mortality) is one of the focus of the global health agenda[5,8]. Undernutrition is a cause of public concern in many developing countries, and reducing stunting prevalence is one of the key components of improving child health[5]. The SDGs included 17 child health interventions that collectively account for all stages of the continuum of care for child health and are known for their well-documented effects on child mortality and health[9]. These interventions emphasize behavioral actions revolved around access to health services, feeding, and sanitation services[4]. Since the official implementation of the SDGs, the interventions have brought about remarkable changes globally[10]. For instance, the under-5 mortality rate showed a 7% decline in the year 2017 from 42 deaths per 1,000 live births in 2015. With regards to infant mortality, an overall reduction of 49 per cent was reported in 2015 from 77 deaths per 1,000 live births in 2000. Overall, the total number of under-5 deaths dropped to 5.4 million in 2017 from 9.8 million in 2000[10].

While there was modest progress in child health over the last few years in Africa, there are still substantial inequalities in both child health outcomes and interventions[11,12]. Disadvantaged groups in a

population (i.e., those less educated, who are poor, living in economically impoverished regions) bear a higher burden of disease and death mainly due to poor childcare practices [6]. To achieve the ambitious SDG goals, interventions need to reach the various underserved population groups[11].

Despite substantial decline in mortality rate in Sub-Saharan Africa since the year 2000, the region is still experiencing the highest rates[13]. In 2017 alone, Sub-Saharan Africa contributed nearly half of the global deaths[14]. Childhood illnesses, mainly caused by poor hygiene and sanitation, contributed a larger proportion of these deaths[11,14]. Health seeking for common childhood morbidities has also been unacceptably low, especially for Ethiopia (29%)[11]. Child health and survival is generally determined by several social, economic, demographic, environmental, cultural or behavioral factors[15,16]. Understanding child health and survival in developing countries requires looking at the leading factors (child feeding, sanitation and health service) that contribute to child health[4,17,18].

Childhood undernutrition is the other major health outcome affecting millions of children today. Worldwide undernutrition such as stunting, wasting and micronutrient deficiencies contribute to the death of 3.1 million children[19]. Globally, 159 million children are affected by stunting and 50 million children are affected by wasting[20]. In Sub-Saharan Africa, the prevalence of underweight, stunting and wasting in children under 5 was 21%, 40% and 9%, respectively[13]. Though not adequately studied, children may suffer from multiple nutritional problems (especially anemia and stunting) sharing many common risk factors [21,22]. Inadequate child feeding and hygiene practices, and childhood illness coupled with poor health service utilization are often associated with multiple negative nutrition outcomes[21].

Recent evidence and WHO publications emphasized a set of interventions and practices to reduce the huge gap in child survival between poor and rich countries [23–28]. Three of the key priority areas of childcare practices/ interventions during infancy and childhood are: 1) promoting good nutrition (breastfeeding, diet diversity, food frequency, timely initiation of complementary feeding and

micronutrient supplementation); 2) health service utilization (such as ANC, institutional delivery, postnatal care and child immunization, vitamin A supplementation, deworming) and 3)Water access, sanitation and hygiene practices. Studies indicate that these sets of childcare practices play a significant role in reducing childhood undernutrition and mortality in Africa and other developing countries[29]. Scaling up of these essential curative, preventive and promotive childhood interventions are necessary to curb childhood morbidity and mortality [6,30].

Ethiopia is one of the Sub-Saharan African countries with poor health service infrastructure and high health disparities across its various sub-populations[31]; and the disparities in child health interventions are worrisome. The Ethiopian Government claims that the country has been striving to ensure universal access to health care through its national Health Sector Development Program (HSDP) [32]. Despite these efforts, the most recent national data[33] suggest that the country is still experiencing poor child health outcomes, namely, under 5 morbidity and mortality, and child undernutrition. There have also been high disparities in terms of child health care practices and interventions such as antenatal care, delivery care postnatal care services and childhood immunization[33].

Given this, research focusing on disparities in childcare practices and their impacts on child health outcomes is relatively scarce in Ethiopia. At this time, the very few studies conducted on child health are based on only one or two indicators or focused on a specific region or district. Nearly all previous studies on child health outcomes and practices were limited in addressing the risk factors of a single problem such as undernutrition [34,35], and very few attempts were made to assess the predictors of concurrent health outcomes and/or interventions. These studies are useful and provide valuable specific information related to these outcomes and interventions. However, there is also some benefit and utility in examining the effects of a consistent set of social determinants and various child health outcomes and interventions using a set of independent variables[36]. Despite increasing interest to prioritize the key

interventions to reduce the unacceptably high child health outcomes, there are little or no studies conducted to quantify the effects of the three core sets of predictors (child feeding practices, WaSH practice and health service utilization) in a single measure Also, none of the previous studies in Ethiopia attempted to estimate the population level impacts of these key child health care practices on health care seeking behavior for common childhood illnesses and multiple nutritional morbidities. Systematic monitoring and investigation of these impacts will provide relevant information for policymakers concerned with reducing the inequalities.

The present study thus addresses an urgent area of need. It investigates the magnitude–of disparities in three main child health care practices and further investigate the population-level impacts of these sets of variables on child morbidity (i.e., maternal health-seeking behavior for key childhood illnesses and multiple nutritional morbidities). It uses data based on national Demographic and Health Surveys (DHS) conducted in 2016.

1.2 National health development goals and policy frameworks in Ethiopia

The Ethiopian Constitution recognizes the vulnerable position of children in its society and guarantees their right to protection and affirms the obligation of the government to the implementation of these rights. Article 36A states that every child has the right to life[37]. In line with the constitutions, Ethiopia has introduced health and nutrition policies that have been implemented during the last two decades. The policies and strategies in place are also aligned to the Global goals, policies, and guidelines such as those of the former MDGs, the new SDGs, and the UN child's right conventions and principles. The following is a brief account of the national health policy in general and child health and nutrition policies and strategies.

The 1993 Ethiopian health policy was one of the most comprehensive health policies of the country, which was prepared based on an analysis of the determinants of the health of population [38]. The policy primarily aimed at increasing access to all segments of population with promotive, preventive, essential curative and rehabilitative health services through decentralized and integrated health care delivery systems[39]. This policy was translated into a 20-year long term health development plan called 'Health Sector Development Program (HSDP)' (1996-2015), sub-divided into five-year tiers[39].

The HSDP was aimed at achieving the health-related Millennium Development Goals (MDGs)[40,41]. The Health Sector development program is the main medium for translating the national health policy into action[40,41]. The HSDP contains a national child survival strategy which aims to reduce neonatal, child and under-5 mortality rates[42]. The key activities of the strategy include child vaccination, enhancing exclusive breast feeding, vitamin A supplementation, enhancing skilled delivery uptake, newborn resuscitation, prevention of hypothermia, improving the young and infant feeding[42].

The year 2001 was the time the Water, Sanitation and Hygiene (WaSH) sector got more attention by the government. With considerable support from development partners, the Ethiopian Government developed a water sector strategy in 2001 and a water sector development program in 2002[43]. These strategies extended through 2002 to 2016. The policy primarily aimed at providing sustainable, efficient, reliable, affordable, safe, and adequate drinking water and sanitation services to both rural and urban population to rural and urban households[39,44].

The Health Extension Program (HEP), which was developed in 2004 by the Ministry of Health in collaboration with the Ministry of Education, was a key pillar of the country's national health plan. The program was aimed at improving primary health services in rural areas, focused on prevention, basic curative care, and health promotion by establishing primary health care units (lower level) that include a health center and five satellite health posts[41,45]. An innovative community-based approach was

used for the implementation of the HEP using a step-by-step change, which starts by training early adopters and those trained would be a model family to other community members[40]. The local government administrators such as Kebele leaders (i.e. kebele is the smallest administrative segment) and Health Extension Workers (HEWs) were the ones who selected the first families for the training based on the family's their earlier previous participation in the communities and their readiness to be trained[40,41]. The HEWs are middle-level health professionals who are deployed at each kebele to provide basic health, nutrition, environmental hygiene and sanitation services to the community.

The National Strategy for Infant and Young Child Feeding (IYCF) was developed in 2004[46]. The main objective of the strategy was to improve the IYCF practices in the country by standardizing the practices and outline the technical directive for interventions[46]. The strategy document emphasized the importance of the first 12 months. This is the period when growth faltering takes hold due to sub-optimal infant feeding practices[46]. The document outlines seven key messages to be delivered by HEWs[46]: promoting optimal feeding, promoting complementary feeding at 6 months; controlling vitamin A deficiency, nutritional care of the sick child during and after illness; improve women's nutrition; reduction of anemia; and controlling iodine deficiency[46].

The National Nutrition Program (NNP) was implemented in two phases for 10 years; each phase lasted five years[47]. The NNP targets the most vulnerable (such as those under 2 years as well as pregnant and lactating women)[47]. There were additional strategies added in the NNS that were not included in the National Strategy for IYCF. The launching of NNP since 2008[47] was another important commitments to improve the widespread malnutrition in Ethiopia [48].

Once the implementation of NNP 1 (2008-2013) was completed, the government launched another round NNP for 2016-2020 (NNP II). The revised NNP gives priority to young children under the age of two, pregnant and lactating women, adolescents, infants and young children[49]. The NNP II

targeted reducing the prevalence of three crucial indicators for children under five: stunting from 40 per cent to 26 per cent; underweight from 25 per cent to 13 per cent and wasting from 9 per cent to 4.9 per cent [50]. The main strategic objective of NNP II is integrating nutrition-sensitive and nutrition-specific programs and enhanced inter-sectoral coordination. In addition, NNP II emphasizes the scale-up of best practices of processing of agricultural products at the household level. NNP II was also aligned to Sustainable Development Goal and the international *Seqota Declaration* to end child malnutrition by 2030 and improve the lives of Ethiopian children.

The National Child Survival Strategy (2005 – 2015) and its subsequent second cycle (2015-2020) were instrumental in guiding the design and implementation of high impact newborn and child health interventions in the country[51]. The National Newborn and Child Survival Strategy (2015/16-2019/20) primarily targeted reducing infant and neonatal mortalities to 29 per 1000 children, 20 per1000 live births and 11/1,000 live births, respectively[51,52]. For this reason, the strategy document identified and prioritized 39 high impact and cost effective newborn and child survival interventions [51,52]. Like other related health policies and strategies, this one also capitalized on the importance of childcare practices such as nutrition, improving accessibility to health services and promoting good hygiene and sanitation at all levels. The Ministry of Health believes that the strategy was instrumental in achieving MDG 4 by reducing the infant and child mortality three years ahead of 2015 by two thirds from its 1990 level[52].

To sum up, the Ethiopian government has made significant financial and programming investments in the implementation of the various health policies and programs, more specifically to the Ethiopian Health Sector Development Program (HSDP). It has allocated extensive resources and made educational opportunities and healthcare services available to rural communities in Ethiopia [31]. The HEWs, deployed in a ratio to population of 1:2300, are mandated to conduct community outreach,

education/training sessions and extension activities, and provide healthcare supports to millions of poor Ethiopian households[39,41,45]. In nearly a decade, the number of health posts and health centers in Ethiopia grew by almost six-fold[32,49].

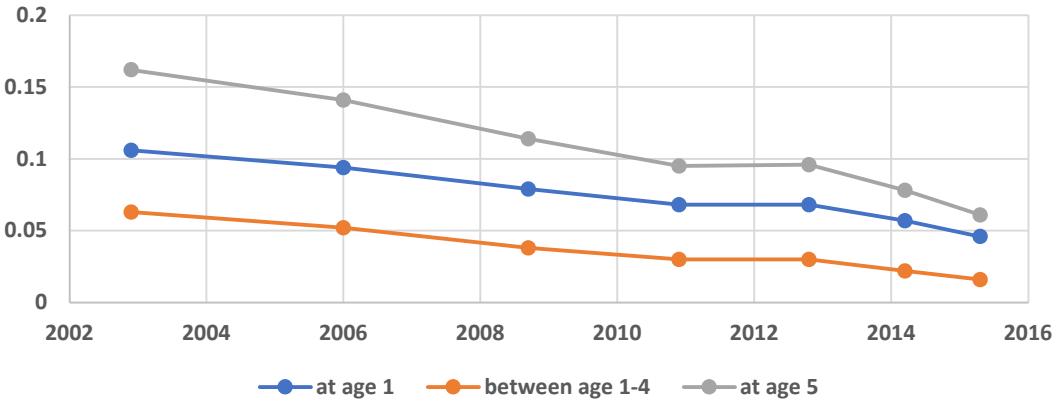
Most policies and programs described above are relatively newer, and their impacts are yet to be seen in few years' time. However, there are momentous changes in the health condition of the population that was apparently due to the implementation of these policies and strategies. Among these changes, the most frequently reported are chronic malnutrition decreasing from 52% to 38%, an increased maternal and child health service utilization, a remarkable increase in access to improved water and basic toilet facility, and reduction of the prevalence of childhood morbidities such as diarrhea among under-5 children from 23.6% in 2000 to 10% in 2016[33]. A significant reduction was also reported in the major communicable diseases such as HIV/AIDS, malaria, and tuberculosis[39]. All these have brought about a significant increase in the average life expectancy of the population from 45 years in 1990 to 65 years in 2016[33].

1.3 Child health outcomes in Ethiopia

Under-5 mortality: Ethiopia's current rates of infant and mortality of 59 and 88 deaths per 1000 live births, respectively, is higher than the average rates of many other developing countries[53]. Despite the reported improvement in the national averages (see Figure 1.1), there are substantial inequalities in child health outcomes among the different socio-economic subgroups (i.e., poorest vs. richest and no education vs. higher education) persist and progress is uneven [54]. For instance, the rate of under-5 mortality for the rural and urban population was 114 deaths per 1,000 live births and 83 deaths per 1,000 live births, respectively [33]. There was also a substantial difference between the poorest and the richest quintiles (137 and 86 deaths per 1,000 live births, respectively). A recent assessment by the International

Fund for Agricultural Development[55] confirmed that Ethiopia has huge systematic inequalities in child health outcomes both within households and community levels.

Figure 1.1 Trends of death probabilities at age 1, between 1-4 and at age 5, Ethiopia.



Source: CSA and ICF (2016)[33]

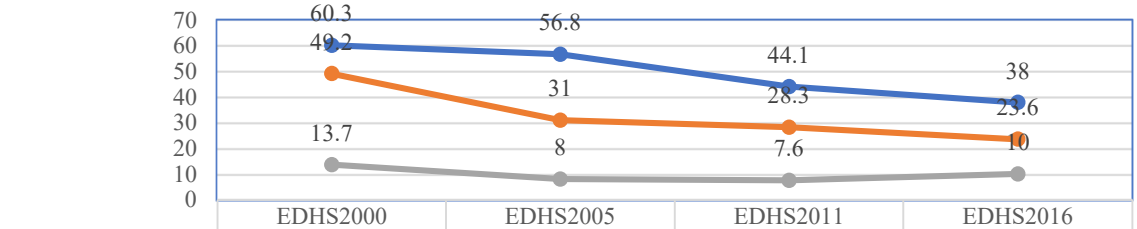
The most common childhood illnesses contributing to the higher under-5 mortality in Ethiopia are diarrhea, acute respiratory infection (ARI) and malaria. Even though the prevalence of diarrhea in Ethiopia has shown a slight decline from 13 % in 2011 to 12 % in 2016 [33], it still accounts for the deaths of 8% of children under the age of five in the country[56]. Poor access to safe water (57%) and proper hand-washing practices (7%) in rural communities contributes to the high burden of childhood morbidity and mortality in Ethiopia [33]. The overall prevalence of ARI among under-5 children in Ethiopia was 7.9%, with the highest prevalence in the Tigray region (14.92%)[33]. A recent national-level study indicated that the odds of developing ARI were nearly five times higher in children who had diarrhea compared with their unaffected counterparts [57]. Malaria is still among the ten top leading causes of morbidity and mortality in children under-5 years[58].

A recent systematic review of under-5 mortality in Ethiopia[59] indicated that child survival is a function of a range of risk factors including, but not limited to, parental sociodemographic, socioeconomic, and behavioral variables and nutritional, environmental, and sanitary factors. It was

reported that breastfeeding, infections, healthcare, hygiene practice, and preceding birth interval were found to explain much of the variations in under five mortality. Some sociodemographic variables such as maternal education, maternal age at first birth and mothers' marital status, birth order and household income were also frequently reported explanatory variables[59].

Undernutrition and anemia: Malnutrition takes different forms. Wasting (thinness) is a form of acute undernutrition caused by a decrease in food consumption and/or illness [25]. Stunting (shortness) is chronic malnutrition caused by inadequate nutrition over long periods of time, leading to the failure of linear growth[25]. The most common forms of malnutrition in Ethiopia include acute and chronic undernutrition (low energy and/or protein intake), vitamin A deficiency (VAD), iron deficiency anemia (IDA), and iodine deficiency disorder (IDD)[60]. There was a significant decline in the rate of stunting and underweight by 34.5% and 41.5%, respectively, in the last 17 years (2000-2016) [49]. However, undernutrition among under five children is still one of the most significant public health concerns in the country[49]. About half (48.2%, equivalent to 6.3 million) of children under the age of five years were malnourished [33]. The most recent national data indicates 38% of children under five years of age were stunted[33]. The figure is much higher for children residing in rural areas (40%) than urban areas (25%) [33]. Child malnutrition, more specifically stunting, is found to be associated with the quantity and quality of infant feeding[35,61].

Fig 1.2 Trends of malnutrition among under five children



	EDHS2000	EDHS2005	EDHS2011	EDHS2016
Stunting	60.3	56.8	44.1	38
Underweieght	49.2	31	28.3	23.6
Wasting	13.7	8	7.6	10

Source: CSA and ICF (2016)[33]

Anemia is a condition of low hemoglobin and that is often caused by iron deficiency in Ethiopia and has serious and common public health significance. Anemia can also signify current infection, particularly malaria (this is part of the body's response to malaria since the parasite utilizes iron from the host). The prevalence of anemia among under-5 children had dropped from 54% in 2005 to 40% in 2011, and it rebounded between 2011 and 2016 to 57 % [33]. The increase may arise due to significant changes in diet, especially a decline in the consumption of iron rich food. In contrast, the national micronutrient survey reported a lower anemia prevalence in children under five years of age of 34.4%[39]. The World Health Organization (WHO) classified anemia prevalence above 40% as a severe public health problem requiring comprehensive interventions [62]

Studies have associated the high prevalence of anemia in Ethiopia with a range of socioeconomic and demographic variables including sanitation, household food modifications, morbidity related variables, having poor dietary diversity, early or late initiation of complementary feeding, poor quality of breastfeeding and children of mothers utilizing less iron folate during pregnancy[63].

Compared to the losses suffered in the other African countries, child undernutrition and micronutrient deficiencies (including anemia) pose greater challenges to the economic and human

capital development of Ethiopia. Recent figures suggest that childhood undernutrition and micronutrient deficiencies cost 16.5% of its GDP which was equivalent to USD 4.7 billion [64]. Undernutrition has also been reported to be responsible for 28% of all child deaths in Ethiopia[64]. There are also recent reports about the significant impacts of undernutrition and micronutrient deficiency on the school performance of children in Ethiopia. For instance, a recent study by Dawd and colleagues[34] reported that the mean score of stunted children, compared to non-stunted children, on non-verbal reasoning and school readiness tests. The same study found that anemic children had a lower score for the verbal reasoning test compared to those without anemia[34]. This has forced the government of Ethiopia to allocate proportionately more resources and policy level attention to maternal and child nutrition issues during the last few years. The issuance and implementation of the National Nutrition Program (NNP I and II) have been an integral part of this effort [49].

1.4 Childcare practices in Ethiopia

A thorough review of the Ethiopian nutrition and health policies and strategies (presented in section 1.2) suggests that the country is prioritizing three sets of care practices and interventions [39,40,46,50,51] to improve child survival. These are: a) Good child feeding practices, especially for infant and young children, b) Improve access to child health services (such as ANC, PNC, delivery, immunization and micronutrient supplementation) and c) Improve the very poor Water, Sanitation and Hygiene (WaSH) and overall household environment.

Given the high burden of under-5 mortality and morbidity, the Government of Ethiopia has been working hard to reduce child mortality and morbidity through these cost-effective and high impact on child survival interventions. The National Newborn and Child Survival Strategy(2015-2020), for instance, acknowledged nutrition, health services and sanitation interventions in their ability to reduce

under 5, infant and neonatal mortalities by 2020[51]. Similarly, the NNP and IYCF strategies capitalized more on coordinated implementation of these interventions at all levels [50]. The impacts of these interventions have not yet been measured at the population level[56]. Furthermore, the main risk factors for improper practices or inadequate services are not well addressed at the national level. The following are descriptions of each of these groups of practices.

Child feeding practices*:* In Ethiopia, child feeding practices are generally worrisome[35,65]. For instance, about 60% of infants were not exclusively breastfed by age 4-5 months[33]. Nearly half of all infants <6 months of age were not exclusively breastfed. More than one in four infants still received pre-lacteal feeds that may predispose the child for infectious diseases and risk of diarrhea [66]. It was reported that mothers give herbal extracts to their children, discarded colostrum, and introduced complementary feeding as early as 3 months[66,67]. The early introduction of complementary feeding before the age of 6 months increased the risk of infections and further contributed to malnutrition[68]. Further, child feeding practices in Ethiopia are typically characterized by very low adherence to the WHO child feeding recommendations where solid/semi-solid diets were of low micronutrient content and below minimum diversity and meal frequency[65,69]. According to the Central Statistics Agency 2016 report, only 7% of Ethiopian children aged 6-23 months have a minimally acceptable diet[33]. Studies in Ethiopia noted that the incidence of stunting was higher in infants/young children whose diets were poorer in quantity and quality[61]. Ethiopia also has one of the poorest performance in terms of other nutritional interventions such as provision/use of iodized salt (< 20%), and among those aged 6-23 months only 38% consumed vitamin A rich foods in the day before the interview and just over half (53%) of children aged 6-59 months received vitamin A supplement [33]. Consumption of iron rich food among children 6-23 months was only 22% [33].

Child health service utilization: Ethiopia is experiencing very poor child health services utilization. The three main child health services are antenatal care (ANC), delivery care, and postnatal care (PNC), all of which significantly determine the survival of children [33]. The prevalence of other preventive health services (such as vitamin A supplementation, iron supplementation, deworming and immunization) is also unacceptably low.

Both the prevalence of institutional delivery and postnatal care service utilization have been very low, 28% and <10%, respectively[33]. According to the Ethiopian demographic health survey (EDHS) report, there has been a substantial improvement in the proportion of mothers visiting ANC at least one time before delivery, which increased from 27% in 2000 to 63% in 2016 yet remains low. Similarly, only a quarter of births in Ethiopia were delivered with the assistance of skilled birth attendants[33]. In Ethiopia, antenatal and delivery care utilization by mothers is not only beneficial in terms of avoiding adverse pregnancy outcomes (pregnancy complications), but it is also an important entry point for delivery of the essential nutrition actions message through the current health extension program[51].

In Ethiopia, a substantial number of deaths of children under-5 years of age in the country are due to vaccine–preventable diseases[70,71]. Despite Ethiopia's encouraging progress to improve accessibility and provision of the vaccination services through its health extension programs, full vaccination coverage is still far from reaching the WHO's target figure of >90%. The prevalence of those fully immunized with recommended vaccine dosages showed a modest increase from 14% in 2000 to 42% in 2016[33]. There are also high regional variations in coverage varying significantly from only 9% of children fully vaccinated in the Afar region to 79% in Addis Ababa. Most previous studies conducted in Ethiopia [72–75] attributed the low prevalence of immunization to lack of awareness among mothers or caretakers about the importance of immunization, and the inconvenient place and/or timing of immunization and feared side effects of vaccines.

Studies conducted in Ethiopia on examining the effects of health service utilization on child health and survival indicated the importance of varied explanatory variables[59]. For instance, a community-based case-control study conducted in Jimma (Southwestern Ethiopia) reported excess mortality among children who had never been immunized [24]. In another study, Fantahun and colleagues reported that unvaccinated children had the highest U5M compared to those who were vaccinated at least once [76]. Infants whose mothers attended antenatal visits exhibited a lower risk of death than those whose mothers did not[77]. As part of antenatal care services, giving two tetanus toxoid injections to the mothers before childbirth decreased neonatal mortality[78]. Most of these studies, however, were conducted at local/ regional level whose findings cannot be generalized at the national level. Also, all of these provided an incomplete picture of child health service utilization as they did not consider a comprehensive outcome measure.

Water, hygiene, Sanitation (WaSH) and indoor pollution*:* One of the goals among the UN's most recent Sustainable Development Goals (SDGs) was ensuring universal access to adequate and equitable sanitation and hygiene for all and to end open defecation by 2030[1,79]. Water, Sanitation and Hygiene (WaSH) generally includes a number of practices/situations which affect the health and survival of children, including safe drinking water and sanitation, hand washing with soap, access to toilets, cigarette smoking, type of household cooking fuel used and position of the kitchen and household air pollution [80]. Poor sanitation is a leading cause of child mortality in developing countries[80], and Ethiopia is no exception.

The overall household environment in terms of indoor air prolusion is also very poor, which significantly impacts child health and survival. Factors such as the fuel type used, the presence/absence of ventilation, household density, and the quality of housing can determine the levels of internal air pollution. Given the poor quality of housing (such as wall and floor materials) coupled with large family

sizes that generally characterize rural Ethiopia, it may not be surprising if many traditional houses are reported not to have sufficient space for air per individual. Local studies on the impacts of these factors are very rare.

During the last two decades, significant progress was made in the Ethiopian WsSH sector. For instance, the overall access to water supply has improved from 13% in 1990 to about 60% in 2016[33]. However, still only about 23% of rural and 27% of urban have access to an improved latrine. More than 32 Million (43%) of rural and about 1.25 million (8%) of the urban population have no access to any type of toilet facility and exclusively defecate in the open field[44]. On the other hand, recent evidence indicated that communicable diseases, which are attributed to unsafe and inadequate water supply, and unhygienic waste management, are responsible for 75 % of the health problems in Ethiopia [27]. For instance, lack of access to safe water, poor environmental condition, and crowded living conditions results in acute childhood diarrhea which is the leading cause of death in children in Ethiopia. [39].

Previous studies conducted in Ethiopia in this subject focus on regional samples and single sanitation/ hygiene variables (such as toilet facilities or access to drinking water). For example, a local level study in southern Ethiopia [81] based on a sample of 597 child-mothers/caregiver pairs reported a significant association between household sanitation practice and anthropometric status of the pre-school children. There are no national-level studies exclusively addressing WaSH components comprehensively.

1.5 Objectives of the study

This study primarily aims at examining the disparities in key child care practices (i.e., child feeding practices, key child health service utilization and hygiene and sanitation practices) and health

outcomes (morbidity and multiple nutritional deficiencies) in Ethiopia based on nationally representative data. The sub-objectives include:

i) Examine determinants and disparities in childcare practices in Ethiopia.

a) To examine the determinants of infant and child feeding practices based on the Infant and Child Feeding Index (ICFI) for children age 6-23 months.

b) To examine the inequalities in key child health service utilization in Ethiopia.

c) To examine the main barriers of good hygiene and sanitation practices at the household level.

ii) Examine the disparities in child health outcomes in Ethiopia

a) To identify the main predictors of seeking treatment for two most common childhood illnesses (diarrhea and ARI) among children 0-59 months.

b) To examine the risk factors for concurrent child nutritional problems (stunting and anemia) and multiple nutritional outcomes.

1.6 Research questions

The following questions warrant a critical and in-depth investigation:

a) What is the magnitude of disparities in child feeding practices in Ethiopia?

b) What are the key determinants of water access, sanitation, hygiene and household environmental pollution?

c) What are the key factors associated with child health service utilization in Ethiopia?

d) What are the major determinants of care seeking for common childhood illness (ARI and diarrhea) occurrences?

e) Is there any significant association between childcare practices and childhood multiple nutritional morbidity?

1.7 Significance of the study

The rationale for conducting this study is twofold. First, as the primary focus of this study is to examine the inequalities using comprehensive health inequality indicators from nationally representative data, the findings may be useful on a national scale in informing planners and policymakers about child health and survival status in Ethiopia. Many non-governmental organizations (NGOs), private organizations and community-based organizations in Ethiopia will benefit from such a comprehensive study for their planning, geographic targeting and monitoring and evaluating programs. Secondly, results obtained from this study, including the research articles to be published in peer-reviewed international journals, will add to the body of knowledge and contribute to the discourse on issues of child health inequalities among disadvantaged populations, a topic of growing importance in Ethiopia and Sub-Saharan Africa.

1.8 Definition of key terms

Under five mortality:	Death occurring before the fifth birthday
Childhood morbidity:	Common illnesses (such as diarrhea, Acute Respiratory Infection, Pneumonia, and malaria) occurring during the first five years after birth.
Undernutrition:	undernutrition includes being underweight for one's age, too short for one's age (stunted or chronic undernutrition), dangerously thin (wasted or acute undernutrition), and deficient in vitamins and minerals (micronutrient malnutrition)[25].
Health seeking:	any action or inaction undertaken by individuals (mothers or care takers) especially during episodes of diarrhea and ARI.

Child health:	refers to child's state of physical, intellectual, mental, social, and emotional well-being.
Child health outcomes:	defined in this context as any outcome (such as undernutrition, mortality, and morbidity) arising from poor care practices
Inequalities:	defined in this context as the disparities or difference in childcare practices and health outcomes across groups in a population.

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CHAPTER TWO

REVIEW OF LITERATURE AND CONCEPTUAL FRAMEWORK OF THE STUDY

The Sustainable Development Goal 3 prioritizes certain health interventions during infancy and childhood[71]. These interventions which significantly contribute to child survival and other health outcomes in most developing countries can be grouped into three sets:[71] 1) Access to and utilizations of health services (such as pre and post-natal health care services);[71] 2) Infant and young child feeding practices including timely initiation and optimal feeding,[10] and; 3) hygiene and sanitation practices including access to safe water and sanitation facilities[71]. The following few sections highlight the importance of these practices and their effects on child health outcomes.

2.1 Determinants of feeding practices and impacts on child survival

Inadequate child feeding practice is a public health concern in developing countries, especially among infants and young children (6-23 months). Susceptibility to nutritional problems is high in the first 1000 days (from conception to 24 months of age of the child). Studies reported that poor early childhood growth (stunting) in the first 1000 days (24 months) of life or poor foetal growth in the period of pregnancy results in irreversible damages including lower birth weight, short adult stature and poor academic performances in schools[1,2].

Improper feeding of infants and young children denotes early cessation of breastfeeding, starting complementary feeding before 6 months of birth or starting it later than the eighth month, and poor diet diversity[1,3]. Such practices tend to increase the risk of child undernutrition remarkably between 3 to 24 months of age[1,3]. A recent national-level study of undernutrition in Ethiopia reported that the prevalence of undernutrition is significantly higher among older children (>24 months) compared to younger ones

(6-23 months)[4]. Only one in three younger children and one in six older children in sub-Saharan Africa were fed adequately diverse diets or overall acceptable diets[5].

Ensuring wide coverage of exclusive breastfeeding alone would spare the lives of 1.2 million children every year globally[6]. Early initiation of breastfeeding is beneficial both for the mother and the child in stimulating the release of hormones that help in contraction of the uterus and minimize post-partum bleeding[6]. The health and growth of infants and young children could benefit more if mothers continue breastfeeding their children at least until 24 months of age, along with other foods [7–9]. While there is very little evidence about the positive impacts of breastfeeding on stunting, there has been ample evidence showing that breastfeeding significantly reduces mortality and morbidity in neonates and infants[8].

The World Health Organization/WHO strongly recommends timely initiation of complementary foods at six months of age. This is mainly because breast milk alone is not enough to meet the nutritional requirements of 6-23 months of age children[10]. Infants and young children should get both minimum diet diversity and minimum meal frequency to remain healthy[10]. Children should be fed the minimum number (i.e., four or more) food groups out of 7 food groups: grain, tubers & roots; legumes & nuts; dairy products; flesh foods; eggs, vitamin A rich fruits & vegetables, and other fruits and vegetables)[10]. Poor diet diversity is strongly associated with risks of deficiencies of essential micronutrients such as vitamin A, iron and zinc in young children[11]. The minimum acceptable diet is a combination of minimum diet diversity and minimum meal frequency[12]. Promoting adequate complementary feeding for children aged 6–23 months is key to reducing child stunting[3,13,14]. This makes the first two years of life very critical for any intervention that aims to avert growth faltering and associated consequences in young children[7,8]. It is estimated that 6% of all deaths under-5 years of age in developing countries can be prevented by appropriate feeding [15].

Studies around the world reported several factors that determine proper child feeding practices. Of factors associated with appropriate complementary feeding practice, maternal education is one of the most frequently reported. Studies in Ethiopia and elsewhere indicated that mothers who attended primary and secondary schools and above are more likely to practice appropriate complementary feeding compared to those mothers who have no formal education[16–22]. The lack of formal schooling may pose a potential challenge on knowledge reception capacity and translation of interventions directed to improve maternal and child nutrition as well as child caring practices[7].

The effects of other important maternal factors, especially women's empowerment, on the feeding of under-5 children, are some of the areas least investigated. The degree of women's access to and control over important household resources determine household food consumption and child feeding in most developing societies[23]. Studies reported that women and children are at greater risk of suffering from malnutrition in places where gender inequality is a significant concern[24]. Recent research conducted in Sub Saharan African countries showed that the overall empowerment of women was positively associated with multiple IYCF practices in Mali, Rwanda, and Sierra Leone[23]. Poor autonomy may affect gender roles and intra-household food distribution, both of which may have a subtle impact on the nutrition of both women and young children[25].

Studies conducted in five Asian countries and Tanzania and Northern part of Ethiopia reported child age as a good predictor variable[1,16,21]. A recent study in Ethiopia [16] reported that older children (12–17 and 18–23 months) are about three times more likely to be fed appropriately compared with younger children (6–11 months). Having a smaller family size (1–3 persons) also results in good feeding practices[16]. There is also growing interest in examining the association between mother's health service utilization and feeding practices. Recent studies in Ethiopia[16] indicated that there is a significant association between antenatal care visit and diet diversity and feeding practice. This finding also agrees

with the studies conducted in Nigeria and five Asian countries[19,21] where inadequate antenatal care was associated with inappropriate complementary feeding.

2.2 Determinants of child health service utilization

Health service utilization is an important component of child health promotion. Evidence shows that two-thirds of child deaths in low- and middle-income countries (LMICs) could be prevented if adequate and proper health interventions were utilized [26]. The utilization of such interventions in high childhood mortality regions remains low [26].

Antenatal care, skilled attendance during pregnancy, birth, and early post-natal checkup, child immunization are the most appropriate interventions in ensuring child health and survival and will help in attaining the Sustainable Development Goals [27].

The World Health Organization defined Antenatal Care (ANC) as "care before birth and included education, counseling, screening, and treatment to monitor and promote the well-being of the mother and the fetus[28]. Antenatal care, especially when performed from the early stages of pregnancy, advocates regular check-ups for the health of the pregnant woman and early interventions in case of any complications [29]. Despite significant progress, the proportion of deliveries attended by skilled health personnel is still low in Sub-Saharan African countries[28].

The WHO recommends ANC visits of at least four times for normal pregnancies. Antenatal visits by mothers are not only beneficial in terms of avoiding adverse pregnancy outcomes (pregnancy complications), but it's also an important entry point for delivery of the ENA (essential nutrition actions) message through the current HEP (health extension program) [28].

Similarly, skilled attendance during pregnancy and post-natal checkups are the most cost effective interventions in preventing child and maternal death and attain the Sustainable Development

Goal [27]. Previous studies have established the inverse relationship between skilled attendance at birth and the likelihood of occurrence of maternal and child deaths. [30–35]. The role of skilled attendance at birth has been a priority intervention area in resource-poor countries due to its effectiveness in reducing maternal mortality and morbidity [36]. The use of SBAs at birth would reduce the mortality rate by a range of 13% to 33%[36]. Moreover, the use of skilled attendance at birth is also considered as a cost-saving intervention in lowering the incidence of morbidity[36].

Regarding postnatal care, a large proportion of maternal and neonatal deaths occur during the first 48 hours after delivery. This makes the first two days following delivery as the most critical period for monitoring complications arising from the delivery. Safe motherhood programs have long been recommending that all women receive a health checkup within two days of delivery. Postnatal services ensure that women and newborn children are not experiencing complications following delivery and provide an important opportunity to assess the infant's development.

One of the most important influences of health service utilization is the increased uptake of child immunization. The utilization of health facilities during pregnancy and after delivery is very instrumental in increasing the prevalence of full immunization[37]. A recent study in Senegal reported that women with four antenatal visits during pregnancy were 3 times more likely to have their children vaccinated by the age of 12–23 months than those with a lower number of antenatal visits[37]. Similar findings were seen on other studies in LMICs and sub-Saharan African countries[38–44]. Similarly, children whose mothers delivered in health facilities were more likely to be vaccinated than those whose mothers delivered at home[37]. A recent study in Ethiopia, based on national data, showed that the three key maternal and child health services (ANC, PNC and delivery care) were significantly associated with the full immunization of children aged 12–23 months[45]. Other local-level studies in Ethiopia, specifically in the Amhara and Oromia regions, reported a higher likelihood of receiving complete

vaccination among those who were born at health institutions than those born at homes[39,42,46]. Similarly, postnatal care utilization also significantly contributed to full immunization in some of the studies conducted in Ethiopian and other African countries [38,39,42,44].

Previous studies have identified a wide range of factors affecting maternal and child health service utilization in the context of developing countries. Some of these factors are linked to the mothers' attributes, while others are related to either the household and community characteristics or even related to the child's attributes.

The findings on the impacts of maternal education on health service utilization are mostly consistent across studies. Earlier studies reported a positive linear association between women's years of formal education and the use of maternal and child health services[47]. Recent research shows that the positive impact of maternal education on child health and service utilization significantly reduces the presence of individual and community level controls[48,49]. It is well recognized that formal education helps women to transforms their attitudes towards healthy living, about traditional gender roles, allowing her to achieve greater decision-making autonomy within the household[48].

The influence of women's autonomy on the use of health care appears to be as important as other known determinants such as education. Women's autonomy, such as decision-making power and control over important household resources, significantly impacts the use and choice of services [50]. The decision-making power of women can have a significant effect on the ability of women to seek health services and/ or in accessing and receiving medical care even in places where services are readily available[51,52]. A recent Ethiopian study [51] indicated that women working and generating income of their own did not significantly affect their utilization of delivery and postnatal care services. The reason for the absence of association was explained by the fact that the decision on health spending is usually made by their husbands[51]. Other studies conducted in developing countries generally confirmed that women

who are able to decide on health care spending by themselves were more likely to use health care services than women whose health care spending was controlled by other people[32,51].

Studies found a strong association between maternal age and utilization of child health service [30,53–56]. In relation to this, parity is one of the demographic determinants with an important influence on women's health-seeking behavior. A number of studies have shown that women with a smaller number of children to be more consistent in utilizing skilled delivery services than women with more children[56]. Studies conducted in Ethiopia and other developing countries (such as Bangladesh, Bolivia, Malawi and Philippines)[30,56]indicated that women 35 years or older tend to use skilled services less often than younger women, especially those below 19 years.

In another line of thought, some studies reported that enhanced maternal health-seeking behavior reduced the rates of health services utilization[26]. The likely explanation for this relationship is that it is possible that mothers with high health-seeking behavior in the developing countries receive more preventive interventions; for example, they may make sure their children receive an immunization (a component of maternal health-seeking behavior) against preventable childhood killer diseases [26]. Their children will thus be less likely to fall ill, translating to reduced usage of health services. Lack of education and poor knowledge about maternal health care contribute to delays in seeking care during pregnancy and childbirth[57,58]. Though it is not as strong as maternal education, husband's education also reflects preferences for health-care utilization[53].

Some studies focus on child-related factors affecting the likelihood of health service utilization[49,59]. A recent study in Nigeria, based on the DHS data, reported that children with high multiple childhood deprivation indices have a higher likelihood of health services usage compared to those with lower childhood deprivation index scores [26]. Household wealth is one of the most frequently reported variables that positively influence health service utilization [60]. However, there are studies

reporting the reverse association between wealth and health service utilization in some poor communities. For instance, such studies indicate that the poor may have higher health-seeking behavior [61] due to higher health concerns or disease burdens.[62].

Other studies capitalize on a broader context and relate poor service utilization with other community-level variables such as residence, ethnicity, culture, media, and religion. This was explained by the fact that women's autonomy, gender relationships, and social networks are affected by these factors[63,64]. There are studies demonstrating urban-rural residences[56,65], community-level economic status/wealth index[53,66], religion[67], and exposure to media[63,66] to be important and relevant socio-demographic characteristics associated with the use of antenatal, skilled delivery and postnatal care services in several communities.

The rural-urban differentials in health service utilization are usually confounded with differences in infrastructure, education, and other resources. For instance, poor people in rural areas may find it difficult to cover transport costs to health facilities, particularly the disabled and pregnant may not attempt long distances to seek health care without adequate means of transport[61]. Other studies associate the poor health-seeking behavior of rural women with women's preference for health facility attributes such as good technical quality, reliable supply of medicines, functioning equipment and respectful provider attitude[68]. Cultural factors, such as the need for privacy or customary, also influence the utilization of facility delivery care service. The social taboos and belief systems combined with mistreatment from health workers, and lack of parent engagement in the delivery process have discouraged women from seeking institutional birth[69]. According to the 2011 Ethiopian DHS, 31 % of rural women reported that facility deliveries were not customary[70].

The effect of exposure to public media sources like listening to the radio, watching television, and reading newspapers, on health service utilization is usually positive. A study in Nigeria has shown

that community media saturation was found to be a strong predictor of health service utilization[32]. However, a study in Ethiopia[51] found no promising effects on skill delivery and postnatal service utilization in Ethiopia. The explanation given for such a non-significant association was that most women had no education and lived in rural areas where there is little or no exposure to printed and non-printed mass media.

2.3 Determinants of and child health impacts of water, sanitation, hygiene and indoor pollution

Water, Sanitation, Hygiene, and overall household indoor pollution (WaSH+) includes a number of practices/situations which affect the health and survival of children, including safe drinking water and sanitation, hand washing with soap, access to toilets, cigarette smoking at home, type of cooking fuel used and position of the kitchen and reduced household air pollution[71]. Growing evidence suggests a link between WaSH+ practices and key health outcomes for children[72]. In poor societies, like in most households in Ethiopia, the role of WaSH+ on child health and survival would be high. Combined water, sanitation, and handwashing interventions fall into the broader category of development-sensitive interventions.

Growing evidence suggests that as much as 50% of child undernutrition may be attributable to poor WaSH practices[73]. For instance, fecal bacteria from both human and animal sources by infants and young children through mouthing soiled fingers and household items are common in many rural low-income environments[72]. This, in turn causes intestinal infections, which affect a child's nutritional status by diminishing appetite, impairing nutrient absorption, and increasing nutrient losses[74]. A recent study in an Indian state[75] indicated a significant effect of the mother's/caregiver's reported hygiene practices and household sanitation and drinking water conditions on child stunting[75]. The protective effect of the mother's/caregiver's reported practice of washing their hands with soap before food against

child stunting was stronger among households with access to piped water[75]. Another Indian study, based on ecological analysis, reported a significant association between the prevalence of open defecation and stunting[76].

Studies of the determinants of WaSH+ practices are very limited. The few available studies documented evidence of a significant association between certain socio-economic variables and hygiene and sanitation practices at the household level.

Studies conducted in developing countries reported that the educational level of households has a significant association with access and use of sanitation facilities [77–79]. Some studies also confirmed the influential role played by paternal education in household-level hygiene and sanitation practices [80]. It is well known that a minimum education provides parents with a general awareness of how to utilize available resources for improving hygiene and sanitation in their household[77].

Household variables (such as household size and wealth) are most often reported as key determinants of WaSH practices. For instance, a study in South Africa reported a significant association between large household size and the use of unsafe water sources in rural areas [81]. Smith and Hanson (2003) found that household income is one of the key determinants of access to water and sanitation facilities[82]. Another study estimated that households in the lowest wealth quintile were more likely to lack improved water access and sanitation, compared with households in the highest wealth quintile [78]. Though not commonly reported, women's participation in decision making impacts household hygiene and sanitation. Recent studies revealed that the existence of power hierarchies and dynamics within households, which constrained female's participation in decision-making processes, adversely affects access to sanitation facilities[75,83].

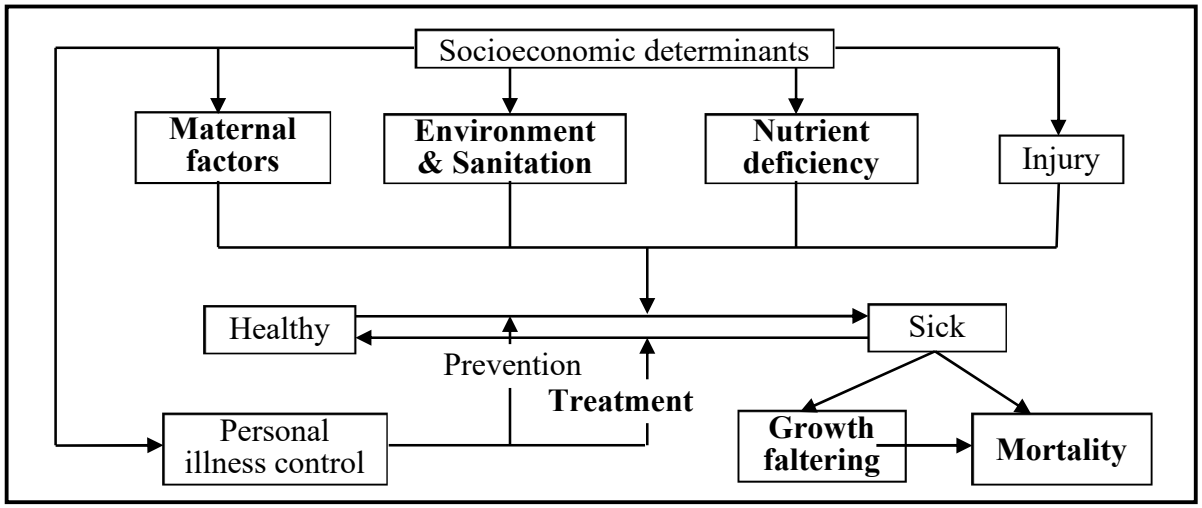
Studies conducted on the relationship between religion and WaSH in African and Asian contexts showed that Muslims have better practice compared to Christians, Hindus and other religious followers.

For instance, a recent study in India reported that Muslims were more likely to practice good toilet use compared to others[84]. A similar finding was reported in a study by Geruso and Spears. (2018)[76]. Samuel (2018) in his study of the Ghanaian community, explained the higher sanitation among the Muslim with the fact that in Islam, sanitation encompasses keeping the body and its surroundings clean"[85].

2.4 Conceptual Framework of the study

Understanding child health requires looking at the inequalities in children's mortality and analyzing the factors that contribute to these disparities[86]. The health of children is generally determined by a wide range of social, economic, demographic, environmental, cultural or behavioral factors[87,88]. The study of the key drivers of both mortality and morbidity has become more systematic with the development of an analytical framework of Henry Mosley and Lincoln Chen [88]. It has become one of the most widely used tools for analyzing the health of children as it integrates both social and health science methodologies [87]. This analytic framework introduced a single outcome variable (i.e., child survival) that combined both mortality and morbidity [87]. The framework proposed by Moseley and Chen[88] is depicted in Figure 2.1. The analysis in this study will employ a more simplified framework, containing the list of variables provided in Figure 2.2.

Figure 2.1 Mosley and Chen framework for the study of child survival[88]



The framework classifies the predictors of child health and survival into direct and indirect determinants [87,88]. While the indirect factors included underlying or background variables (such as maternal factors, environmental contamination, injury, and nutrient deficiency), those having direct effects on child survival are labeled as proximate determinants. The proximate determinants include a set of treatment or prevention variables, which include breastfeeding, immunization, sanitation, birth spacing and source of drinking water[88]. According to Mosley and Chen, the background factors should pass through the proximate variables mentioned above to influence child health outcomes.

Thus, research in child morbidity and mortality generally falls into two broad categories[89]. One group of scholars consider underlying factors as having a direct relationship with mortality of under five years of age[90]. Whereas, others tried to explain the direct effect of the proximate determinants on the health of under-five years of age without taking into account underlying factors [91,92].

Studies in developing countries have reported a wide range of determinants of morbidity and health outcomes. Some of these studies capitalized on the importance of maternal factors and early life exposures such as caregiving and quality of parenting, maternal depression, home organization, exposure to domestic violence and neighborhood safety[93]. The major social determinants frequently reported included maternal education, family income, high dependency[12,47,94,95] and household headship[86]. Other determinants of health include father's participation in childcare, alcohol and drug use by parents and cultural beliefs[96,97].

Individual-level factors such as breastfeeding, number of live births, sex of infant, maternal age at birth and birth interval are often reported as key determinants of morbidity and mortality[86,88]. Some studies in Africa showed that the mortality of children under five years appears to be higher among children of high birth rank, whose mothers had high parity, whose mothers are older and among children belonging to in large households[86]. Birth intervals have been well established as one of the key

proximate determinants of childhood mortality, which passes through breastfeeding, survival status of a preceding child and multiple pregnancies to influence survival of children[89,98–101].

Education and income are the most reported strata that researchers have used to explain variations and inequality in health and mortality [102,103]. Studies around the world report that the poorest segments of a population generally experience higher morbidity and mortality than the wealthier classes [104,105]. Parental education level has also become an increasingly important determinant of inequalities in child survival in Sub-Saharan Africa[106,107]. Analysis of DHS data for five countries showed that patterns of change in absolute and relative educational inequalities in child health outcomes are similar to those of wealth-related inequalities [108].

Some studies have emphasized the contextual variables, which include several non-household and individual factors impacting children's health. These factors may include rural-urban residence, availability and access to health centers, common values and norms all contribute significantly to shaping the health behaviors. Studies showed that the location of residence (urban vs. rural) had a significant influence on child survival and thus, residing in rural areas increased the probability of a child dying before their fifth birthday[109]. In some countries, urban-rural residence may be considered as a proxy variable for socioeconomic conditions, highlighting its influence on mortality. In some other countries, urban residence by itself appears to positively influence the survival of children[109].

Though less investigated, environmental variables also serve as background determinants of child health and survival. Using Demographic and Health Survey data for six Francophone countries in Central and West sub-Saharan Africa, Elen and colleagues[110] found that environmental factors—a safe source of drinking water, electricity, and quality of housing materials—are the most important contributors. Gamper-Rabindran and colleagues[111] examined the effect of piped water on infant mortality rate in Brazil, and found that the provision of piped water and other public health input

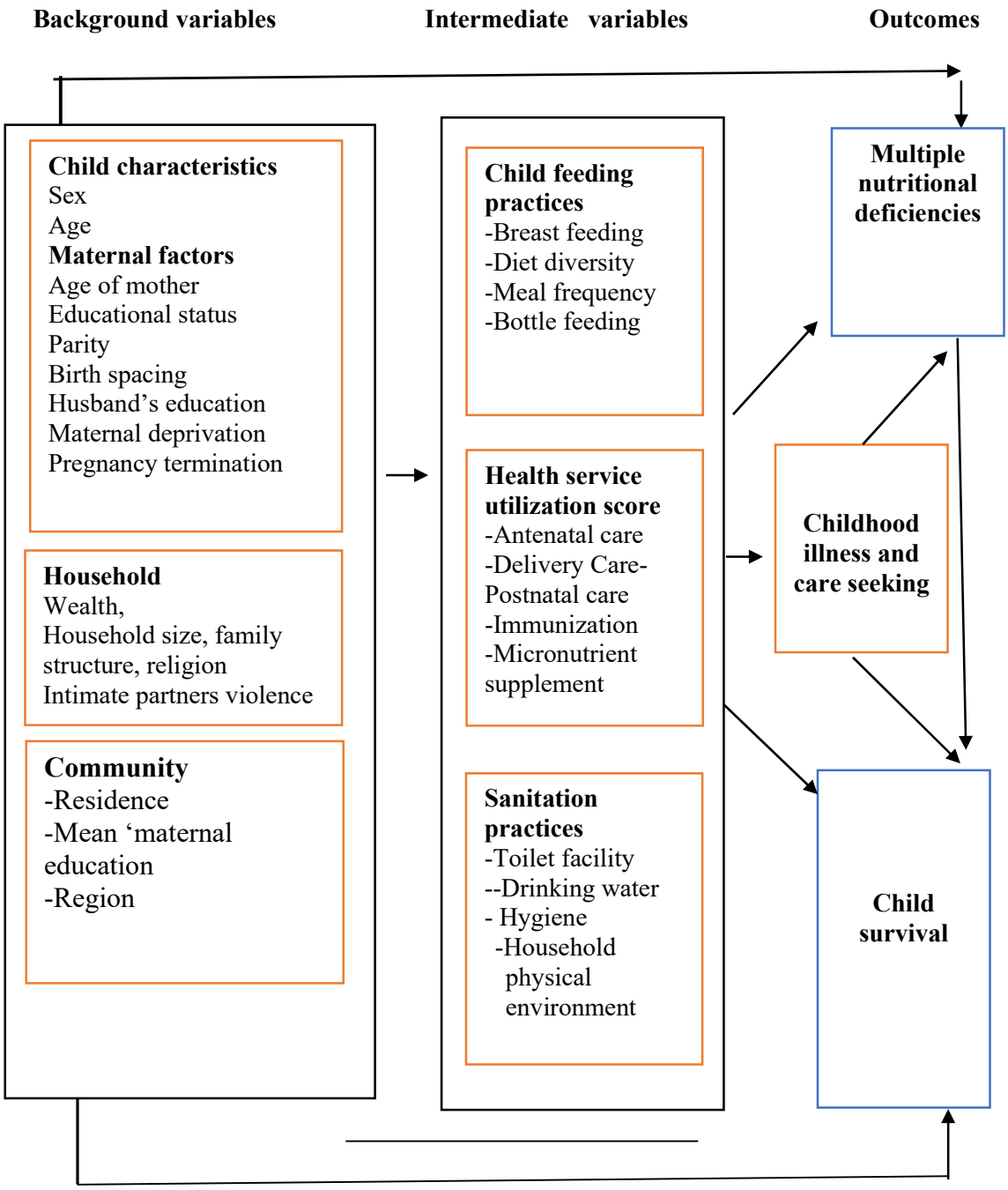
reduces infant mortality significantly. In its broader context, environmental variables including, but not limited to, climate change, the quality of water, air and other ecological factors are sometimes classified as determinants of child health[47,112].

Since the development of the Mosley and Chen's child survival model, a variety of statistical modelling strategies have become common[87]. These analytical approaches can be grouped into two types. The first one is the analysis of links between background factors (such as individual, household and community variables) and each proximate determinant (i.e., the three sets of intermediate variables in figure 2.2). The second approach entails models that incorporate an outcome variable, generally mortality/undernutrition, using both proximate determinants and background factors often implemented in a stepwise process, first including background factors, and then incorporating proximate determinants[87]. The second approach entails the importance of proximate pathways through which the background variables operate[87].

In this study, both approaches are used: analysis starts with modelling the three intermediate variables using the background variables, followed by modelling health seeking for common childhood illness and multiple nutritional deficits using both background and intermediate variables. In this study, the original Mosley and Cohen framework is modified (see Figure 2.2) to simplify the analysis based on the second approach described above.

Due to the broad scope of the subject, the analysis presented in this thesis uses only the five outcome variables (see figure 2.2), leaving child survival. A full pledged article using Mosley and Cohn's formulation of child survival is already submitted for publication using the same data set (please see the preprint form of the article here: https://assets.researchsquare.com/files/rs-43682/v1/6ff98540-47bd-4afe-8a99-1ef4d84cb578.pdf.

Figure 2.2 Conceptual framework for the study of inequalities in child health care interventions and outcomes in Ethiopia.



Source: Developed and expanded based on Mosley and Chen child survival framework (Mosley and Chen, 1984)[88]

2.5 Gaps in Research

National-level research on maternal and child health has been key to monitoring and evaluating of progress towards Sustainable development goals. There is still a wide gap in our knowledge of child health and survival, which can be bridged through research production and utilization through evidence-based policy and practice. One way to promote evidence-based policy and practice is to "map" research (identify gaps) and prioritize research needs through a review of local and international research conducted in the recent past. In the above sections, an attempt was made to provide an overview of these studies to identify the gaps to be addressed.

Research on infant feeding has recently shifted from focusing on exclusive breastfeeding in the first 6 months to more comprehensive feeding practices in the first two years [113]. The available studies on this subject, in general, focus on child diet diversity or breastfeeding and are less comprehensive in measuring child feeding as an outcome variable. In Ethiopia, no national level studies attempt to address the components of feeding children as a continuum and comprehensive measure.

Similarly, studies conducted around child health services utilization in Ethiopia addressed each component (ANC, institutional delivery, and postnatal care services) as independent entities. In practice, these services are a continuum of actions where attendance of one will affect the likelihood of adhering to the next service. As the various components of health service utilization become a continuum of interventions (i.e., starting from ANC to child immunization), addressing the determinants for single health service (such as ANC, delivery or postnatal care) does not illustrate a complete picture. For example, women who recently attended ANC at a health facility usually have about twice the odds of giving birth in the health facility and get their child immunized and receive other postnatal care services [114]. Also, while previous studies adequately addressed the effects of socioeconomic and demographic

factors on a single component of health services (such as ANC), nearly none of them have dealt with its impacts on early childhood mortality and morbidity.

Similarly, the bulk of the studies on child undernutrition followed a similar fashion, focusing on a single outcome variable (either stunting, underweight or wasting)[4]. There has been little attention given to concurrent nutritional problems[115]. Since recently, there has been a growing interest in examining the determinants clustering/occurrence of two or more nutritional deficiencies in a single individual. For instance, the prevalence of both anemia and stunting is very high in most sub-Saharan African countries. As each of anemia and stunting poses a significant challenge to the health system as well as the survival of children [116,117], their co-occurrence would be even more detrimental. However, studies on concurrent stunting and anemia(CAS) are limited despite the availability of a large body of literature on each of anemia and stunting[115].

The present study is, therefore, meant to bridge the above-mentioned gaps by introducing a comprehensive measure of childcare practices and outcomes. The reviewed studies would help in developing the conceptual framework, guide variable selection and measurements.

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CHAPTER THREE

GENERAL METHODOLOGY

3.1 The study area and population

Ethiopia is a landlocked country and geographically located in the Sub-Saharan Africa[1]. The country is largely characterized by high and ragged mountains with flat topped plateaus, deep gorges, river valleys and plains[2]. The country receives mean annual rainfall ranges between 500 and 2000mm for the highland, and between 300 and 700mm for the midland[2].

The country has an estimated population of 109 million people (the second most populous country in Africa, after Nigeria)[3], residing in nine Regional States, which are divided into zones, and then further subdivided into districts (*woredas*) and smaller (*kebeles*) administrative units [4](Figure 3.1). The majority of Ethiopians (about 85%) live in rural areas and the remaining are urban residents[5]. The population is unevenly distributed with nearly half of the population living in the highlands. The Ethiopian population is characterized by a young age structure with a median age of not more than 18 years – a feature of a rapidly growing population[5]. Adult literacy is 39 percent[6], with a gap between female literacy (29 percent) and male literacy (49 percent).

The country heavily relies on an agrarian economy. Ethiopian agricultural sector employs nearly 85% of its population[7]. About a third of the Ethiopian population still lives below the poverty line[7], more than 50% have no education and limited access to healthcare services[8]. In 2015, 57% of the population was using improved drinking water sources and 28% had improved sanitation[9]. Despite efforts to ensure universal access to healthcare [10], the country is still experiencing severe health inequalities and poor child health outcomes[4].

Figure 3.1 Administrative map of Ethiopia[11]

3.2 Data sources

For all chapters in this thesis, the Ethiopian Demographic and Health Survey (EDHS) data were used. It is a nationally representative survey conducted every five years since the year 2000, and it is carried out nationally by the Central Statistical Agency (CSA) under the guidance of the Ministry of Health (MOH)[8]. The EDHS collected data from all the nine regions and included a total of 645 enumeration areas (EAs) i.e., an EA is a geographic area consisting of 200–300 households. The sampling design for all the DHS surveys was a two-staged stratified cluster sampling[12]. The surveys followed standard and comparable questionnaires containing three main categories: 1) Household Questionnaire, 2) Women's Questionnaire, and 3) Men's Questionnaire. The samples for surveys were designed to provide population and health indicators at the national (urban and rural) and regional levels[8].

In the EDHS, mothers were interviewed. To ensure the reliability and validity of the data, all DHS data collection worldwide follows similar standard procedures. Rigorous staff training and pilot tests are conducted for each new DHS model questionnaire to ensure the quality and quantity of data to be generated[8]. There have also been several specific validation studies to measure the validity and

reliability of certain variables. For example, a recent study based on DHS data from 16 low and middle-income countries reported very high reliability of the asset-based wealth indices (Kappa >0.75)[13]. Similarly, DHS validated the variables measuring intimate partner violence across 10 countries[14]. Infant and Young Child Feeding indicators in DHS questionnaire were adequately validated by the Food and Nutrition Technical Assistance/FANTA across countries[15]. Mosley and Cohn validated the child survival variables across several developing countries[16].

This study used the children's' file containing both sociodemographic and health related variables for 10641 under-5 children for all chapters except chapter four and eight. In chapter four, the study of Infant and Young Children's' feeding practice, only children aged 6-23 months were used for the analysis. Similarly, in chapter eight (which dealt with inequalities in multiple nutritional deficits), the analysis excluded infants below six months of age since EDHS did not collect data on hemoglobin level for this age group. A total of 9218 children aged 6–59 months were extracted from the dataset for final analysis.

3.3 Measures and statistical analysis

Chapter 4: *Disparities in Infant and Young Child Feeding practices in Ethiopia:*

The chapter primarily aimed at identifying the key risk factors of poor Infant and Young Child feeding (IYCF) practices using a comprehensive outcome measure among children of age 6-23 months in Ethiopia. The IYCF was constructed based on four key indicators: breastfeeding, avoidance of bottle feeding, Diet Diversity Score (DDS), and Minimum Feeding Frequency (MFF). Each of these indicators was computed for children of 8-6 months, 9-12 months, and 12–23 months separately based on the recommendations of WHO and other previous studies [17,18]. The exposure variables were categorized into three major groups: individual characteristics (age of the child, sex of the child, parental education, work

status), household characteristics (household wealth status, access to radio, religion, type of family structure, presence of other under 5 children, children ever born) and community variables (service utilization scores and type of residence). Most of these exposure variables were used in the same way that they were originally coded in EDHS, while some of them were recorded to fit the present analysis. The details on the construction of some of these explanatory variables are given in Table 3.2 below. The hypothesized relationship between selected explanatory variables and the outcome variable was examined using proportional odds regression.

Chapter 5: *Inequalities in adherence to the continuum of child health service utilization in Ethiopia:*

Chapter 5 primarily aimed at examining the determinants and inequalities in key child health service utilization. In this chapter, four outcome variables were used. The first outcome was the child health service utilization score, which was constructed from the affirmative responses of six key child health interventions associated with the most recent birth. It included ANC service (> 4 visits), delivery of the last child at health facilities, postnatal care services, vitamin A intake, iron supplementation and intake of deworming by the index child. This outcome variable thus took a count form, which ranges from 0 to 6. It takes a value of '0' if the mothers' response to the six indicators is "no", and 6 if mothers respond 'yes' to all the six indicators. The three key health services (ANC, delivery, and postnatal care) were also used as outcome variables at the secondary analysis to assess if ANC impacts the likelihood of institutional delivery and postnatal care.

The exposure variables were categorized into three major groups: Maternal and child factors (which includes birth order, mothers' education, age, work status, mother's level of exposure to intimate partners violence, ever experienced pregnancy termination, parity, access to information/radio), household factors (which include non-monetary wealth index, religion, and type of family structure);

and community variables (residence, mean wealth at the cluster level, mean maternal education at community level). The details on the construction of some of these explanatory variables are given in Table 3.2 below. The mixed-effect Poisson regression model was employed since the response variable had a count nature with clearly right-skewed distribution.

Chapter 6: *Socioeconomic disparities in household water access, hygiene, sanitation and indoor pollution practices (WaSH+) in Ethiopia:*

This chapter focused on examining the key determinants of household WASH. Thus, the unit of analysis was the household. The outcome variable was made to commensurate with all the components of SDG 6 (ensuring hygiene and sanitation). The outcome was constructed based on the linear and combined effects of four sets of variables: Access to safe drinking water supply, toilet facilities, household pollution, and hygiene. Each item was scored as 0 or 1, with 1 representing a positive behavior. The constructed score values ranged between 1-4, which was categorized into four groups based on median values: very poor (1), poor (2), good (3) and very good (4). The exposure variables were categorized into three major groups: individual characteristics, household characteristics and community variables. The individual variables included sex of household, age of the mother, parental education, mothers' work status, radio listening and maternal autonomy. The household variables were religion, household size, household wealth and type of marital structure (polygamy vs. monogamy) and the two community-level variables are residence and region. The details on the construction of some of these explanatory variables are given in Table 3.2 below. Due to the categorical nature of the outcome variable, the hypothesized relationship with selected explanatory variables was examined using proportional odds (ordered logistic) regression.

Chapter 7: *Health Care-Seeking Behaviors for Common Childhood Morbidities in Ethiopia: The Effects of Maternal Behavior and Access to Key Health Services:*

The main objective of chapter 7 was to assess the determinants of health care seeking behaviour for the two most common childhood illnesses: diarrhea and ARI. The chapter used two dichotomous outcome variables: appropriate treatment-seeking for diarrhea and ARI, respectively. The outcome was constructed based on mothers' responses to questions on recent episodes of various forms of morbidities. Appropriate healthcare-seeking behavior was defined as situations when mothers visited any health facility/institution during episodes of childhood illnesses for diarrhea or ARI. In a follow-up question, mothers who reported the occurrence of diarrhea or ARI symptoms were asked if the child required medical attention. The outcome variable was coded as "1" if care was sought and "0" if no care was sought. For the purpose of this analysis, the explanatory variables were divided into three major categories: Predisposing factors (Sex of household head, birth order, parity, religion, paternal education, maternal education, IPV); enabling factors (wealth at the household level, work status, community-level wealth, overall community literacy and residence); need factors which include behavioral variables (utilization of ANC, delivery care, postnatal care, and immunization). The details on the construction of some of these explanatory variables are given in Table 3.2 below. Binary logistic regression analyses were then conducted to examine the association between selected explanatory variables and the two morbidity variables, adjusting for confounders.

Chapter 8: *Multiple anthropometric and nutritional deficiencies in young children in Ethiopia: Effects of maternal and childcare practices:*

This chapter used two levels of analysis. In the primary analysis, the outcome variable is nutrition deficit, which was defined as a child having one of the four most common nutritional

problems: stunting, underweight, wasting and anemia. A coding of 1 was used if a child had any of the three anthropometric deficits (stunting, underweight, wasting) or anemia and "0" if the child experienced none of the four nutritional problems. For the secondary analysis, concurrent anemia, and stunting (CAS), both of which had an unacceptably high prevalence in the population, were used as the outcome variable. For the CAS, 1 represented if a child was both anemic and stunted the same time, and 0 otherwise. Children concurrently stunted and anemic were defined as having HAZ < −2 and hemoglobin < 11 g/dL[19].

The analysis used a wide range of factors influencing multiple anthropometric deficit and CAS, which were broadly classified as maternal and child characteristics (maternal education, autonomy, maternal parity, maternal age, child's age, child's sex, child's birth order); household factors (the type of family structure, religion, household wealth); child care practices (feeding practices, child health service utilization score, hygiene and sanitation practice score); and community-level variables (mean maternal education and wealth at the cluster level, and type of residence). The details on the construction of some of these explanatory variables are given in Table 3.2 below. Mixed-effects Poisson regression (for the count outcome variable) and mixed-effect logistic regression model (for CAS) were employed to test the effect sizes of individual, household, and community factors.

For each chapter described above, the multivariate regression analysis began with checking if there was any multicollinearity between the explanatory variables using tolerance test, variance inflation factors (VIF). Using the routine Collin in Stata, a VIF >10 or mean VIF> 6 represents severe multicollinearity[21]. The purposeful selection of explanatory variables was used for model building. The approach is commonly used when the main purpose is risk factor modeling and not just prediction. In addition to significant covariates, this variable selection procedure has the capability of retaining important confounding variables, resulting potentially in a slightly richer model[22]. A P-value of ≤ 0.05

was used to ascertain statistical significance. Bivariate analyses were used to select potential explanatory variables for multivariable analysis. All predictors which statistically associated with a p-value of <0.2 at bivariate level were subsequently included in the initial multivariable regression model. For all analyses conducted in chapters 4-8, the model selection criterion was the Akaike Information Criterion (AIC), and the level of statistical error was set to be 5%[23].

All analyses were weighted according to DHS guidelines to adjust for differences in the probability of selection and interview between cases in a sample, either due to design or unequal weighting. In the DHS surveys, the sample is selected many times with unequal probability to expand the number of cases available for certain areas or subgroups for which statistics are needed[24]. Data cleaning and management were carried out using different software R-Stat (for graphs), STATA and SPSS version 20.

Table 3.1 Summary of studies in this thesis

Title of study	**Specific objectives to be addressed**	**Sample used for the analysis**	**Method & analysis**
Chapter 4: Disparities in Infant and Young Child Feeding (IYCF) practices in Ethiopia	Objective i (a)	3240 children aged 0-23 months	Descriptive and Proportional odds regression
Chapter 5: Inequalities in adherence to the continuum of child health service utilization in Ethiopia	Objective i (b)	10641 under five children	Descriptive; mixed effect Poisson regression model; mixed effect logistic regression model
Chapter 6: Socioeconomic disparities in household water access, hygiene, and sanitation in Ethiopia	Objective i(c)	10641 households	Proportional odds regression
Chapter 7: Health care seeking behaviors for common childhood morbidities in	Objective ii (a)	Diarrhea (n=1227) and ARI (n=1280)	Binary logistic regression

Ethiopia: The effects of maternal behavior and access to key health services			
Chapter 8: Multiple anthropometric and nutritional deficiencies in young children in Ethiopia: effects of maternal and childcare practices	Objective ii (b)	9218 children aged 6-59 months	Mixed effect Poisson regression and mixed-effect logistic regression models

Table 3.2 presents a description of the key outcome or explanatory variables used in the study. The list focuses on those which are constructed by combining a set of questions with binary responses (yes/ no). Most background variables (such as age, sex, birth order, etc.) are self-explanatory, and hence, are not included in the table.

Table 3.2 Description of key variables used in the study

Name of variable	**Description**	**Variable type**
Infant and Young Child feeding (IYCF)	It was constructed based on four key indicators: breastfeeding, avoidance of bottle feeding, Diet Diversity Score (DDS), and Minimum Feeding Frequency (MFF). The four indicators are binary (coded as 0 or 1) and were combined to form the IYCF for each child.	Count variables ranging 0-4
Diet Diversity Score	It was measured based on the consumption of the seven food groups (0=no, yes=1) according to the WHO's IYCF guideline. The food groups are: (i) grains, roots, and tubers; (ii) legumes and nuts; (iii) vitamin A rich fruits and vegetables; (iv) flesh foods (meat, fish, poultry and liver/organ meats); (v) eggs; (vi) dairy products (milk, yogurt, cheese); (vii) other fruits and vegetables.	Count variable ranging 0-7
Minimum meal frequency	It was defined as receiving solid, semi-solid or soft foods (but also including milk feeds for non-breastfed children) for a minimum number of times in the previous day. The scoring was done by child age and breast-feeding status since the minimum requirement varies across age.	Count
Health service utilization scores	Constructed from the affirmative responses of six key child health interventions associated with the most recent birth. It included ANC service, delivery of the last child at health facilities, postnatal care services, vitamin A intake, iron supplementation and intake of deworming by the index child.	Count variable ranging 0-6

Antenatal care/ ANC	Was coded '1' if the mother attended 4 or more visits at the health facility during her last birth, and '0' otherwise.	Binary
Institutional delivery	Was coded as '1' if the mother delivered her most recent child in health institutions or '0' otherwise.	Binary
Postnatal care	Was coded as '1' if the most recent child was taken to health facility for general checkup within the first two months of his/her birth.	Binary
WaSH+	Constructed from four binary responses; water access, type of toilet facility (improved/non improved), hygiene/ approximated by hand washing, and indoor pollution. The combined variable ranged between 0-4.	Ordinal
Health seeking behavior for Acute Respiratory Infection/ ARI and Diarrhea	ARI: Derived based on mothers' responses to questions if their child had a fever, cough, chest congestion, or short rapid breaths in the two weeks preceding the survey. Coded as 'yes' and 'No' Diarrhea: Derived based on mothers' responses to questions if their child had abnormal increase in the frequency, volume, or liquidity of stools, lasting from a few hours to several days. Coded as 'yes' and 'No' Health care seeking behavior was coded as "1" if mothers sought care during such episodes and "0" if no care was sought.	Binary
Concurrent Anemia and Stunting / CAS	Coded as '1' if an index child had both anemia and stunting, and "0" if the child experienced one or none of these two.	Binary
Intimate Partners Violence/IPV	Constructed from mother's binary response for five sets of questions about her experiences of violence by her partner (beating, insulting, causing physical assault, chasing from home, and slapping) during a reference period of 12 months.	Ordinal
Women's autonomy	Maternal autonomy was constructed from a set of dichotomous responses about mother's participation in decision making on matters pertaining to (a) the woman's health, (b) major purchases and (c) visits friends or family (mobility). Coded as '1' if the women made at least one of the three decision domains, either alone or jointly with her husband, and '0' otherwise.	Ordinal
Wealth index	Household wealth was estimated in the EDHS with ownership of household assets (such as mobile phone, radio…etc.), housing quality, and water and sanitation facilities. DHS used principal component analysis to categorize responses into quartiles. It was sorted into three categories for the purposes of analysis: poorer, middle, and richer	Ordinal
Type of family structure	Was coded as '1' if the respondent's husband has another wife (i.e. polygamy) and '2' otherwise (i.e. monogamy)	Binary
Parental education	Parental educational attainment was grouped into three categories: no education, primary and secondary or more.	Ordinal

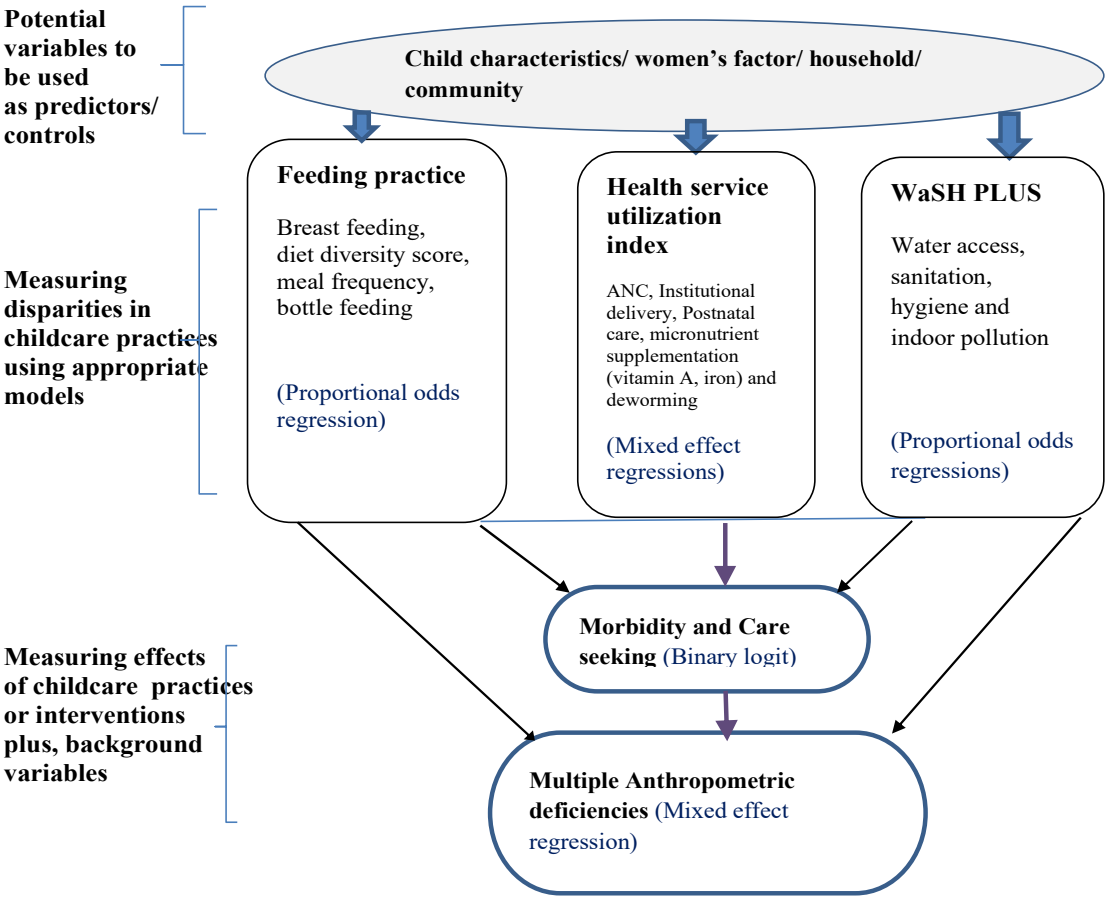
3.4 Ethical procedures and considerations

The DHS followed previously approved standard protocols, data collection tools, procedures[25]. Participation in the survey was voluntary, and permission to use the data for the purposes of the present study was granted by ORC Macro International (U.S.) and Central Statistics Authority (Ethiopia). Ethical approval was also received by the University of Saskatchewan Behavioral Research Ethics Board.

3.5 Workflow and analytical schema

The indicators analyzed under the entire thesis work fall under two categories. The first category includes major SDG health outcome variables (under-5 mortality, morbidity, and undernutrition). The second category includes childcare variables which represent three key groups of factors/interventions: child feeding index, water, sanitation and hygiene practice score and health service utilization scores (Figure. 3.2).

Figure 3.2 Workflow and analytical schema



The analysis begins with examining the three childcare practices using the socio-economic and demographic variables as possible determinants. Each of the three childcare practices contains a set of variables. However, the individual variables combined linearly to form the outcome variables, as described in chapters 4-6. The childcare practices are thought to have a direct link with child health outcomes (nutritional morbidity). Therefore, chapters 7-8 address disparity in the two health outcome variables (multiple nutritional deficiencies, and health-seeking behavior).

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CHAPTER FOUR

DISPARITIES IN INFANT AND YOUNG CHILD FEEDING PRACTICES IN ETHIOPIA

The paper is under review in BMC Archives of Public Health as; Nigatu Regassa Geda, Cindy Xin Feng, Bonnie Janzen, Rein Lepnurm, Carol J. Henry and Susan J. Whiting (2020). Disparities in infant and young child feeding practices in Ethiopia.

I contributed to the study design and conceptualization of the study, entire data analysis, data interpretation and drafted the manuscript.

4.1 Abstract

Background: Undernutrition among children is a priority area of public health concern in Ethiopia. The purpose of this study was to examine disparities in Infant and Young Child Feeding (IYCF) practices among children 6-23 months.

Method: Data were drawn from the 2016 Ethiopian Demographic and Health Surveys (EDHS). A total of 3240 children aged 6-23 months were used for the present analysis. The outcome variable was IYCF practice score (ranging 0-7), which was constructed based on the linear and combined effects of four sets of variables: breast feeding, avoidance of bottle feeding, diet diversity score and minimum meal frequency. IYCF practice score was further recoded into three categories. Proportional odds regression was used to assess the determinants of IYCF category.

Results: The proportional odds regression analysis showed that IYCF scores significantly decreased by 5% (AOR= 0.95; 95% CI: 0.935-0.972) for every unit increase in the child's age. Households with fathers of primary and secondary and above level education were 1.37 times (95% CI: 1.139-1.655) and 1.67 times (95% CI: 1.256-2.229) more likely to be in the high IYCF category than in the poor IYCF category. The likelihood of being in the high IYCF practice category decreased for non-working

mothers by 30% (AOR= 0.70; 95% CI: 0.589-0.831) compared to those working in gainful employment. The chance of being in the high IYCF practice category decreased by 29% for households with no access to radio (AOR=0.709; 95% CI: 0.588-0.854). Those with medium and rich/richer wealth category were 1.54 times (95% CI: 1.222 -1.940) and 1.40 times (95% CI: 1.111-1.752) more likely to belong to high IYCF practice category than being in poor IYCF category. For every unit increase in health service utilization, the chance of falling in higher IYCF category increases by 1.15 times (95% CI: 1.084-1.229). The chance of falling in higher IYCF practice category decreases for rural residents by 37% (AOR=0.630; 95% CI: 0.474-0.837) compared to those residing in urban areas.

Conclusion: For a child, the first two years is the time span during which linear faltering of growth is most prevalent and the period when the process of becoming stunted is almost complete. Thus, it is extremely important for health professionals, such as Health Extension Workers, to pay more attention to this critical period and implement both nutrition-sensitive and specific interventions at grassroot levels, focusing on children living in rural poorer/poorest households.

Keywords: Complementary Feeding**,** Diet Diversity, Ethiopia, Infant and Young Children Feeding

4.2 Introduction

Worldwide, undernutrition, such as stunting, wasting and micronutrient deficiencies, is responsible for the death of 3.1 million children under-5 annually[1]. About 28 % of children under the age of 5 years are stunted in low- and middle-income countries[2], and sub-Saharan Africa is experiencing the highest prevalence (40 %) of stunting[2]. The risk of undernutrition increases as the age of the child increases, especially during 3 to 24 months of age, and remaining reasonably stable after that[3]. Evidence suggests that suboptimal child feeding practices are the main culprit and one of the leading causes of child undernutrition during this period[2].

The World Health Organization/WHO recommended exclusively breastfeeding up to 6 months after birth, along with continued breastfeeding up to 2 years or beyond[4]. For proper growth of children, a set of core indicators of good IYCF practices are recommended during the first 24 months of life[4,5]. The core indicators include the introduction of complementary foods at 6–8 months), minimum dietary diversity, and minimum meal frequency. Appropriate complementary feeding of children has been promoted as one of the strategies to combat growth faltering and associated ill-health consequences in young children[1,6]. Despite increased efforts, many low- and middle-income countries do not adhere to this[2,6]. For instance, only one in three or one in six 6–23-month-old children in sub-Saharan Africa were fed adequately diverse or overall acceptable diets, respectively[7]. Generally, suboptimal feedings are practiced in countries having the highest burden of malnutrition [8,9].

In Ethiopia, efforts are being made in implementing a multi-sectoral plan of nutrition intervention (as prescribed in *Sekota* Declaration and National Nutrition Program) to end the high burden of undernutrition in Ethiopia by 2030 [10]. However, the country is still experiencing one of the worst scenarios in IYCF practices. The most recent national survey indicates that nearly half of all infants <6 months of age were not exclusively breastfed. More than one in four infants still received pre-

lacteal feeds that may predispose the child for infectious diseases and risk of diarrhea[11]. In addition, one in two children was not put to breast within one hour after birth. Only 42% of children receive the minimum number of meals, less than 10% of children <24 months achieve minimum dietary diversity (i.e consumption of at least 4 food groups), and only 6% meet the criteria for the minimum acceptable diet[11]. Studies conducted in different parts of the country also confirmed that the majority of children in the 6-23 month age group were improperly fed (i.e., not exclusively breastfed used pre-lacteal food, were bottle fed, and had inadequate intake of micronutrients) [12],[13]. While poverty is the underline cause, the very poor IYCF practices are direct contributors of the unacceptably higher levels of anthropometric and micronutrient deficiencies among children in Ethiopia[1415] in the year 2016, which were, for underweight, stunting and anemia among children under 5 years, 25.0%, 38% and 57%%, respectively[11].

Studies conducted on this subject in Ethiopia attempted to examine the association between socioeconomic factors and infant and child feeding practices. However, these studies had some limitations worth adressing[12]. First, most of these studies were based on a single child feeding indicator, usually diet diversity score [12,16–18]. This approach reduces the possibility of obtaining a complete picture of IYCF practices in Ethiopia. Second, almost all studies conducted were based on data collected at district or sub-district levels, limiting their generalizability to a larger population. Third, although the application of this outcome measure is not new, its application in a national context (Ethiopia) using robust statistical tools would increase the proper identification of risk factors to enhance our understanding of under and malnutrition of children in Ethiopia.

The present study aims to identify the key risk factors of poor IYCF practices using a comprehensive outcome measure among children age 6-23 months in Ethiopia based on nationally representative data. It is hypothesized that IYCF practice is a function of household attributes.

4.3 Methods and materials

4.3.1 The study context

Ethiopia has a federal system with nine autonomous Regional States, each divided into zones, districts and sub-districts/ kebeles [19]. Fueled by a high level of the fertility rate, the country is amongst the fastest growing non-oil economies in the world [20]. In 2016, the average life expectancy in Ethiopia was 64 years, and under-5 mortality was 62 per 1000 births. Between 1990 and 2017, Ethiopia's life expectancy at birth increased by 18.8 years [22]. Adult literacy is one of the lowest in Sub Saharan Africa, which is 39 percent[21]. In 2015, 57 percent of the population were using improved drinking water sources, and in the same year, sanitation coverage was 28 percent[23].

4.3.2 Data sources

The EDHS is a series of cross-sectional surveys conducted every five years since the year 2000. The survey employed a two-stage stratified cluster sampling. The EDHS collected data from all the nine regions and included a total of 645 enumeration areas (EAs) i.e., an EA is a geographic area consisting of 200–300 households[11]. For the current work, the children's' file, which contained entries for 3240 cases was used. Information about child feeding practices was collected from all women who had at least one child living with them and who was born two-years preceding the survey. The EDHS followed previously approved standard protocols, data collection tools and procedures, and participation in the survey was voluntary[24]. More detailed descriptions of the sampling, data collection procedures and detailed set of questionnaires are found at https://dhsprogram.com/publications/publication-fr328-dhs-final-reports.cfm.

Permission to use the data for the purposes of the present study was granted by ORC Macro International (U.S.) and Central Statistics Authority (Ethiopia). Ethical approval was also received by the University of Saskatchewan Behavioral Research Ethics Board.

4.3.3 Measure of the outcome and exposure variables

The outcome variable is the Infant and Young Child feeding (IYCF) score. It was constructed based on four key indicators: breastfeeding, avoidance of bottle feeding, Diet Diversity Score (DDS), and Minimum Feeding Frequency (MFF). Each of these indicators was computed separately for children of 6-8 months, 9-12 months and 12–23 months, based on the recommendations of WHO and previous studies[5,25]. Mothers were asked if they were breastfeeding their child during the survey period, if they use bottle feeding, the number of times they feed their index child, and food groups consumed.

For breastfeeding, a score of +2 was given to children 6-8 and 9-11 months, and +1 was given for children aged 12-23-month-old infants who were breastfed. A score of 0 was given to non-breastfeeding infants of all ages. Diet diversity score was measured based on the consumption of the seven food groups (0=no, yes=1) according to the WHO's IYCF guidelines [5,26]. The food groups are: (i) grains, roots, and tubers; (ii) legumes and nuts; (iii) vitamin A rich fruits and vegetables; (iv) flesh foods (meat, fish, poultry and liver/organ meats); (v) eggs; (vi) dairy products (milk, yogurt, cheese); (vii) other fruits and vegetables. [5,26]. The DDS value was obtained by summing up the dietary diversity score, which ranges from zero to seven, where a higher score indicates better diet diversity.

Minimum meal frequency was defined as receiving solid, semi-solid or soft foods for a minimum number of times in the previous day. The scoring of the meal frequency varied by child age and breast-feeding status[26,27]. For 6-8-month-old infants, feeding frequency was used to account for the times for complementary foods, excluding breastfeeding and formula-feeding. Scores of +1 and +2 were given for infants who met the lower end of the recommendation and those who meet or exceed the higher end, respectively [27]. For infants 6-8 months, those with 0-1-time complimentary food consumption was given a score of 0, 2 times a day received a score of +1 and 3 times or more +2. For 9-11 and 12-23 months, a score of 0 was given for those who were fed 0-2 times, +1 was given for 3 times

and +2 for those with 4 or more times fed. The index was calculated by adding up the scores. For each age category, the combined score ranged between 0-6.

Avoidance of bottle feeding was included as an indicator in this study as desirable feeding practices. Bottle-feeding is usually considered as unfavorable practice as improper sanitation and formula preparation with bottle feeding can introduce microorganisms to the infant that increase the child's risk of illness and malnutrition[28]. This indicator takes a value of +1 if mothers did not use bottle feeding and '0' otherwise.

The index was divided into three categories based on median values: a score of 0–2 was considered low, 3–4 as medium and 4+ as high. Nearly similar procedures of categorization were used in other similar studies[25]. The variables and scoring system used are shown in Table 4.1. Higher categories indicate more favorable feeding practices.

Table 4.1: Variables and scoring system used to construct the IYCF Score

Variable	**IYCF Scoring**		
	6-8 months	**9-11 months**	**12-23 months**
Breast feeding	Yes=2 No=0	Yes=2 No=0	Yes=1 No=0
Bottle feeding	Yes=0 No=1	Yes=0 No=1	Yes=0 No=1
Diet Diversity	0–1=0 2=1 3+= 2	0–2=0 3=1 4+=2	0–2=0 3=1 4 +=2
Feeding frequency	0–1=0 2=1 3+=2	0–2=0 3=1 4+=2	0–2=0 3=1 4=2 5+=3
Total score	**7**	**7**	**7**

The choice of potential factors associated with IYCF practices was guided by the literature review and available information on variables collected by EDHS questionnaires. The exposure variables were categorized into three major groups: individual characteristics (age of the child, sex of the

child, parental education, work status), household characteristics (household wealth status, access to radio, religion, type of family structure, presence of other children under 5, children ever born) and community variables (service utilization scores and type of residence). Most of these exposure variables were used as originally coded in EDHS, while some of them were recorded to fit the present analysis. Household wealth was used as a proxy to household income and was estimated in the EDHS with ownership of household assets[24]. The service utilization score was constructed from the affirmative responses of six key child health interventions associated with the most recent birth. It included ANC service (> 4 visits), delivery of the last child at health facilities, postnatal care services, vitamin A intake, iron supplementation and intake of deworming by the index child. This variable was a count ranging from 0 to 6.

4.3.4 Statistical Analysis

The distribution of various sociodemographic variables was described using frequencies and proportions. Due to the categorical nature of the outcome variable, the analysis started by checking the proportional odds regression assumption using a score test[29] to determine if the proportional odds model is appropriate in this analysis. The null hypothesis of the score test is the proportional odds assumption is met and the alternative hypothesis is the proportional odds assumption is violated. As the p-value of the score test is p-value>0.05, the proportional odds assumption is not violated, so the proportional odds regression model is appropriate in the present study. Correlations among the explanatory variables were checked using the Variance Inflation Factor (VIF)[29]. The bivariate proportional odds regression was conducted to select the most promising explanatory variables for multivariable proportional odds regression. Variables with a p-value<0.20 in the bivariate analysis were selected for entering the initial multivariable proportional odds. Akaike Information Criteria (AIC) was used to select the final model.

Two-way interactions were assessed for some significant variables. Odds ratios with 95% confidence intervals were calculated for each factor in the ordered logistic regression model.

All analyses were weighted using the weight variable computed by the Central Statistics Authority of Ethiopia [11]. Analysis of the data was carried out using STATA version 13 [31].

4.4 Results

Table 4.2 displays study participant characteristics (n=3240). About 88% of the respondents were residing in rural areas. The proportion of female children was slightly higher (52%). Just over 60% of mothers (61%) had no education, 30.3% and 8.5% reported primary and post-secondary education, respectively. Among fathers, 38.9% and 13.4% had a primary and secondary level of education, respectively. In 60% of the households, respondents reported the presence of other under-5 children. Only about a quarter of the mothers were working outside their home during the survey period. Close to 72% of the households did not have access to media (radio). Most of the respondents had a Muslim religious background (41%) followed by Orthodox Christians (35%). Half of the respondents reported having 0-3 children ever born. Those with children ever born of 4-6 and 7+ were 30.8% and 19.2%, respectively. A greater proportion (44.2%) of the households were in the poorest/poorer households compared to those living in richest/richer households (34.1%) (see Table 4.2). Close to 10% of the respondents were living in polygamous households (see Table 4.2).

Table 4.3 presents the results of ordered logistic regression for key determinants of IYCF. We started the regression analysis by testing the proportional odds assumption using the Score test, and the result confirmed parallel line assumptions were met. Thus, the ordered logistic regression was fitted. Multicollinearity analysis among the explanatory variables indicates that none of them had a significant relationship. The scatterplot between the dependent and continuous independent variables confirmed linearity assumptions are met.

Table 4.2. Results of bivariate proportional odds regression for predictors of Infant and Young Child Feeding practices, Ethiopia, n=3240.

			95% C.I. for OR		
Characteristics	**N (%)**	**OR**	**Lower**	**Upper**	**p-values**
Sex of the child					
Male	1556(48.0)				
Female	1684(52.0)	0.920	0.760	1.115	0.397
Age of the child	14(8) *	0.917	0.907	0.927	0.000
Education of mother					
No education	1981(61.1)				
Primary level	983(30.3)	1.798	1.435	2.253	0.000
Secondary and above	276(8.5)	4.241	3.290	5.465	0.000
Education of father					
No education	1547(47.7)				
Primary	1260(38.9)	1.911	1.510	2.417	0.000
Secondary and higher	433(13.4)	3.698	2.900	4.716	0.000
Presence of other under-5 children					
No	1301(40.1)				
Yes	1940(59.9)	0.670	0.553	0.813	0.000
Mother's Work status					
Working	870(26.8)				
Not working	2371(73.2)	0.539	0.441	0.659	0.000
Children ever born					
0-3	1621(50.0)				
4-6	997(30.8)	0.683	0.547	0.854	0.001
7 and above	622(19.2)	0.560	0.418	0.751	0.000
Access to radio					
Yes	919(28.3)				
No	2322(71.7)	0.386	0.316	0.472	0.000
Religion					
Orthodox	1129(34.8)				
Muslim	1315(40.6)	0.740	0.597	0.917	0.006
Others	797(24.6)	0.688	0.522	0.908	0.008
Type of family structure					
Monogamy	2756(85.1)				
Polygamy	319(9.8)	0.821	0.604	1.117	0.209
Health service utilization score	1(3) *	1.369	1.281	1.463	0.000
Wealth index					
Poor/ poorer	1432(44.2)				
Medium	705(21.7)	2.206	1.637	2.972	0.000
Rich/ richer	1104(34.1)	3.854	3.086	4.814	0.000
Place of residence					
Urban	395(12.2)				
Rural	2845(87.8)	0.288	0.235	0.354	0.000

*Median and IQR values

The significant individual-level variables were the age of the child, maternal and paternal education, and maternal work status. The IYCF score significantly decreases by 5% (AOR= 0.95; 95% CI: 0.935-0.972) for every unit increase in the child's age. Children with fathers of primary and secondary and above education were 1.37 times (95% CI: 1.139-1.655) and 1.67 times (95% CI: 1.256-2.229), more likely to belong in higher IYCF score category than being in the poor category. The likelihood of falling in higher IYCF practice decreases for children from non-working mothers by 30% (AOR= 0.70; 95% CI: 0.589-0.831) compared to those working in gainful employment.

Among the household variables, access to radio, religion and household wealth were significantly associated with IYCF practices. The chance of falling in higher IYCF practice decreases by 29% for households with no access to the radio (AOR=.709; 95% CI: 0.588-0.854). Children living with parents of 'other religion' followers were 21% less likely to belong to higher feeding categories (AOR=0.785; 95% CI:0.626-0.985) compared to those from parents of Orthodox Christian followers. Those from medium and rich/richer wealth households were 1.54 times (95% CI: 1.222 -1.940) and 1.40 times (95% CI: 1.111-1.752) more likely to belong to better IYCF practice category than being in poor IYCF category, respectively.

The two community and service-related variables (residence and health service utilization scores) have become significantly associated with IYCF practice. For every unit increase in health service utilization, the chance of a child falling in a higher IYCF category increases by 1.15 times (95% CI: 1.084-1.229). The chance of falling in higher IYCF practice category decreases for rural children by 37% (AOR=0.630;95% CI: 0.474-0.837) compared to those residing in urban areas.

Table 4. 3. Results of multivariable proportional odds regression for predictors of Infant and Young Child Feeding practices, Ethiopia.

		95% C.I. for AOR		
Characteristics	**AOR**	**Lower**	**Upper**	**p-values**
Age of the child	0.953	0.935	0.972	0.000
Education of woman				
No education				
Primary level	1.112	0.908	1.360	0.304
Secondary and above	1.347	0.992	1.829	0.056
Education of husband				
No education				
Primary	1.373	1.139	1.655	0.001
Secondary and higher	1.673	1.256	2.229	0.000
Presence of other under-5 children				
No				
Yes	0.892	0.756	1.054	0.180
Mother's Work status				
Working				
Not working	0.699	0.589	0.831	0.000
Children ever born				
0-3				
4-6	0.997	0.826	1.204	0.976
7 and above	0.977	0.773	1.234	0.847
Access to radio				
Yes				
No	0.709	0.588	0.854	0.000
Religion				
Orthodox				
Muslim	1.136	0.907	1.423	0.267
Others	0.785	0.626	0.985	0.036
Health service utilization score	1.154	1.084	1.229	0.000
Wealth index				
Poor/ poorer				
Medium	1.540	1.222	1.940	0.000
Rich/ richer	1.396	1.111	1.752	0.004
Place of residence				
Urban				
Rural	0.630	0.474	0.837	0.001
Cons	0.429	0.256	0.719	0.001

4.5 Discussion

This study has primarily aimed at assessing the factors associated with IYCF practices based on the most recent nationally representative data of Ethiopia. The study used a comprehensive measure of IYCF practices among children 6-23 months. The results of our study provide several noteworthy findings regarding the predictors of infant and young children's feeding practices in Ethiopia. The regression analysis revealed a range of individual, household, and community variables affecting IYCF. Age of the child, paternal education, maternal work status, and children ever born by mothers were the individual-level variables strongly associated with IYCF practices. Among the household-level variables, household wealth, access to radio and religion significantly predicted IYCF practices. Health service utilization and type of residence were important service-related and community-level predictors of IYCF practices in Ethiopia.

About 80% of the children aged 6-23 months in Ethiopia were found to have a very poor or poorer IYCF score (i.e., score less than 4 out of 7 possible scores). There are no comparable national-level studies conducted in Ethiopia using the same outcome measure; however, the finding is consistent with local studies in Ethiopia which reported unacceptably low prevalence for nearly all indicators. For instance, a study conducted in Southern Ethiopia documented that only 50.9% of mothers introduced timely complementary feeding at 6 months, 22.2% achieved minimum dietary diversity, only 12% of them received the minimum acceptable diet;39.8% of mothers fed their children using bottle[13]. The figure in this study is much lower than reported in other studies in Africa and Asia. For example, in Zambia, the proportion of children aged 6–23 months given more than four food groups in a day was 37.1%[8], 29.5% in Uganda and 16% in India[9].

An inverse association was found between the age of the child and IYCF practice i.e., the likelihood of a child falling in higher IYCF practice decreases with the age of the child. One possible

reason for the inverse association could be reduced attention as the child grows, possible poor intrahousehold food distribution, early cessation of breastfeeding and resource limitations. Accordingly, stunting is less common in early infancy as most children are being breastfed[33,34]. The risk of impaired growth increases as breastfeeding is discontinued without adequate complementary feeding and with poor diet diversity [33]. However, it is important to note that studies around the world have reached inconsistent conclusions. For instance, a reverse trend was observed in Sierra Leone and Uganda[32]. Other studies also reached a similar conclusion [33,34], while a few others reported a positive relationship between the age of children and IYCF practice[16]. Such inconsistent findings could arise from differences in data collection periods as affected by the seasonality of production and consumption.

The findings indicated that paternal education had a stronger and significant association with IYCF practices. Some studies around the world have reported that educated fathers are more involved with issues of diet/ nutrition and parenting behaviors, which contribute to the overall health and well-being of their young children [35,36]. Additionally, educated fathers provide a higher household income, more freedom and supports, higher social status and stability, and more opportunities for their wives and children[3738]. Allen and Daly [38] summarized studies conducted on the subject and concluded that children of involved fathers are more likely to demonstrate a greater cognitive competency at 6 months of age, tolerance for stress and frustration, better able to handle strange situations, self-acceptance, and personal and social adjustment. The same study reported that when mothers are supportive of their spouse's parenting (provide encouragement, expect and believe parenting is a joint venture), fathers would be more likely to be involved with and responsible for their children[38]. Fathers' education could also result in greater maternal autonomy[39], which in turn positively affects gender roles and good intra-household food distribution, impacting the nutrition of both women and young children [40].

Unlike most previous studies, maternal education did not have a significant association with IYCF. This could be due to little variations in the distribution of maternal education in the sample population (i.e., about two-third of mothers had no education). The inclusion of variables on media exposure could also significantly reduced the magnitude and statistical significance of the maternal education variable [9]. This suggests that maternal literacy and exposure to media could be strong mediators of the link between maternal education and feeding practices and child nutrition outcomes [9]

In the present study, a reverse association was found that non-working mothers were less likely to fall in higher IYCF practice categories than working mothers. Previous national level studies conducted around the world reached inconsistent conclusions. In a study of IYCF practices in Sub Saharan African countries, six of the ten countries demonstrated positive odds ratios (AOR = 1.04–1.29) in the relationship between economic empowerment(work status was a component) and the probability of meeting the minimum meal frequency criterion[32]. A study in the Philippines found that maternal contribution to household income and her control over such income were significantly associated with increased weekly household food expenditure after controlling for potential confounders[41]. Women's employment passes through different pathways to influence good feeding practices. The most prominent pathways could be the fact that working outside home provide women their freedom of mobility, wider social networks, growing understanding of their social environment and decision-making ability regarding interpersonal or family affairs[14,32]. This will, in turn, enhances the ability of mothers to acquire resources, such as information and support from friends and relatives.[42]. Higher economic empowerment of women through employment is expected to be associated with increased financial access to foods and increased food distribution to children [41]. Contrary to this finding, a national level study conducted in Madagascar reported that infants whose mothers did not work outside the home were more likely to have better food consumption practices[43]. The Madagascar study and other scholars argue that working

mothers may have less time available for child care and feeding [44–46]. The benefit of increased income and control over income and the cost of reduced time is often recognized as a trade-off between maternal employment and child care [32]. The employment of mothers may reduce the time for breastfeeding of younger infants, but this could be advantageous to older children since they will have access to better nutritional status compared with their counterparts of unemployed or less financially autonomous mothers[32,47].

Access to media, either printed or non-printed, is usually mentioned in previous studies as a key determinant of behavioral change which positively influences household nutrition and food consumptions[9,48]. Given two-thirds of the respondents had no education, the present study solely focused on the effects of exposure to radio on IYCF practices in Ethiopia. Interestingly, we found that households with no access to radio had a significantly lower chance of practicing good IYCF compared to those having some exposure to radio. The finding is comparable with a nationwide study in India [9], which reported that mothers who were less exposed to media had less knowledge of nutrition. In another study, infants born to mothers who do not read newspapers at all were less likely to obtain iron-rich foods [43]. In a study conducted in Southern Ethiopia, children were found to have higher dietary diversity score in situations where mothers had received IYCF information on mass media in the last month[48]. The finding clearly implies that local authorities could make use media as cost-effective strategies to reach mothers with no education so that they can bring about behavioral change on matters related to acceptable feeding practice and the overall health of their children and themselves.

The findings of a significant reverse association between household wealth and IYCF practices is consistent with previous studies conducted in different parts of the world. Cross country studies confirmed that increased family wealth was associated with better chances of meeting minimum dietary

diversity[4950]. Higher household wealth generally means higher purchasing power and having access to more diverse food and more resources to be allocated to childcare and nutrition [43].

The effects of religion on IYCF practice is another noteworthy finding in this study. Ethiopia is a home of diverse cultures and religions which dictates different food habits and practices [16], and the impacts of religion on IYCF could vary across different settings. A recent study conducted in three countries (Uganda, South Africa, and Burkina Faso) showed a strong relationship between infant feeding practice and religious beliefs [51]. One of the most plausible pathways for religion to influence IYCF practices is through its imposition of health beliefs and food taboos[52]. From a study conducted in Tajikistan, it was reported that religion and culture dictated food taboos restricted consumption of key staple foods and nutrient-rich fruits and vegetables for members of Tajik household[52].

Another remarkable finding of the present study is the significant positive association between health service utilization and IYCF practice scores. This is consistent with previous studies conducted in Ethiopia, which reported that health service utilization by households had a significant positive association with the timely initiation of complementary feeding [17,18]. A study based on national data of Nepal indicated that child feeding was higher among women who had four or more ANC visits and who delivered their child in the health facilities [53]. Another Nepalese study confirmed that antenatal visits, institutional delivery, and postnatal visits have significantly positive impacts on child feeding practices, especially the initiation of breast feeding and complementary feeding for children in 6-8 months. It is well documented that adequate antenatal visits during pregnancy provide an exceptional opportunity for mothers to have counseling on breastfeeding practices [53,54]. In fact, the effects could vary from one service type to another. For example, recent findings in the Oromia region of Ethiopia found to have a statistically significant association between facility types visited and feeding practice where those who received health information from health posts had better dietary diversity (minimum dietary diversity)

for their children compare[12]. The findings suggest that increased promotion of childbirth at health facility and education about child feeding at the facility level is one of the most promising strategies to improve the overall IYCF practices in low-income countries like Ethiopia.

Finally, the present study found that IYCF was significantly affected by the type of residence. Those residing in rural areas had a lower chance of falling in higher IYCF practice categories compared to those living in urban areas. Consistent with this finding, Haina and colleagues[43] reported that children living in rural areas had higher odds of having inadequate consumption of iron-rich food [43]. Within the rural residence, there could also be variations in IYCF practice based on agroecological zones, food productions or feeding cultures. A recent study based on data collected from rural zones of Ethiopia reported a considerable proportion of children in the lowland fed on colostrum and had adequate dietary diversity compared to the midland agro-ecological zone, whereas the midland zones had significantly higher practices of minimum meal frequency[13]. Tasew and colleagues(2019), based on the same data set, found a statistically significant association between lifestyle and feeding a minimum acceptable diet in Ethiopia children from city dwellers and agrarian dominant had more odds to be fed a minimum acceptable diet than children from pastoralist dominant region [16].

Strengths and limitations

Given the very high prevalence of stunting and micronutrient deficiencies among Ethiopian children, which in most part occurred due to poor IYCF practices, the findings could prove useful on a national scale for the planning, targeting, monitoring and evaluating of future nutrition sensitive and specific programs. As this study is the first of its kind in Ethiopia using a comprehensive IYCF outcome variable, its contribution to literature in the subject and program implementation is great. The study also has some methodological limitations worth mentioning. First, the EDHS survey employed a cross-sectional design, where data on the exposure and outcomes were collected at the same point in time.

This limits the assessment of the cause-effect relationship between the explanatory and outcome variables. Longitudinal data collection is needed to better track child IYCF practices from birth to 24 months to examine its causal factors. Second, there are possibilities of omission, under-reporting, or improper reporting of important information as the majority of the respondents had no education. Finally, the outcome variable for the present study was a score variable constructed based on specific WHO recommended indicators. The construction of the index implies equal weights to the components, whereas it is possible some components might be more important than others.

4.6 Conclusion

Despite some improvements in some IYCF indicators over the last few years in Ethiopia, the prevalence of both individual indicators and the combined IYCF practices are unacceptable low among a significant proportion of households in Ethiopia. The study further reiterated that several individual, household and community-level characteristics are associated with inappropriate feeding practices in Ethiopia. Given that the first two years is the time span during which faltering growth is most prevalent and the period when the process of becoming stunted almost completes, it is extremely important for a health professional, especially to pay more attention to this critical period and implement both sensitive and specific nutrition interventions that aim to avert faltering of growth and associated consequences in young children. Improving access to women for gainful employment, community-level nutrition literacy programs, provision of economic support to poor rural women, education and promotion of nutrition messages at maternal and child health facilities and increasing access to a healthy diet are some the measures local authorities should focus on.

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CHAPTER FIVE

INEQUALITIES IN ADHERENCE TO THE CONTINUUM OF CHILD HEALTH SERVICE UTILIZATION IN ETHIOPIA

5.1 Abstract

Background: In developing countries such as Ethiopia, pre and postnatal healthcare service utilization are important investments to curb childhood morbidity and mortality. Despite progress made to improve access to child health services, mothers' consistent utilization of these services has been constrained by several factors. This study is aimed at assessing the inequalities in key child health service utilization, and assess the role of ANC on subsequent service use.

Method: The analysis of the present study was based on the Ethiopian Demographic and Health Surveys (EDHS) conducted in 2016 on a nationally representative sample of 10641children. A health service utilization score was constructed from the affirmative responses of six key child health interventions associated with the most recent birth: Antenatal care/ANC service, delivery of the last child at health facilities, postnatal care services, vitamin A intake, iron supplementation and intake of deworming pills by the index child. A mixed effect Poisson regression model was used to examine the predictors of health service utilization, and three separate mixed effect logistic regression models for assessing the role of Antenatal care (ANC) for continued use of delivery and postnatal care services. Lorenz curve was used to portray inequalities in service utilization score.

Results: The results of Poisson regression showed that **t**he expected mean of health service utilization decreased by 25% for children of non-first birth order (RR=0.753, 95%CI:0.714-.0793), 7.8% for children from a polygamous family (RR=0.922, 95%CI:0.861-0.987), 18.8% for children from non-working mothers (RR=0.818, 95%CI:0.782-0.855) and 14.5% for those living in households with no access to radio (RR= .855, 95%CI:0.815-0.897). The expected mean of service utilization was higher for children from older mothers, mothers with at least primary education (RR=1.216, 95%CI:1.131-1.307),

mothers who had previous experience of terminated pregnancy (RR=1.126,95%CI:1.051-1.207), and for those residing in more affluent households and communities (RR= 1.428, 95% CI: 1.324 -1.540). The results of the mixed-effect logistic regression analysis showed that the odds of postnatal care service utilization were 1.49 times and 9.25 times greater for those who attended ANC and delivered their most recent baby in health institutions.

Conclusion: The study suggests that significant improvement in the prevalence of ANC would help to increase overall score in the use of health services for children. Given the high morbidity and mortality rates of children in Ethiopia, regional and local leaders should strengthen access to health information and facilities, improving education and empowerment for women in order to increase their influence in their households and communities.

Key words: Antenatal care, delivery care, postnatal care, service utilization, micronutrient supplementation, Ethiopia.

5.2 Introduction

Health services such as skilled attendance during pregnancy, institutional delivery, early post-natal checkup, and micronutrient supplementations are the most appropriate interventions in ensuring child health and survival and for attaining the Sustainable Development Goals/SDGs [1].

Antenatal care (ANC), when performed from the early stages of pregnancy, promotes regular check-ups for the health of the pregnant woman and the baby[2]. The World Health Organization/WHO[2,3] recommends that a good quality of care is four visits for normal pregnancies, and should include education, counseling, screening and treatment to monitor and promote the well-being of the mother and the fetus. Despite significant increases in ANC, the proportion of deliveries attended by skilled health personnel is still low in Sub-Saharan Africa and Southern Asia, the regions experiencing the highest numbers of maternal and child deaths[4]. Recent studies in some developing countries reported that women's uptake of ANC by a health professional reduces dropout from maternal and child healthcare services[2,5,6] . Women who have adequate ANC visits during their pregnancy are more likely to visit health facilities for child health services such as vaccinations and nutritional supplements(iron pills and vitamin A) [7,8]. Studies in the developing world have documented that proper utilization of the pre and post-delivery services significantly decreases infant mortality [9–12]. However, consistently deciding to seek care is usually constrained by a wide range of socio-cultural and demographic factors[13].

In Ethiopia, the prevalence of all the key components of health service utilization has been very low for every standard. For example, the last four Ethiopian Demographic and Health Surveys/ EDHS indicated a gradual improvement in the proportion of mothers visiting ANC at least once before delivery, from 27% in 2000 to 63% in 2016 [14,15]. However, only a quarter of births in Ethiopia were delivered with the assistance of skilled birth attendants[15]. In Ethiopia, antenatal and delivery care utilization are not only beneficial in terms of avoiding adverse outcomes for pregnancy or

complications, but they are also important entry point for delivery of the Essential Nutrition Actions (ENA) message[16]. Other preventive health services, such as supplementation of vitamin A, iron, deworming, and immunization to children, also remained very low. For example, less than 10% of Ethiopian children aged 6-59 months received an iron supplement and deworming pills [15].

Previous studies in Ethiopia identified a range of variables affecting decisions to use the aforementioned child health services[10–12,17]. These studies reported that residing in rural areas, having no education, being in lower wealth groups, being older, and having a higher parity were important predictors of ANC, delivery, and/or postnatal care services. However, most of these studies based their findings on a small area or a small sample, and they dealt with only a few components of child health services. In practice, any one of these services is a continuum of actions where attendance of one will affect the likelihood of adhering to the next service types. To the best of our knowledge, no study has attempted to use a more comprehensive measure of health service utilization constructed based on a complete continuum of child health care through the pre and postnatal periods.

The current study, thus, primarily aimed to assess the socioeconomic disparities in the use of children's health services in Ethiopia based on a composite outcome measure. For economically poor countries like Ethiopia, where women have low literacy and little access to services, it is very important to understand how receipt of ANC relates to subsequent vital health services along the continuum of care. Thus, a secondary level analysis will address the association between ANC and uptake of the next two key health service utilizations (delivery and postnatal care) among Ethiopian women.

5.3. Methods and materials

5.3.1 The study context

Ethiopia is the second-most populous nation in Africa with an estimated population of 109 million people[18]. Children (0-14 years) account for about 40% of the total population of the country [19]. Administratively, the country is divided into nine regions and two autonomous cities. The country has an agrarian economy, where agriculture accounts for more than 60% of the GDP and employs nearly 85% of the population[16]. According to World Bank estimates, the Ethiopian economy was the third-fastest growing among those having 10 million or more population in the world (for the period 2000 to 2018), as measured by GDP per capita[20]. However, nearly a third of its population still lives below the poverty line and two-thirds have no education and limited access to healthcare services [21]. Despite remarkable improvements in child survival rates, both infant and child mortality rates are one of the highest in Sub Saharan African countries[15].

Ethiopian national health policy emphasizes health care decentralization and prioritization of health promotion, disease prevention and basic curative services[22]. At the micro-level, the Essential Health Service Package (EHSP) has been used to guide service provision with a clear stratification of service delivery and financial arrangements[22]. The Ethiopian health system is a four-tier healthcare system, which is organized into Primary Health Care Units (PHCUs), District Hospitals, General Hospitals and Specialized Hospitals[23,24]. Under each PHCU, there are five satellite Health Posts, each post serving approximately 5,000 people. The PHC provides essential healthcare usually free for people living in rural areas [23,24]. Health Extension Workers (HEW), deployed to each health post, are mandated to provide antenatal care, administer vaccines, conduct normal and safe deliveries, conduct monitoring of growth, provide nutrition counselling, offer family planning services, and organize referrals for services, hygiene and environmental sanitation, and health education and Communication[23,24].

5.3.2 Data sources

The EDHS of 2016 collected health related information from women of reproductive ages 15-49 [15]. It is a cross-sectional household survey which employed a stratified two-stage cluster sample design. For the present analysis, the recoded data file of the EDHS, which contains entries for 10,641 respondents who had children under five years of age was used. The data file contains household and women's characteristics as well as child health information for the most recent birth. For the present analysis, only those who had the most recent birth (within three years prior to the survey date) were considered. Permission to use the data for the purposes of the present study was granted by ICF international (U.S.) and Central Statistics Authority (Ethiopia) (http://dhsprogram.com/data/Access-Instructions'). Ethical approval was also received by the University of Saskatchewan Behavioral Research Ethics Board.

5.3.3 Measure of the outcome and exposure variables

For the regression analysis, four outcome variables were used. The first outcome was the child health service utilization score, which was constructed from the affirmative responses of six key child health interventions associated with the most recent birth: 1) ANC service (> 4 visits), 2) delivery of the last child at health facilities, 3) postnatal care services, 4) vitamin A intake,5) iron supplementation and 6) intake of deworming by the index child. This outcome variable thus took a count form ranging from 0 to 6; taking a value of '0' if the mothers' response to the six indicators is "no", and 6 if mothers respond 'yes' to all the six indicators. The three key health services (ANC, delivery, and postnatal care) were also used as separate outcome variables of their own to assess the likelihood of institutional delivery and postnatal care.

Health service utilization behavior is thought to depend on a set of individual, parental, household, and community-level characteristics Thus, the exposure variables in the current analysis were categorized into three major groups: Maternal and child factors (which includes, birth order, mothers' education, age, work status, mother's level of exposure to intimate partners violence, ever experienced pregnancy termination, parity, access to information/radio), household factors (which include non-monetary wealth index, religion, and type of family structure); and community variables (residence, mean wealth at the cluster level, mean maternal education at community level).

Most of the background variables (child's sex, age, parental education, type of family structure, parity) were used the way they were coded in the original data. DHS constructed wealth index from selected key household assets and other characteristics that relate to economic status[25]. Intimate partner violence (IPV) was constructed from a set of dichotomous responses on a mother's exposure to violence during a reference period of 12 months.

5.3.4 Statistical analysis

The EDHS data are clustered (i.e., individuals are nested within households, and households are nested within enumeration areas/EAs)[25]. It is thus expected that mothers within the same cluster may have similarities. This violates the assumption of independence of observations across the clusters, and hence, limits the use of conventional regression as an outcome may be measured more than once on the same person[27]. Thus, mixed-effects regression was used. For the present analysis, the enumeration areas/EAs were used as clustering women respondents. Mixed-effects models are useful with data that has more than one source of random variability[27].In this analysis, level one represents the individual (children characteristics), whereas level two is the cluster (community characteristics). Data were analyzed using STATA version 12[26].

Two sets of analyses were conducted. In the primary analysis, a mixed-effect Poisson regression model was used to assess the determinants of service utilization score, which takes a form of count/ rate, and skewed to the right (Figure 5.1). In the secondary analysis, mixed effect logistic regression was used to assess the role of ANC in subsequent service utilization. The analysis began with checking if there was any multicollinearity between the explanatory variables using tolerance test/ variance inflation factors (VIF). Using the routine Collin in Stata, a VIF >10 or mean VIF> 6 represents severe multicollinearity[28]. Then, the bivariate association between child health service utilization and each potential predictor was examined. All predictors statistically associated with a p-value of <0.2 at bivariate level were subsequently included in the multivariable regression models. The model selection criterion was the Akaike Information Criterion (AIC), and the level of statistical error was set to be 5%. In the final model, we used a p-value of <0.05 to define statistical significance. The ratio of Deviance and Degree of Freedom (Deviance/DF) was used to test the model fitness.[29]. The fitness of the model was also compared with a negative binomial regression model using AIC values and dispersion scores.

Further analysis of the continuum adherence to the health care service utilization was carried out using a mixed effect logistic regression model. The model hierarchically builds three separate models; model 1 contained predictors of ANC, model 2 adds ANC as a factor of the place of delivery, and model 3 included ANC and delivery place as key factors of postnatal care service utilization. All the analyses were weighted using the weight variable given by EDHS.

Lorenz curves were used to further depict the SES inequalities in the utilization of ANC, institutional and postnatal services. Concentration Curve (CC) are very conveniently used to illustrate the movement of socioeconomic inequalities in health outcome across groupings[30].

5.4 Results

5.4.1 Distribution of respondents by child health service utilization

Table 5.1 presents the results of chi-square analysis and percentage distribution of ANC, delivery, postnatal care service in Ethiopia by selected characteristics of the respondents and their under-5 children. The overall prevalence of ANC, delivery and postnatal care service utilization were 34%, 26%, 12%, respectively. There were no significant sex differences in the three services (p-value>0.05). Health service utilization was higher among first-order birth compared to those in higher orders (p-value= 0.000). The proportion of antenatal, delivery and postnatal care services was generally lower for older mothers, lower parity, and rural residents (p-value<0.001). Women living in small-sized households were better in utilizing the ANC (39.8%), institutional delivery (48.4%) and postnatal care services (22.3%). About 68.7%, 83.8% and 39.0% of women with secondary and higher education had at least four ANC visits, deliveries assisted by skilled professionals and postnatal care services, respectively (p-value<0.001). It is noteworthy that the proportion of having had at least four ANC visits, institutional delivery and postnatal care steadily increased from the lowest wealth group (poorest/poorer) to the highest wealth group(richest/richer). More women from monogamous households (33.5%) made at least four ANC visits compared to women from polygamous households (22.9%). Similarly, more women from monogamous households had their most recent birth in health institutions (27.1%) and 11.7% of them had postnatal care. Larger proportions of women from Orthodox Christian attended the proper number of ANC visits, institutional deliveries and postnatal care services compared to those from other religions (p-value<0.001). There was a significant association between intimate partner violence (IPV) and the utilization of the three health services, where the proportion increased as the level of IPV increased.

There was a strong significant association between ANC visits and subsequent delivery at health facilities. Among those who had >4 times ANC visits, 58 % of them delivered their last child at health facilities and only 20.3% for those who had <4 times ANC visits (p-value<0.001). Also, 31.4% of those who had >4times ANC visit, received postnatal care services (p-value<0.001). Similarly, among those who delivered their last child at health facilities, 35.2% of them had postnatal care services compared to 3% for those who delivered at home (p-value<0.001).

Table 5.1. Results of the bivariate analysis between the key child health service utilization and socioeconomic variables, EDHS 2016. Ethiopia.

Variables*	At least 4 ANC visits Number (%)	χ2 (p-value)	Institutional delivery	χ2 (p-value)	Postnatal care service	χ2 (p-value)
Sex of the child						
Male	1005(31.9)	0.276	1237(26.0)	0.232	566(11.9)	0.249
Female	992(33.7)		1190(26.7)		509(11.4)	
Child's birth order						
First	480(43.0)	0.000	841(50.2)	0.000	284(17.0)	0.010
Second and above	1517(30.5)		1586(21.0)		791(10.5)	
Age of the mother						
15-24 y	425(31.8)	0.000	679(35.4)	0.000	251(13.1)	0.000
25-34 y	1132(36.3)		1273(25.7)		588(11.9)	
34+ y	440(26.8)		475(20.3)		237(10.1)	
Residence						
Urban	512(63.4)	0.000	803(78.6)	0.000	380(37.2)	0.000
Rural	1485(28.1)		1623(19.8)		695(8.5)	
Household size						
0-3 member	330(39.8)	0.000	439(48.4)	0.000	202(22.3)	0.000
4-6 members	1114(35.2)		1324(28.2)		571(12.2)	
7 and above members	553(26.3)		663(18.4)		302(8.4)	
Education of mother						
No education	975(25.1)	0.000	990(16.1)	0.000	487(7.9)	0.000
Primary level	670(39.5)		908(37.3)		342(14.1)	
Secondary & higher level	351(68.7)		528(83.8)		246(39.0)	
Education of father						
No education	805(25.9)	0.000	879(18.6)	0.000	425(9.0)	0.000
Primary level	754(34.3)		857(24.8)		353(10.2)	
Secondary & higher level	438(55.5)		690(66.7)		298(28.8)	
Parity						
0-3	1161(39.1)	0.000	1589(40.0)	0.000	664(16.7)	0.000
4-6	562(28.9)		579(18.1)		282(8.8)	
7 and above	274(23.2)		259(12.7)		129(6.3)	
Ever terminated pregnancy						
No	1805(32.5)	0.147	2208(26.3)	0.193	967(11.5)	0.090
Yes	192(34.8)		218(26.6)		108(13.2)	
Maternal autonomy						
Yes, some autonomy	492(35.8)	0.004	636(30.8)	0.000	276(13.4)	0.004
No autonomy	1505(31.9)		1791(25.0)		799(11.2)	
Wealth index						
Poorest/poorer	606(23.2)	0.000	648(15.0)	0.000	241(5.6)	0.000
Middle	373(28.6)		438(22.6)		194(10.0)	
Richest/richer	1018(46.6)		1341(45.2)		640(21.6)	

Type of family structure						
Monogamous	1710(33.5)	0.000	2094(27.1)	0.000	904(11.7)	0.000
Polygamous	133(22.9)		170(17.0)		76(7.6)	
Intimate partners violence/IPV						
No or low violence	410(27.1)	0.000	436(18.6)	0.000	166(7.1)	0.000
Mild violence	607(30.6)		706(22.9)		335(10.9)	
High violence	980(37.7)		1284(33.9)		574(15.1)	
Religion						
Orthodox	938(39.1)	0.000	1172(36.8)	0.000	579(18.2)	0.000
Muslim	585(27.3)		734(19.6)		276(7.4)	
Others	474(30.4)		521(22.8)		221(9.7)	
Access to radio						
Yes	777(46.5)	0.000	946(39.1)	0.000	483(19.9)	0.000
No	1220(27.6)		1481(21.8)		593(8.7)	
ANC visits						
<4 times	-		840(20.5)	0.000	447(10.9)	0.000
>4 times	-		1158(58.0)		628(31.4)	
Place of delivery						
Home	-		-	-	220(3.2)	0.000
Institution	-		-	-	855(35.2)	
Mean wealth at cluster/ community level: median (IQR)=2.58(2.14)						
Mean maternal education at the community level: Median (IQR)=4.38(2.75)						

Note: Except for sex of the child, all the variables had a strong chi square association with the respective outcomes($p<0.001$).

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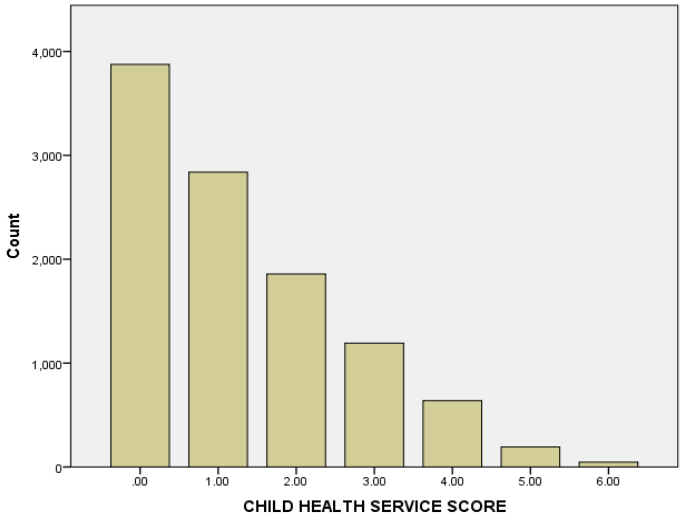
As indicated in the method section, the distribution of the outcome variable followed a Poisson distribution where >60% of the children had lower health service utilization scores (based on the median value) (see Figure 5.1).

Figure 5.1 Distribution of the outcome variable: health service utilization scores, Ethiopia.



5.4.2 Analysis of determinants of health service utilization score

Table 5.2 presents the results of mixed-effect Poisson regression (bivariate) for key explanatory variables of child health service utilization scores. It is noted that 13 of the 14 variables had significant associations with the outcome variable (p-value<0.05) and sex of the child had p-value<0.20.

Table 5.2 Results of bivariate mixed-effect Poisson regression analysis for explanatory variables and the health service utilization score, Ethiopia.

Variables		**95% CI**		
	RR	**Lower**	**Upper**	**p-values**
Sex				
Male [RC]				
Female	0.967	0.934	1.002	0.061
Birth order				
First [RC]				
Second and above	0.624	0.598	0.651	0.000
Age of the mother				
15-24 [RC]				
25-34	0.746	0.713	0.781	0.000
34+	0.850	0.805	0.898	0.000
Residence				
Urban [RC]				
Rural	0.237	0.199	0.281	0.000
Education of mother				
No education [RC]				
Primary level	1.443	1.378	1.512	0.000
Secondary and higher level	1.828	1.716	1.948	0.000
Type of family structure				
Monogamy [RC]				
Polygamy	0.890	0.833	0.951	0.001
Parity				
0-3[RC]				
4-6	0.567	0.543	0.593	0.000
7and above	0.572	.540	0.605	0.000
Ever termination				
No [RC]				
Yes	1.118	1.048	1.192	0.001
Work status				
Yes [RC]				
No	0.793	0.761	0.826	0.000
Wealth index				
Poorest/poorer [RC]				
Middle	1.233	1.157	1.313	0.000
Richest/richer	1.638	1.541	1.742	0.000
Intimate Partners Violence/IPV				
No or low violence [RC]				

Mild violence	1.111	1.049	1.176	0.000
High violence	1.244	1.177	1.317	0.000
Access to radio				
Yes [RC]				
No	0.742	.0709	0.775	0.000
Mean wealth at cluster/ community level	1.824	1.742	1.910	0.000
Mean maternal education at the community level	1.246	1.195	1.300	0.000

Note: RC= Reference Category; RR= Rate Ratio; CI= Confidence Interval

In Table 5.3, the multivariable mixed effect Poisson regression results are presented. Goodness of fit for the model was checked using the ratio of Deviance and degree of freedom. The result shows that the model fits well (i.e., no substantial overdispersion). In such a model, if the ratio of Deviance /DF is closer to unity (1), the observed and fitted count values are matching, and hence, overdispersion is not a big concern. The output was also compared with a negative binomial regression model to see if the latter fits the data better. However, the estimated dispersion coefficient of the negative binomial regression coefficient (0.946; 95% CI: 0.867- 1.033) suggests that mixed-effect Poisson regression is more appropriate. In addition, comparing the AIC of the two competing models suggest that the mixed effect Poisson regression has a slightly lower AIC (31903.7) compared to the AIC of the negative binomial regression model (AIC= 32475.8).

We started the analysis with only a random effect model to examine what service utilization score varied among mothers clustered together within the EAs before considering individual-level variations. The random effect only model had significant variance (0.470; CI:0.411-0.537). The covariate effect is interpreted as: for every one-unit increase in the covariate, the covariate has a multiplicative effect of e^{β} (denoted as RR) on the expected mean of health care utilization score. The results indicate that, after controlling for other variables, the health service utilization score was lower among children of non-first birth order by 25% (e^{β}=0.753, 95%CI:0.714-0.793) compared to first birth orders. The expected mean of service utilization was higher for women in the age group 25-34 and

34+(RR=1.092, 95%CI:1.031-1.155 and RR=1.703, 95% CI:1.576-1.841, respectively) compared to the younger women (15-24). Mothers with primary education had a higher expected mean of utilizing health services (RR=1.185, 95%CI:1.125-1.248) compared to those with no education. Similarly, the expected mean was higher for children with mothers of secondary and higher education (RR=1.216, 95%CI:1.131-1.307) compared to those with no education. The rate of service utilization scores was lower by 7.8% for children from polygamous families (RR=0.922, 95%CI: 0.861-0.987) and by 18.8% for non-working women (RR=0.818, 95%CI:0.782-0.855). The expected mean became lower by 14.5% for households with no access to radio (RR= 0.855, 95%CI:.815-.897). Similarly, the expected mean significantly decreases with parities: lower by 43.5% for women having 4-6 parities (RR=0.597,95%CI:0.565-0.631) and by 51.5% for those with parities of 7+(RR=0.485,95%CI:0.448-0.524).

The expected mean of service utilization appeared to be higher by 1.21 times among mothers who had previous experience of terminated pregnancy (RR=1.126, 95%CI:1.051-1.207) compared to the reference category. The expected mean of service utilization became higher for those residing in more affluent households and those whose mothers experienced mild to high intimate partner violence. After controlling other variables in the model, children residing in communities with mean wealth at the cluster level had higher health service utilization scores (RR=1.428, 95%CI:1.324- 1.540).

Table 5.3: Results of multivariable mixed effect Poisson regression for the covariates and the health service utilization score, Ethiopia.

Individual, household and community variables		**95% CI**		
	RR	**Lower**	**Upper**	**P-values**
Random effect coefficients	0.470 *	0.411	.0537	<0.05
Fixed effects				
Sex of the child				
Male [RC]				
Females	0.969	0.934	1.005	0.096
Birth order				
First [RC]				
Second and above	0.753	0.714	0.793	0.000

Age of the mother				
15-24 [RC]				
25-34	1.092	1.031	1.155	0.002
34+	1.703	1.576	1.841	0.000
Residence				
Urban [RC]				
Rural	1.238	0.998	1.536	0.052
Education of mother				
No education [RC]				
Primary level	1.185	1.125	1.248	0.000
Secondary and higher level	1.216	1.131	1.307	0.000
Marital form				
Monogamy [RC]				
Polygamy	0.922	0.861	0.987	0.019
Parity				
0-3 [RC]				
4-6	0.597	0.565	0.631	0.000
7and above	.0485	0.448	0.524	0.000
Ever termination				
No [RC]				
Yes	1.126	1.051	1.207	0.001
Work status of mothers				
No [RC]				
Yes	0.818	0.782	0.855	0.000
Wealth index				
Poorest/poorer [RC]				
Middle	1.114	1.043	1.189	0.001
Richest/richer	1.283	1.199	1.371	0.000
IPV				
No or low violence [RC]				
Mild violence	1.081	1.018	1.147	0.011
High violence	1.126	1.061	1.194	0.000
Access to radio				
Yes [RC]				
No	0.855	0.815	0.897	0.000
Mean wealth at cluster/ community level	1.428	1.324	1.540	0.000
Mean maternal education at the community level	1.033	.997	1.069	0.071
Constant	.0664	0.044	0.099	0.000
(Scale) offset	1			
Deviance goodness-of-fit/DF = 1.31 Number of groups: 588				

5.4.3 The role of ANC on subsequent delivery and postnatal care service utilization

In Table 5.4, results from three models of fixed-effect logistic regression analysis are given. Model 1 contains predictors of ANC visits; model 2 (place of delivery) contains all the variables in

model 1 plus ANC; and model 3 (postnatal care service utilization) contains all the variables in the previous models plus place of delivery.

In the first model, seven factors have become significantly associated with ANC service utilization (p-values<0.05), namely birth order of the child, age of the mother, maternal education, paternal education, wealth index, access to radio and mean wealth at the community level (Table 5.4). Keeping other factors fixed, the odds of ANC decrease by 21% (AOR=0.794; 95%CI:0.663-0.951) for children in second and above birth order compared to those in the first rank. The odds of ANC increase as the age of women increases. Women in the age group 25-34 and 34+ are 1.36 times (95%CI: 1.143-1.625) and 1.32 times (95% CI1:0.036-1.670) more likely to receive >times ANC, respectively, compared to young women aged 15-24. The odds of ANC visit is higher for mothers with primary (AOR=1.433; 95%CI: 1.233-1.666) and secondary+ education (AOR= 2.048; 95%CI:1.61-2.603) compared to those who had no education. Similarly, the likelihood of ANC visits increases as the education of father increases.

Mothers living in richer and richest households had a significantly higher chance of having >4 times ANC visits (AOR=1.400; 95%CI:1.155-1.697) compared to those residing in poorer/ poorest households. Those who had reasonable access to media (radio) had a higher likelihood of having > 4 times ANC visits (AOR=1.374; 95%CI; 1.193-1.584). It is also noted that the odds of having >4times ANC visits increase with increasing wealth index at the cluster level.

In model 2, ANC was added to the model. Five individual and two community-level variables have become significantly associated with delivery service utilization (p<0.05), namely birth order of the child, maternal education, paternal education, ANC visits, residence, mean wealth at the community level and mean maternal education at the cluster level. The effects of access to radio, wealth, and autonomy, which were significant in model 1 have become insignificant in this model (Table 5.4).

Table 5.4 Mixed effect logistic regression model for investigating the effects of ANC on subsequent use of health service utilization, Ethiopia.

	Model 1 **ANC**	**Model 2** **Place of delivery**	**Model 3** **Postnatal care**
	AOR (95%CI)	**AOR (95%CI)**	**AOR (95%CI)**
Random effect only model: EAs	2.550 (2.135-3.044)	6.199 (5.257-7.310)	2.011(1.673-2.416)
Fixed effects			
Birth order			
First [RC]			
Second and above	0.794 (0.663-0.951)	0.552(0.447-0.683)	1.080(0.886-1.315)
Age of the mother			
15-24 [RC]			
25-34	1.363(1.143-1.625)	0.972(0.791-1.193)	1.197(0.980-1.462)
34+	1.315(1.036-1.670)	0.990(0.749-1.309)	1.370(1.042-1.802)
Residence			
Rural [RC]			
Urban	1.204(0.863-1.680)	2.363(1.589-3.513)	0.974(0.713-1.330)
Education of mother			
No education [RC]			
Primary level	1.433(1.233-1.666)	1.498(1.267-1.772)	1.084(0.901-1.303)
Secondary and higher	2.048(1.61-2.603)	2.820(2.088-3.809)	1.275(0.989-1.644)
Education of father			
No education [RC]			
Primary	1.292(1.122-1.489)	1.207(1.028-1.417)	1.014(0.852-1.207)
Secondary and higher	1.427(1.176-1.733)	1.731(1.378-2.176)	1.102(0.892-1.360)
Parity			
0-3[RC]			
4-6	0.941(0.798-1.110)	0.823(0.680-0.995)	0.979(0.801-1.196)
7 and above	0.809(0.643-1.019)	0.910(0.699-1.184)	0.837(0.629-1.114)
Ever termination of pregnancy			
No [RC]			
Yes	1.161(0.943-1.430)	1.187(0.933-1.511)	1.160(0.914-1.472)
Autonomy			
Yes [RC]			
No	1.030(0.899-1.180)	0.926(0.791-1.084)	1.017(0.870-1.189)
Wealth index			
Poorest [RC]			
Middle	1.158(0.963-1.393)	1.046(0.854-1.281)	1.395(1.101-1.769)
Richer	1.400(1.155-1.697)	1.121(0.905-1.388)	1.363(1.064-1.745)
IPV			
No or low violence [RC]			
Mild violence	0.864(0.749-1.996)	0.957(0.813-1.125)	1.096(0.924-1.300)
High violence	0.997(0.844-1.176)	0.899(0.744-1.088)	0.968(0.786-1.191)
Access to radio			
No [RC]			
Yes	1.374(1.193-1.584)	1.043(0.881-1.235)	1.609(1.374-1.883)
Mean wealth for community	1.412(1.249-1.596)	1.615(1.401-1.862)	1.029(0.906-1.170)
Mean maternal education at the community	1.025(0.970-1.084)	1.125(1.053-1.202)	1.008(0.957-1.061)

ANC service use <4 times [RC] >4 times		2.892(2.503-3.343)	1.490(1.278-1.736)
Place of delivery Home [RC] Institutions			9.252(7.691- 11.128)
Random effect coefficient	0.839 (.664-1.062)	1.321 (1.052- 1.659)	0.358(.238-.542)
AIC Number of groups = 588	6724.66	5347.40	4811.56

Note: RC: Reference category

In model 2, the odds of institutional delivery decreased by 45% for children of higher birth order (AOR=0.552; 95%CI: 0.447-0.683) compared to first birth orders. Those residing in urban areas were 2.4 times more likely to deliver at health facilities (AOR= 2.363; 95%CI:1.589-3.513). The odds of ANC visits were higher for mothers with primary (AOR=1.498; 95%CI: 1.267-1.772) and secondary+ education (AOR= 2.82; 95%CI: 2.088-3.809) compared to those who had no education. Similarly, the likelihood of ANC visits increased as the education of father increases. The likelihood of delivering at health institutions increases with increased mean wealth and mean maternal education at the cluster level (AOR=1.615 and AOR=1.125, respectively). As expected, the ANC became the strongest factors of institutional delivery (AOR=2.892; 95%CI: 2.503-3.343).

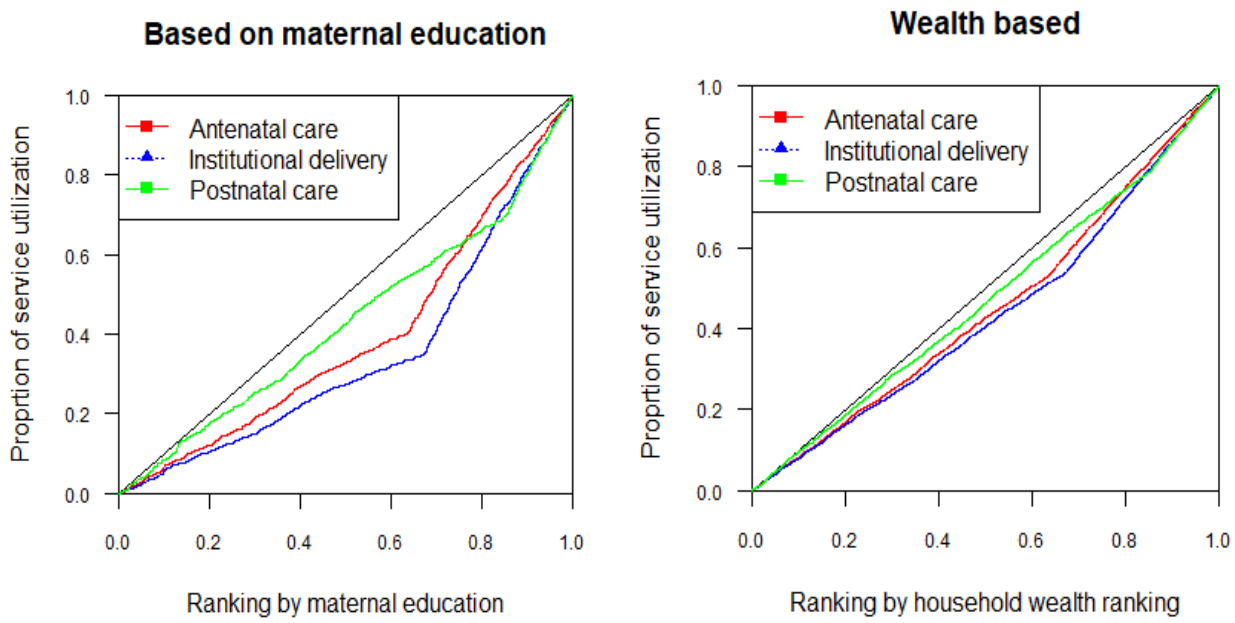
In the last model (postnatal care), four variables were significantly associated with the outcome variable: birth order, education of mother, age of mother, wealth index, access to radio, ANC and place of delivery. Women's likelihood of using postnatal care services was higher for subsequent births (AOR=1.080; 95%CI:0.886-1.315) compared to their first birth, and the likelihood is also higher by 1.37 times for older women (AOR=1.37;95% CI:1.042-1.802) compared to younger ones. Household wealth index appeared to be a strong factor associated with the propensity of postnatal care service utilization. The odds of postnatal care utilization were1.40 times (AOR=1.399; 95%CI: 1.101-1.769) and 1.36 times (AOR=1.363; 95%CI:1.064-1.745) higher for medium level and richer/richest wealth households. The odds of postnatal care service utilization is higher for women who had access to radios (AOR=1.609;95% CI:1.374-1.883).

Model 3 further examined the combined effects of ANC and delivery service utilization on postnatal care needs of mothers. Holding other factors fixed, both ANC and delivery service utilizations have become strongly associated with postnatal care service utilization. The odds of post-natal care service utilization were higher for those who had >4 times ANC visits compared to those who had <4 times ANC visits (AOR=1.490; 95%CI:1.278-1.736). Similarly, the likelihood of postnatal care service utilization was higher for women who had institutional deliveries compared to those who had home deliveries (AOR=9.252; 95%CI: 7.691- 11.128).

5.4.4 Wealth and education-based inequalities in health service utilization

As shown in Tables 5.3 and 5.4, both household wealth and maternal education were consistently identified as important SES factors associated with child health service utilization score. The Lorenz curve depicted in Figures 5.2 indicates higher inequality in the outcome between the categories of the two SES variables. More specifically, the cumulative percentage of wealth distribution/ maternal education is plotted against the cumulative percentage of the corresponding population (ranked in increasing size of share). The extent to which the curve sags below a straight diagonal line indicates the degree of inequality of distribution in the health outcomes concerned. As shown in the two figures below, the gap between the diagonal line and the curves is wide, especially for maternal education. The gap is indicative of the fact that those in the lower socioeconomic group are disadvantaged in terms of health service access.

Figure 5.2: Lorenz curve of inequalities for health service utilization scores based on maternal education and household wealth categories, Ethiopia.



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5.5. Discussion

The study aimed at (1) assessing the key explanatory variables associated with the use of pre and postnatal child care service scores and place of delivery for children under five years and (2) examining the role of ANC on the continuum of adherence to institutional delivery and postnatal care service utilization in Ethiopia based on nationally representative data.

The finding indicates that the six components of health service utilization were very low by any standard, resulting in overall low utilization scores. For instance, it is noted that only a third of the most recent pregnancies had at least 4 ANC visits, only 26% of last births occurred in health facilities and only 12% received postnatal care services. A review of the national trends suggests a significant increase in ANC and institutional delivery in Ethiopia during the last few years. For instance, only 10% of births in EDHS 2011 survey was delivered by a skilled provider[31] compared to the 26% in 2016 EDHS survey.

The reported rate was lower than the average for sub-Saharan Africa (42.9%)[32]. The implications of the low rates of these services on maternal and child health outcomes is important.

It was found that the first birth order had a higher chance of getting proper health services during the pre and postnatal periods. The result of the mixed effect logistic regression analysis further confirmed that health-seeking behavior for ANC and delivery care was significantly determined by the birth order of the index child. Though most studies in the subject have not focused on the influence of birth order on health-seeking behavior[33–35], the few available pieces of evidence generally indicate that mothers tend to invest less in health and child well-being for higher-order births than first-order births [33,36,37]. A recent study based on data from 29 African countries attributed the poor antenatal and delivery service utilization to the increased maternal experiences and increased economic challenges due to increased family sizes[9]. In most Ethiopian cultures, first birth is the most wanted, often accompanied by colorful ceremonies than any subsequent births. The finding implies the need for continued education on the importance of adequate prenatal and postnatal care to higher-order births.

The age of women is another demographic variable predicting the rate of child health service utilization score. The results of both mixed-effect Poisson and logistic regression analysis showed that older mothers have higher odds of adhering to pre and postnatal health care service use. In relation to this, women of lower parity were more likely to have higher service utilization scores. Age of women and parity are the most commonly reported factors impacting both ANC and delivery care service utilization in Ethiopia and developing countries context [38–40]. One plausible reason for the inverse relationship between parity and service utilization could be increased limitations of resources and time as the number of children to be raised increases. Some studies also attribute this to increased confidence of mothers as they have more children [13,41].

The positive effect of maternal education on a mother's chance of utilizing child health services is strong. A comparable national report showed that 69.6 %of births to women with a secondary school education occurred in a health facility and with skilled assistance compared to 4.3 percent of births for women with no education[31]. Nigussie and colleagues[12] found that women with a higher level of education (secondary and above) were 10.6 times more likely to use safe delivery services that those with lower education levels. Another study in North Gondar Zone, Ethiopia, reported that the use of skilled birth attendants was significantly influenced by the level of education. Other studies also made similar conclusions [9,10,42]. One of the reasons for this might be education promotes certain dimensions of autonomy such as freedom of movement, decision making power and control over finance can exert a strong influence over service use and service choice [43]. Education generally creates favorable self-selection bias where knowledgeable or better-educated women invest in health services since they possess superior knowledge about the associated benefits to their personal health as well as the health of their children[33].

Our study disproves the general notion that paternal education has little or no effect on ANC, PNC and delivery service utilization[44], which has led many researchers to mainly focus and at times, exclusively report on the importance of maternal education in studying health inequities [44,45]. Results from the mixed effect logistic regression model showed that women living with educated fathers are more likely to use ANC and delivery services. This is not surprising as some previous studies have reported that educated fathers are more likely to involve in child wellbeing such as diet/ nutrition, exercise, play, and parenting behaviors, which contribute to the overall health and well-being of their young children [46,47]. Additionally, educated fathers provide a higher household income, more freedom and supports, higher social status and stability, and more opportunities for their families (wives and children) to access healthcare services[43,48,49].

It is noted that women with poor access to media had a lower chance of utilizing child health services. An Ethiopian study conducted by Mehari[50] showed that women who frequently watch TV were more likely to receive skilled assistance during delivery. A study in India concluded that women's exposure to information through radio, television and newspaper significantly increased the utilization rates of skilled delivery services[51]. As most Ethiopian women have no education, they benefit little from printed media, getting information through an informal way or radio. Further, the proportion of Ethiopian women having radios in their households is low (about 33%)[15].

Significant disparities are noticed in the likelihood of utilizing the health services across household wealth quintiles. Women in the wealthiest households are more likely than women in the poorest households to have used child-related health services. Also, the expected mean of utilization increased by 1.43 times for every one-unit increase in mean wealth at the cluster level. The Central Statistics Authority's report [31] showed that 45% of women in the highest wealth quintile used assistance from SBAs compared with 2% percent of women in the lowest wealth quintile. Another study in Ethiopia reported that women in the rich and richest wealth group were 1.8 and 3.4 times higher, respectively, to use skilled assistance [11]. Similarly, Mehari [50] also reported a strong association between wealth index and the utilization of skilled delivery care services.

The finding on the positive association between utilization of the health services and urban residence is consistent with previous studies conducted in Ethiopia and elsewhere. It was found that mothers in rural areas are less likely to received ANC during pregnancy, and subsequently, they will have a lower likelihood to adhere to the delivery and postnatal care services. It's not surprising that rural deliveries are less likely to be in facilities than are urban, since facilities in rural areas are on average further away, and distance strongly affects uptake. A study based on national-level data from 29 sub-Saharan African countries [9], for instance, reported the odds of urban women delivering in a health

facility more than doubled the odds of rural women delivering in a health facility. According to EDHS 2011, 49.8% of those urban residences deliver at health centers, while only 4.1% of the rural residents deliver at health facilities. Bell and colleagues[40] observed similar trends for Bolivia, Malawi, Indonesia, Bangladesh and the Philippines in their analysis of data from their Demographic health surveys.

Further analysis of the three key health services (ANC, delivery, and postnatal care) indicates consistent positive impacts of ANC on the continuum of utilizing delivery and post-natal care services. Interestingly, of all the potential predictors entered in the second regression model, ANC had the greatest effects on both institutional delivery and postnatal care service utilization. This means that if women get access to ANC services during her pregnancy, she is more likely to give birth at the health institution compared to those who did not have the prescribed number (>4) of antenatal visit. This adherence was further examined in the third regression model where both ANC and institutional delivery were combined to contribute the greatest effect on the likelihood of mothers' utilization of postnatal care services in the first two months after delivery. Controlling for all other variables in the model, the odds of postnatal care service utilization was 1.49 times and 9.25 times greater for those who attended ANC and delivered their most recent baby in health institutions. The findings are consistent with a recent study conducted based on data from 58 Demographic and Health Surveys from 29 sub-Saharan African countries, which confirm that ANC attendance was predictive of facility-based delivery[9].

Finally, the present study has both limitations and strengths. Regarding the limitations, the cross-sectional nature of the EDHS survey limits the ability to draw a cause-effect relationship between the exposure variables and the outcomes. Because most of the survey respondents (mothers) had no education, there might be some response bias and measurement errors during data collection. On the other hand, the most plausible strength of the present study is that the findings can be generalized to the

entire population/ regions of the country. Thus, its use in monitoring and evaluation of health services and related programs is high. Since comprehensive outcome measures and more sophisticated statistical analysis are used, the findings could benefit program implementation at the community level.

5.6 Conclusion

The findings of the present study implicated that promoting proper antenatal care services is very beneficial in increasing the likelihood of mothers utilizing subsequent services such as delivery and postnatal care services. As Ethiopia is striving to achieve the SDG targets to reduce the current unacceptably high maternal and child mortality, more efforts should be made by local and regional governments in addressing the main challenges related to poor maternal motivation as related to health care services utilization. Some of these challenges could be addressed by improving women's access to education, giving more attention to younger women, increasing access to information, and improving household economic status.

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CHAPTER SIX

SOCIOECONOMIC DISPARITIES IN HOUSEHOLD WATER ACCESS, SANITATION, HYGIENE, AND INDOOR POLLUTION (WaSH+) IN ETHIOPIA

6.1 Abstract:

Background: Over the last decade, despite progress made in improving WaSH+ at the household level, Ethiopia is still experiencing one of the poorest household environment, hygiene, and sanitation practices. The purpose of this study was to examine the disparities in combined household Water, Sanitation, Hygiene, and indoor pollution (WaSH+) practices.

Method: Data were drawn from the 2016 Ethiopian Demographic and Health Surveys (EDHS). The outcome variable is the WaSH+ score, which was constructed based on the linear and combined effects of four sets of variables: Access to safe drinking water supply, toilet facilities, household pollution, and hygiene. The four categories of the outcome variable were determined using the distribution of the data and based on median values. Proportional odds regression was used to assess the determinants of WaSH+ practices. A total of 10641 cases were used for the present analysis.

Results: The results of proportional odds regression analysis showed that parents with at least primary education were more likely to meet a good WaSH+ practice category than being in the poor category. Muslim religion followers were 1.32 times (95% CI: 1.041-1.668) more likely to fall into good WaSH+ category compared to Orthodox Christian religion followers. On the other hand, the likelihood of having good WaSH+ practice decreases by about 33% for other religions followers compared to Orthodox Christian religion followers (AOR=0.627;95% CI: 0.530-0.743). The likelihood of a household having good WaSH+ decreased by 72.6% for households with large sized households (AOR=0.274; 95% CI:0.209 -0.361). Those with a medium or high wealth category were 4.97 times (95% CI: 3.642-6.768) and 21.39 times (95% CI: 16.474-27.758), respectively, more likely to have better WaSH+ habits than those in the poor category. Two community-level variables, residence, and

region, were significant determinants of household WASH. The odds of rural households having good WaSH+ practice decreased by 68.7% (AOR=0 .313; 95% CI: 0.255-0.385). The odds of falling in higher WaSH+ category decreased by 95% for Amhara region, by 94 % for Oromia, 91% for SNNPR, 94% for Gambelia, 61% for Harari and 85% for Tigray regions compared to Addis Ababa (reference category).

Conclusion: The results of the present study demonstrated persistently high socioeconomic and demographic inequalities in WaSH+ practices among households in Ethiopia. Given the fact that nearly two-thirds of under-5 mortality is caused by hygiene and sanitation-related causes, this study highlights the need for aggressive intervention in promoting good WASH+ practices through continuous community education and behavioral communication strategies to significantly reduce the huge disparity in the population.

Keywords: DHS, Ethiopia, household environment, indoor pollution, hygiene, Sanitation

6.2 Introduction

Lack of safe water, hygiene, sanitation and indoor pollution is one of the world's most pressing public health issues. For instance, approximately 2.5 billion people were reported to have non improved sanitation facilities, and of these, 1 billion people are estimated to practice open defecation[1]. Sub-Saharan Africa has among the lowest levels of access to both drinking water and sanitation globally. It is estimated that more than two-third of households in Sub-Saharan countries use open defecation[2–4]. A recent survey in Benin[5] showed that 58% of the respondents defecated in water while 31% practiced open defecation and only 11% used latrines. Only 40% of households washed their hands with water and soap after defecation. Due to this, the Sustainable Development Goal (SDG) 6 gives attention to water, sanitation and hygiene [6].

Household environmental sanitation and hygiene are critical for Sub-Saharan Africa, including Ethiopia, since poor sanitation has huge implications for public health, especially for women and children. Lack of sanitation and inadequate hygiene is associated with diseases like diarrhea, cholera, typhoid and parasitic infection, mainly due to the ingestion of pathogens in food and water[2,7]. In a study by Jain and Singh [8] to explore the effects of the water crisis, they indicated that 80% of diseases in developing countries result from the use of contaminated water and poor household sanitation. People suffering from these diseases also face malnutrition, and combined with other vulnerable diseases weaken their immune systems[9,10]. It was reported that as much as 50% of undernutrition in children may be attributable to poor WASHpractices [11]. According to a recent estimate, a total of 842,000 deaths from diarrheal diseases each year are thought to be related to water, sanitation and hygiene conditions [12]. A study of data from 71 contemporary developing countries, using pooled multivariate regression analysis of the Demographic Health Survey (EDHS) data, found that adequate household water and sanitation

facilities were strongly associated with a lower risk of child mortality, diarrhea, and stunting in children[13].

Studies around the world report that overall household level hygiene and sanitation are associated with certain socio-economic characteristics such as educational status, location, gender, income, and religious affiliation[14,15]. At the macro level, some studies associated poor sanitation with per capita income and political stability. For instance, a study by Munatami and colleagues[16] estimated the proportion of countries gaining access to sanitation from the years 2000 to 2015 and found that overall sanitation is dependent on different economic and socio-political variables. Their findings indicate that countries with a higher level of education and a stable political environment were more likely to have greater access to sanitation[16]. Similar conclusions were reached by other studies conducted in other developing countries [17,18].

Ethiopia has made some progress in terms of sanitation coverage, from just 8% coverage in 1990 to 28% in 2015. The country has achieved a significant stride in reducing open defecation at the national level (from 93% to 45%) and in rural areas (from 100 % to 53%) in this time period [2,19]. This significant achievement in sanitation was made mainly due to the implementation of Community-Led Total Sanitation and Hygiene (CLTSH)[20]. However, Ethiopia remains one of the Sub-Saharan African countries with the lowest prevalence of combined hygiene and sanitation practices [21]. It was estimated that 60 to 80 % of communicable diseases are still caused by poor hygiene, access to safe water and sanitation services in the country [22]. In addition, poor environmental condition contributes to an estimated 50 % of the consequences of undernutrition[22] Diarrhea , which is mainly caused by poor hygiene and sanitation, is the leading cause of under-5 mortality in Ethiopia, accounting for 23 % of all under-5 deaths representing more than 70,000 children a year[22].

Despite the marked improvement in the coverage of hygiene and sanitation at the national level, substantial inequalities among the different socio-economic subgroups persist. To the best of author's knowledge, no study has been conducted on the national scale focusing on the SES inequalities using combined hygiene, water, and sanitation variables as an outcome variable. Previous studies [23,24] have considered a single measure (toilet facilities or drinking water supply or a single indicator of hygiene) as the outcome variable. Even those studies were conducted at the local level on limited sample households or based on a specific region or district within Ethiopia [25–28]. The present study hypothesizes that there are substantial socio-economic and regional inequalities in overall WaSH+ practices in Ethiopia. The aim of this study is, therefore, to examine the disparities in combined WaSH+ practices in Ethiopia based on nationally representative data.

6.3 Methods and materials

6.3.1 The study context

With close to 110 million people, Ethiopia is the second-most populous nation in Africa, growing at a rate of about 2.5% per annum[29,30]. Administratively, Ethiopia has a federal system with nine autonomous Regional States, each divided into zones, districts and sub districts/ kebeles[31]. Fueled by a high level of fertility rate, Ethiopia has higher proportions of children and youth population than wealthier countries [30]. The country is experiencing one of the highest under-5 mortalities in the world (62 per 1000 births) in 2016. Adult literacy is 39 percent[32]. Between 1990 and 2017, life expectancy in Ethiopia at birth increased by 18.8 years[33]. The Food and Agriculture/ Organization/ FAO estimated that sanitation coverage in Ethiopia was 28 percent in 2015 [34]. Also, 57 %of the total population (93 % of the urban and 49% of the rural residents) were using improved drinking water sources[34].

6.3.2 Data sources

The study used the most recent (2016) Ethiopian Demographic and Health Survey[35], which is a nationally representative cross-sectional survey conducted every five years since the year 2000. The sampling design for the surveys was a two-stage stratified cluster sampling that was not self-weighted at a national level. For the current work, we used children's file, which contained entries for 10,641 cases. EDHS followed previously approved standard protocols, data collection tools and procedures[36]. Participation in the survey was voluntary[36], and permission to use the data for the purposes of the present study was granted by ORC Macro International (U.S.) and Central Statistics Authority (Ethiopia). Ethical approval was also received by the University of Saskatchewan, Behavioral Research Ethics Committee.

6.3.3 Measure of the outcome and exposure variables

The outcome variable is a household environment, hygiene and sanitation score which was constructed based on the linear and combined effects of four sets of variables: Access to safe drinking water supply, toilet facilities, household pollution, and hygiene. The outcome variable was made to commensurate with all the components of SDG 6 and combined as follows:

a) Drinking water source was classified as "improved" which is defined by WHO as households with water piped into the dwelling, piped to the yard/plot, public tap/standpipe, tube-well or borehole, protected well, rainwater, bottled water. The drinking water source was classified as "not-improved" if a household uses an unprotected well, unprotected spring, tanker truck/cart with drum, or surface water[1].
b) Toilet facilities was defined as "improved" if a household uses flush/pour flush to be piped sewer system, flush/pour flush to septic tank, flush/pour flush to pit latrine, ventilated improved pit (VIP) latrine, and pit latrine with slab. Toilet facilities were considered "not-improved" if a

household uses flush/pour flush not to sewer/septic tank/pit latrine, pit latrine without slab/open pit, hanging toilet/hanging latrine, or no facility/bush/field[36].

c) Household environmental pollution was measured using the household density, kitchen arrangement, type of floor, if a household member smoked cigarette, and type of cooking materials. Household density was defined as "crowded" if three or more people slept in one room and "not-crowded" otherwise[37]. Household floor types were categorized as earth/sand and others. Fuel type for cooking was categorized as "clean fuel" in case of using electricity, LPG gas, natural gas, and biogas, whereas the "polluted fuel" category included the use of kerosene, coal, lignite, charcoal, wood, straw/grass/shrubs, agricultural crop, and animal dung[37].

d) Hygiene was defined by hand washing, which is commonly approximated by the availability of soap and water in the household.

The constructed score values ranged between 1-4. We then used the median values to categorize the count outcome variable into four different groups based: very poor (1), poor (2), good (3) and very good (4). The categories provided a "proportional split," where it created group sizes that match the proportions found in the original count variable.

The selection of potential explanatory variables was guided by an extensive literature review and by model fitting procedures. The exposure variables were categorized into three major groups: individual characteristics, household characteristics and community variables. The individual variables included sex of household head, age of the mother, parental education, mothers' work status, listening to the radio and maternal autonomy. The household variables were religion, household size, household wealth and type of marital structure (polygamy vs. monogamy) and two community-level variables: type of residence and region.

Most of the exposure characteristics were used in the same way that they were originally coded in EDHS, while some of them were recorded to fit the present analysis. Those recorded included the age of women who were classified into three groups (years):15-24, 25-34, and 34+. Parental educational attainment was grouped into three categories: no education, primary and secondary or more. Household size was measured as small (<3 members), 4-6 medium and 6+ large household size. Maternal autonomy was constructed from a set of dichotomous responses about mother's participation in decision making and household purchase. Household wealth was used as a proxy to household income and was estimated in the EDHS with ownership of household assets [36].

6.3.4 Statistical analysis

Data cleaning, management and analysis were carried out using STATA version 13 [38]. The distribution of various sociodemographic variables was described using frequencies and proportions. Following descriptive analyses, bivariate (Chi-square) analyses were conducted.

The hypothesized relationship between selected explanatory variables and the outcome variable was examined using proportional odds regression. Due to the categorical nature of the outcome variable, the analysis started by checking the proportional odds assumption using a score test[39] to determine if the proportional odds assumption is appropriate in this analysis. The null hypothesis of the score test, the proportional odds assumption is met, and the alternative hypothesis of the score test, the proportional odds assumption is violated. As the p-value of the score test is p-value>0.05, the proportional odds assumption is not violated, so the proportional odds regression model is appropriate in the present study. Correlations among the explanatory variables were checked using the Variance Inflation Factor (VIF). Initially, bivariate proportional odds regression was conducted to select the most promising explanatory variables for multivariable proportional odds regression. Variables with a p-value<0.20 in the bivariate analysis were selected for entering into the initial multivariable proportional odds. Akaike Information

Criteria (AIC) was used to select the final model. Two-way interaction was assessed by taking the cross product of two significant variables. Odds ratios with 95% confidence intervals were calculated for each factor in the proportional odds regression model.

All analyses were weighted using the weight variable computed by the Central Statistics Authority of Ethiopia [40].

6.4. Results

Table 6.1 summarizes the characteristics of the participants and the results of bivariate (using chi-square) analysis for the association between the outcome variable and the sociodemographic variables. It is noted that all variables had a strong significant association with household environmental hygiene and sanitation practices.

The profiles of the respondents indicate that most households were headed by males (86%). Most of the respondents (53.0%) were in the main childbearing ages of 24-34. The proportion of those in the age group 15-24 and 34+ were 22 % and 25%, respectively. The mean age of respondents was 29.02 years (with SD of 6.62). Close to 73% of the respondents were not working and 90% of the households were in rural areas. Most of the respondents had a Muslim religious background (40.6%) followed by Orthodox Christian (34.6%). Two-thirds of the mothers and half of fathers had no education, only 6.8% and 11.2% of mothers and fathers were in secondary and above levels, respectively. A little more than half of the respondents lived in medium-size households (4-6 members), yet many (39%) were living in large size households (7+ members). A greater proportion (46.8%) of the households were in the poorest/poorer households compared to those living in richest/richer households (32.5%) (see Table 6.1). About 73% of the households did not have access to radio. In terms of the type of family structure, 11% of the respondents were living in polygamous households.

Table 6.1 Results of percentage distribution and bivariate analysis for household hygiene and sanitation score by socioeconomic characteristics, Ethiopia.

Characteristics	n(%)*	Very Poor n(%)	Poor n(%)	Good n(%)	Very n(%)good	Chi square
Sex of the household head						
Male	494(86.0)	2260(23.8)	4393(46.3)	1996(21.0)	845(8.9)	190.41(0.000)
Female	1529(13.9)	282(18.5)	573(37.5)	374(24.5)	299(19.6)	
Age of the respondent						
15-24 years	2446(22.2)	242(9.9)	1206(49.3)	702(28.7)	297(12.1)	503.91 (0.000)
25-34 years	5843(53.0)	1397(23.9)	2491(42.6)	1299(22.2)	655(11.2)	
34+	2734(24.8)	903(33.0)	1269(46.4)	370(13.5)	192(7.0)	
Education of mothers						
No education	7284(66.1)	2124(29.2)	3457(47.5)	1397(19.2)	307(4.2)	2377.7 (0.000)
Primary level	2951(26.8)	401(13.6)	1372(46.5)	773(26.2)	405(13.7)	
Secondary and above	788(7.1)	17(2.2)	138(17.5)	201(25.5)	432(54.8)	
Education of husband						
No education	5637(51.1)	1543 (27.4)	2662(47.2)	1147(20.3)	285(5.1)	1711.75 (0.000)
Primary	4116(37.3)	894(21.7)	1992(48.4)	904(22.0)	327(7.9)	
Secondary and higher	1270(11.5)	105(8.3)	313(24.6)	319(25.1)	533(42.0)	
Mother's autonomy						
Yes, some autonomy	2483(22.5)	558(22.5)	1038(41.8)	541(21.8)	346(13.9)	47.39 (0.000)
No or poor autonomy	8539 (77.5)	1984(23.2)	3928(46.0)	1829(21.4)	797(9.3)	
Mother's Work status						
Working	2988(27.1)	620(20.7)	1215(40.6)	702(23.5)	452(15.1)	123.71 (0.000)
Not working	8035(72.9)	1922(23.9)	3752(46.7)	1668(20.8)	692(8.6)	
Access to radio						
Yes	2949(26.8)	499(16.9)	1135(38.5)	731(24.8)	584(19.8)	469.13 (0.000)
No	8073(73.2)	2043(25.3)	3831(47.5)	1639(20.3)	560(6.9)	
Religion						
Orthodox	3772(34.2)	505(13.4)	1698(45.0)	1078(28.6)	490(13.0)	403.67 (0.000)
Others	7251(65.8)	2036(28.1)	3269(45.1)	1292(17.8)	654(9.0)	
Type of family structure						
Monogamy	9243(83.9)	2018(21.8)	4207(45.5)	2055(22.2)	963(10.4)	121.93 (0.000)
Polygamy	1219(11.1)	429(35.2)	520(42.7)	184(15.1)	86(7.1)	
Household size						
1-3 members	1156(10.5)	0(0.0)	505(43.7)	405(35.0)	246(21.3)	1691.78 (0.000)
4-7 members	5593(50.7)	858(15.3)	2475(44.3)	1531(27.4)	728(13.0)	
7+	4274(38.8)	1684(39.4)	1986(46.5)	434(10.2)	170(4.0)	
Wealth index						
Poorest	5156(46.8)	1996(38.7	2476(48.0)	631(12.2)	53(1.0)	3438.81 (0.000)
Poorer	2280(20.7)	379(16.6)	1271(55.7)	570(25.0)	60(2.6)	
Middle	3587(32.5)	167(4.7)	1219(34.0)	1169(32.6)	1032(28.8)	
Place of residence						
Urban	1216(11.0)	23(1.9)	142(11.7)	295(24.3)	755(62.1)	4132.51 (0.000)
Rural	9807(89.0)	2519(25.7)	4824(49.2)	2075((21.2)	389(4.0)	
Region						
Tigray	716(6.5)	80(11.2)	309(43.2)	216(30.2)	11015.4)	2451.42 (0.000)
Afar	114(1.0)	33(28.9)	42(36.8)	24(21.1	15(13.2)	
Amhara	2072(18.8)	270(13.0)	993(47.9)	659(31.8)	150(7.2)	

Oromia	4851(44.0)	1262(26.0)	2315(47.7)	941(19.4)	332(6.8)	
Somali	508(4.6)	158(31.1)	174(34.3)	87(17.1)	89(17.5)	
Benishangul	122(1.1)	45(36.9)	58(47.5	14(11.5)	5(4.1)	
SNNPR	2296(20.8)	681(29.6)	1047(45.6	390(17.0)	179(7.8)	
Gambela	27(0.2)	9(33.3)	9(33.3)	5(18.5)	4(14.8)	
Harari	26(0.2)	1(3.7)	7(25.9)	8(29.6)	11(40.7)	
Addis Adaba	244(2.2)	0(0.0)	2(0.8)	16(6.6)	226(92.6)	
Dire Dawa	47(0.4)	3(6.5)	10(21.7)	10(21.7)	23(50.0)	

*computed from the total

The proportional odds assumption was tested using the score test (p-value = 0.202). An insignificant test statistic indicates that the final model does not violate the proportional odds/ parallel lines assumption. Thus, the proportional odds regression was fitted. Multicollinearity analysis among the explanatory variables indicates that none of them had a significant relationship (VIF<10). The scatterplot between the dependent and continuous independent variables confirmed linearity assumptions are met. Generally, a positive coefficient (AOR > 1) means that increases in the explanatory variable lead to higher values (better household level hygiene and sanitation) of the response variable, while negative coefficients (beta <0 or AOR < 1) mean that increases in the explanatory value lead to a decreased in the response value. Table 6.2 presents the results of proportional odds regression for key determinants of WaSH.

Table 6.2. Results of multivariable proportional odds for assessing the association between selected factors and household environment, hygiene, and sanitation practices in Ethiopia.

		95% C.I. for AOR		
Characteristics	**AOR**	**Lower**	**Upper**	**p-values**
Sex of the household head				
Male				
Female	1.294	1.068	1.571	0.009
Age of the respondent				
15-24 years				
25-34 years	0.846	0.698	1.026	0.089
34+	0.870	0.674	1.124	0.287
Education of woman				
No education				
Primary level	1.481	.1.230	1.783	0.000
Secondary and above	1.663	1.352	2.045	0.000

Education of husband				
No education				
Primary	1.155	1.043	1.278	0.006
Secondary and higher	2.267	1.861	2.761	0.000
Mother's autonomy				
Yes, some autonomy				
No or poor autonomy	0.903	0.821	0.992	0.033
Mother's Work status				
Working				
Not working	0.918	0.831	1.015	0.094
Access to radio				
Yes				
No	1.043	0.938	1.161	0.436
Religion				
Orthodox				
Muslim	1.318	1.041	1.668	0.022
Others	0.627	0.530	0.743	0.000
Type of family structure				
Monogamy				
Polygamy	1.005	0.889	1.136	0.936
Household size				
1-3 members				
4-7 members	0.825	0.657	1.037	0.102
7+	0.274	0.209	0.361	0.000
Wealth index				
Poor/ poorer				
Medium	4.965	3.642	6.768	0.000
Rich/ richer	21.385	16.474	27.758	0.000
Place of residence				
Urban				
Rural	0.313	0.255	0.385	0.000
Region				
Addis Ababa				
Afar	0.346	0.207	0.579	0.000
Amhara	0.048	0.029	0.079	0.000
Oromia	0.064	0.041	0.100	0.000
Somali	0.315	0.196	0.506	0.000
Benishangul	0.030	0.019	0.048	0.000
SNNPR	0.086	0.054	0.1382	0.000
Gambela	0.057	0.034	0.094	0.000
Harari	0.389	0.241	0.629	0.013
Tigray	0.146	0.094	0.227	0.000
Dire Dawa	0.759	0.458	1.256	0.283
AIC= 17507.46 BIC=17990.61				

The significant individual-level variables were the education of the mother, education of father, maternal autonomy, and sex of household head. Female headed households were 1.29 times (95% CI: 1.068-1.571) more likely to have more chance of falling in good WaSH+ category compared to male headed households. Households with mothers of primary and secondary and above level education were 1.48 and 1.66 times (95% CI: 1.230-1.783 & 95%CI: 1.422-2.465) more likely to have more chance of falling in good household WaSH+ category than being in poor WaSH+ category. Similarly, households with fathers of primary and secondary and above education were 1.16 times (95% CI: 1.043-1.278) and 2.27 times (95% CI: 1.861-2.761) more likely to belong in higher WaSH+ category than being in poor WaSH+ category. The likelihood of belonging to good WaSH+ category decreases by 9.7% for households with poorer maternal autonomy (95% CI: 0.821-0.992).

Among the household variables, religion, household size and household wealth have significantly associated with the outcome variable. Muslim religion followers were 1.32 times (95% CI: 1.041-1.668) more likely to fall into good WaSH+ category compared to Orthodox Christian religion followers. On the other hand, the likelihood of falling in good household WaSH+ practice decreases by about 37.3% for other religion followers compared to Orthodox Christian religion followers (AOR=0.627;95% CI: 0.530-0.743). Households with large size (7+members) were 72.6% (AOR=0.274; 95% CI:0.209 -0.361) less likely to fall into good WaSH+ category than being in poor WaSH+ category. Those with medium and rich/richer wealth categories were 4.97 times (95% CI: 3.642-6.768) and 21.39 times (95% CI: 16.474-27.758) more likely to belong to better WaSH+ category than being in poor WaSH+ category.

Two community-level variables, residence, and region were significant determinants of overall household environment, sanitation, and hygiene. The chance of rural households being in the

higher sanitation category decreased by 68.7% (AOR=0 .313; 95% CI: 0.255-0.385). In examining the association between region and the outcome variable, Addis Ababa was taken as a reference category. It is seen that the chance of falling in higher hygiene and sanitation category decreased by 95% for Amhara region, by 94 % for Oromia, 91% for SNNPR, 94% for Gambella, 61% for Harari and 85% for Tigray regions compared to the reference category. Diredawa administration was the only one having an insignificant association (p-value>0.05).

The analysis considered examining the interaction effects of selected significant explanatory variables (maternal and paternal education; wealth and residence types; maternal education and wealth). None of these interactions had significant association with the outcome variable.

6.5. Discussion

The study examined the disparities in household WaSH+ practices in Ethiopia based on a nationally representative data. The findings indicate that a substantial proportion (more than half) of the households had very poor or poor WaSH+ status as defined by a composite score based on four indicators described in the method section above. No doubt that unimproved WaSH+ practices have a number of economic, social, and environmental impacts and adversely influence the full realization of human development[41,42]. Diseases borne by poor sanitation and hygiene are the most common causes of death among the poor in developing countries[7,41].

This study examines the association between women's decision-making autonomy and WaSH+ practices among households in Ethiopia. The finding indicates that the likelihood of practicing good WaSH+ increases with mothers' decision-making autonomy. This finding is consistent with a study conducted in neighboring Kenya based on Kenyan DHS, which found that women's decision-making power for major household purchases was positively associated with households having better

sanitation[43]. The authors further suggest that increased gender equity could potentially have spillover effects that result in more households opting to improve their sanitation conditions[43]. It is, however, unclear about how women's role in household decision making affects whether a household opts for better sanitation [43]. One possible reason could be related to the fact that women's ability to influence households' decisions related to sanitation practices are usually moderated by several individual and household characteristics. Empirical evidence from Kenya and Nepal, for instance, suggests that women's decision making autonomy on major household purchases is associated with age, education, employment status, number of children, place of residence, and wealth levels[43,44]. Older women, having their own income with better education, have the greater bargaining power to influence health and sanitation practices at their households, including water supplies, transparency and management of sanitation interventions[43–45]. Thus, since recently, many development programmers in the water and sanitation sector acknowledge the need for women participation for their success[45].

Our analysis indicated substantial education-based inequalities in WaSH+. The likelihood of good WaSH+ practice was much higher among mothers with primary and secondary education compared to those who have no education. The finding is consistent with earlier studies conducted in different parts of the world, including Ethiopia. As indicated by findings from a local study[2], respondents with little or no education were less likely to utilize latrine compared to those having a primary and above level of education. Our finding also agrees with a study carried out by Koskei, which reported that the educational level of households has a significant association with households' access and use of sanitation facilities[46]. Other studies conducted in developing countries context reached a similar conclusion [9,41]. From the findings of this study, about two-thirds of the women had no formal education. This could explain why most households have very poor or poor WaSH+ practices. It is well known that a minimum education provides women with a general awareness of how to utilize available

resources for improving their household's hygiene and sanitation[41]. Education may enable women to make independent decisions and to have greater access to household resources that are important to hygiene and sanitation.

Interestingly, the disparities in household WaSH+ based on father's education have become significant. This finding seems to divert from the general notion that paternal education, compared to maternal education, makes little impact on household environmental pollution, hygiene, and sanitation. A substantial body of research shows that a meaningful shift has taken place in the last 50 years in parenting roles, whereby more educated fathers are becoming more involved in household chores[47].

The study found a positive association between household size and household WaSH+ status. The finding is consistent with a study conducted in South Africa where there was a strong association between household size and obtaining water from an unsafe source in rural areas. The same study indicated that an increase in household size is related to using unimproved toilet facilities[48].

Interestingly, our findings indicated that religion and WaSH+ practices are associated. It was noted that Muslim religion followers had a significantly greater chance of practicing good household WaSH+ compared to Orthodox Christian households. However, the practice is lower among other religions followers compared to Orthodox Christians. Studies around the world reported inconsistent results. For instance, a recent study in India reported that Muslims were more likely to practice good toilet use compared to others. However, when the location is controlled, the effect of religion declined by about two-third [49]. Further, estimates do not show evidence of religion-specific differences in other sanitation practices, such as handwashing or observed fecal material near homes[49]. A similar finding was reported by a study by Geruso, Michael, and Dean Spears[50]. Samuel [51], in his study of the Ghanaian community, explained the higher sanitation among Muslims with the fact that the religion strictly

dictates keeping the body and its surroundings sane and serene, and thus, such that some amenities such as toilets, bathrooms and a good sewage system should be found in various Muslim communities[51].

The study demonstrated a strong positive association between asset-based wealth index and household WaSH+ practices. Though the comparison of our findings with other previous studies is somehow difficult mainly due to wide variations in the way wealth is measured, the few studies conducted in low income countries across different continents have indicated inconsistent findings about the magnitude and trends of wealth-based inequalities in the respective countries [9,14]. Thus, the relationship between wealth-based inequality and WaSH is not always conclusive. Smith and Hanson[14] establish that household income is one of the main determinants of access to water and sanitation facilities. From their study conducted in Cape Town, South Africa, households with lower incomes (below 800 Rands) have limited opportunities to improve their water and sanitation conditions [9]. Also, while the higher income groups can afford to buy more and are also able to afford private alternatives in times of shortages, these may be too expensive for the urban poor as they barely are able to meet the three basic needs of food, water and shelter[9].

Two community-level variables were associated with household WaSH+ practices, namely residence and region. Regarding residence, urban residents had a higher likelihood of practicing good WaSH+ compared to those living in rural areas. In a recent large-scale study conducted over 29 Sub Saharan African countries, the combined SDG coverage for urban residents was 8 times higher compared to those living in rural areas[21]. The significant differences in hygiene and sanitation practices across different regions could be due to a variety of reasons. The likelihood of falling in a good WaSH+ category was lower for all regions, taking Addis Ababa as a reference category. All regions have low sanitation compared to Addis Ababa. A recent study by Giday and colleagues[2] attributed spatial differences to the well-coordinated support and supervision of health extension workers, district-level

health office, volunteer community in imparting continuous education at grassroot level about communicable diseases.

Strength and limitations

Given more than 60% of childhood deaths occur in Ethiopia mainly due to preventable communicable diseases arising from poor sanitation and hygiene, the findings could prove useful on a national scale for the planning, targeting, monitoring, and evaluating of future sanitation promotion programs. The study also has some methodological limitations worth mentioning. First, the EDHS survey employed a cross-sectional design, where data on the exposure and outcomes were collected at a specific point in time. Second, there are possibilities of omission, under-reporting, or improper reporting of important information as most of the respondents had no education. Finally, the outcome variable for the present study was a score variable constructed based on reported access to sanitation and hygiene facilities and does not necessarily guarantee the utilization of these facilities.

6. 6 Conclusion

Poor sanitation, water scarcity and inappropriate hygiene behavior are the main causes of morbidity and mortality in children. The present study found that there is substantial socioeconomic and demographic inequalities in household environment and WASHpractices among households in Ethiopia. Given the fact that nearly two-thirds of under-5 mortality in Ethiopia are caused by hygiene and sanitation-related factors, the findings of our study imply that future reductions in inequalities in childhood morbidities and under-5 mortality would largely depend on the country's ability to significantly remove or reduce the adverse effects of the abovementioned key risk factors or promote their desirable behaviors. There should be aggressive and continuous community education and behavioral change communication strategies that will eventually help to significantly promote

knowledge, attitude and practices on basic hygiene. The fact that poor household sanitation is common among resource-poor households and regions, narrowing down the rural-urban and regional disparities in access to sanitation infrastructure and economic opportunities should be a priority concern.

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CHAPTER SEVEN

HEALTH CARE SEEKING BEHAVIOURS FOR COMMON CHILDHOOD MORBIDITIES IN ETHIOPIA: THE EFFECTS OF MATERNAL BEHAVIOUR AND ACCESS TO KEY HEALTH SERVICES

The paper was submitted to BMC International Journal for Equity in Health and is posted in Research Square website https://www.researchsquare.com/article/rs-44306/v2 as Nigatu R Geda, Cindy Xin Feng, Susan J Whiting, Rein Lepnurm, Carol J Henry, Bonnie Janzen (2020). Health care seeking behavior for common childhood morbidities in Ethiopia: The effects of maternal behavior and access to key health services. *DOI: 10.21203/rs.3.rs-44306/v.paws*

I contributed to the study design and conceptualization of the study, entire data analysis, data interpretation and drafted the manuscript.

7.1 Abstract

Background: Childhood morbidities such as diarrhea and pneumonia are the leading causes of death in Ethiopia. Appropriate healthcare-seeking behavior of mothers for common childhood illnesses could prevent a significant number of these early deaths; however, little nation-wide research has been conducted in Ethiopia to assess mothers' healthcare-seeking behavior for their children. The main purpose of this study was to examine the disparities in healthcare-seeking behavior and associated factors among mothers during their child's illness: diarrhea and Acute Respiratory Infection (ARI).

Method: The study used the Ethiopian Demographic and Health Surveys (EDHS) conducted in 2016 on a nationally representative sample of 10641 children under the age of five. The main determinants of care-seeking during diarrhea and Acute Respiratory Infection (ARI) episodes were assessed using multiple logistic regression analyses while adjusting for complex survey design.

Results: Only 43% and 35% of households sought medical attention for their children in episodes of diarrhea and ARI, respectively, during a reference period of two weeks before the survey. The odds of seeking care for diarrhea are lower for non-working mothers versus working mothers. The likelihood of seeking care for diarrhea or ARI is higher for fathers who had education versus no education. The place of delivery for the child, receiving postnatal checkup and getting at least one immunization in the past determined the likelihood of seeking care for ARI, but not for diarrhea. The odds of seeking care are higher for both diarrhea and ARI among households that are headed by females and where mothers experienced domestic violence. Religion and types of family structure are also significant factors of seeking care for diarrhea episodes, but not for ARI.

Conclusion: Given the high morbidity and mortality rates for children in Ethiopia, a deeper understanding of the health-seeking behaviour of mothers may provide insights for identifying the potential gaps and developing improvement of mothers' awareness and perception towards childhood problems

Keywords: Acute Respiratory Illness, Diarrhea, Determinants, Health Services, Morbidity, Ethiopia.

7.2 Introduction

Reducing preventable deaths of newborns and children under-5 years of age is one of the priority areas of sustainable development [1]. The direct causes of most early age mortality are diseases that are preventable and treatable, namely pneumonia, diarrhea, malaria, and measles (in descending order) [2–4]. Despite efforts in ensuring universal access to health care through the national Health Sector Development Program [5], Ethiopia is still experiencing one of the highest prevalence of poor health outcomes for children, especially regarding under-5 mortality [6]. For children under-5 years old, mortality is 114 deaths per 1,000 live births in rural areas and 83 deaths per 1,000 live births in urban areas. Common childhood illnesses and nutritional deficiencies have been the underlying cause for a significant proportion (at least 28%) of all child deaths in Ethiopia [7]. Most of these lives could be saved through affordable treatment measures like antibiotics for acute respiratory infections, oral rehydration for diarrheal diseases, and the use of appropriate drugs for malaria[1,8]. Poor healthcare-seeking behavior of parents has been shown to contribute to ineffective prevention and control of morbidity and mortality related to health conditions [9]

In this regard, research-based evidence on care-seeking behavior on common morbidities is required in order to design appropriate child survival strategies in countries like Ethiopia, where the early mortality rate is high [10]. In Ethiopia, only a small proportion of children with common childhood illnesses receive appropriate health care[8,10]. While care-seeking behavior is generally influenced by availability, quality of services, and personal choices, the roles played by maternal and behavioral variables are crucial. Low care-seeking behavior is particularly pronounced among households in the poorest quintile, in rural areas, with poor parental education, and those who are non-users of basic maternal and child health services[8,10–12]. Other contributing factors could be: accessibility to service; severity of illness; trust in healthcare providers; and prior beliefs concerning treatment of the illness[13].

Previous studies conducted on the health of children in Ethiopia have focused on small/ local areas [8,10] micro-level data or have addressed only one population category (such as rural areas)[14]. The present study addresses these limitations by using nationally representative data and considers a wide range of variables. Drawing from the existing literature, it is hypothesized that care-seeking from public/private health facilities during episodes of the two most common childhood illnesses, namely diarrhea and Acute Respiratory Infection (ARI) would be lower among those who did not have access to key health services for children (Antenatal care/ANC, institutional delivery service, postnatal care, and basic immunization services). It is also posited that poor care-seeking would be more a function of maternal factors such as the living context, knowledge, and resources of these women.

Therefore, this study aims to assess the socioeconomic disparities in healthcare-seeking behavior among mothers during their child's illness.

7.3 Materials and Methods

7.3.1 Conceptual Framework

The conceptual framework (Figure 7.1) for factors of-health seeking behaviors for mothers of children with diarrhea and ARI conditions is based on Anderson's behavioral model[15]. The model assumes that health-seeking behavior is a function of three sets of characteristics: predisposing, enabling, and need. The actual seeking of health services is assumed to be a sequential and conditional function of the individual's predisposition to use health services, their perceived need to use them, and their ability to obtain the services [5].

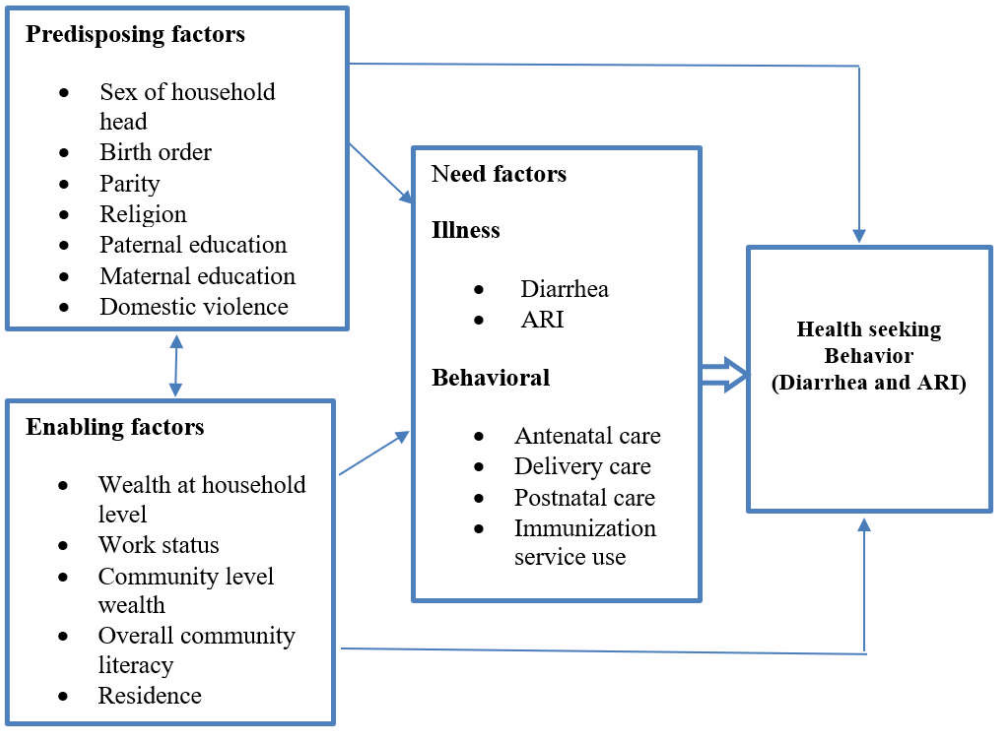

Figure 7.1: Conceptual Framework of the study developed based on Anderson's behavioral model of health service utilization[15]

7.3.2 Data and study population

The present study was conducted using a nationally representative cross-sectional data of the most recent Ethiopian Demographic and Health Survey (EDHS, 2016). The data were collected from 10,641 ever-married (15–49 years) drawn from the nine regions. The EDHS employed a two-stage stratified cluster sampling[6]. Well trained and experienced interviewers conducted the surveys. For the present analysis, only those who reported episodes of acute respiratory and diarrhea illness during the two weeks preceding the survey date are considered. The detailed description of methods, design, instruments, participants, and sampling frame had previously been published by the Central Statistics Authority of Ethiopia and Macro International [6]. Permission to use the data for the purposes of the present study was granted by ORC Macro International and Central Statistics Authority. Ethical approval for this study was obtained from the University of Saskatchewan.

7.3.3 Measures

Two dichotomous outcome variables were considered in the current analysis: appropriate seeking of treatment for diarrhea and ARI, respectively, constructed based on mothers' responses to questions on recent episodes of various forms of morbidities. Appropriate healthcare-seeking behavior was defined as situations when mothers visited any health facility/institution during episodes of childhood illnesses for diarrhea or ARI. Information on the diarrhea episode during the reference period of two weeks was used. Diarrhea is described as an abnormal increase in the frequency, volume, or liquidity of stools, lasting from a few hours to several days[16,17]. ARI is derived based on mothers' responses to questions if their child had a fever, cough, chest congestion, or short rapid breaths in the two weeks preceding the survey[6]. The WHO referred these symptoms as "suspected pneumonia" [6]. The EDHS survey considered them as a proxy measure of pneumonia[16]. In a follow-up question, mothers who reported the occurrence of these symptoms were asked if the child required medical attention. Health care seeking behavior was coded as "1" if mothers sought care during such episodes and "0" if no care was sought.

The choice of potential explanatory variables was guided by literature reviews and model fitting procedures. To capture the key determinants of care-seeking, a wide range of explanatory variables were included. For the purpose of this analysis, the explanatory variables were divided into three major categories: 1) Predisposing factors (Sex of household head, birth order, parity, religion, paternal education, maternal education, IPV); 2) enabling factors (wealth at the household level, work status, community-level wealth, overall community literacy and residence); and 3) need factors which include behavioral variables (utilization of ANC, delivery care, postnatal care, and immunization). Most of the background variables such as child's sex, age, parental education, type of family structure, parity were used the way they were coded in the original data. The remaining variables were constructed by combining certain items. Of importance are those measured using indices such as intimate partner

violence (IPV), wealth index, community-level wealth, and community-level maternal education. IPV was constructed from mother's binary response for five sets of questions about her experiences of violence by her partner (beating, insulting, causing physical assault, chasing from home, and slapping). The variable was dichotomized into no/ low IPV and high IPV based on the average value. Household wealth was estimated in the DHS with an asset-based index that combined information about ownership of consumer goods, housing quality, and water and sanitation facilities [6]. This is a combined measure of the cumulative living standard. Community-level wealth was measured based on the mean of the wealth index of each household in a cluster. Similarly, mean maternal education at the community level was measured based on information on the highest education achieved by each individual woman. These two variables were used in the analysis as continuous variables.

7.3.4 Statistical Analysis

Data were analyzed using SPSS, version 20 [18]. Percentage and frequency were used to describe the distribution of child morbidity status and care-seeking by selected socio-demographic characteristics. Bivariate logistic regression was conducted to select the variables with p-values <0.2. Multiple logistic regression analyses were then conducted to examine the association between selected explanatory variables and the two-health care seeking variables. Both crude odds ratio (COR) and adjusted odds ratio (AOR) with 95% confidence interval (CI) were computed. A backward model selection method was employed. We used a p-value≤ 0.05 to ascertain statistical significance[19]. All analyses were weighted per DHS guideline [6].

7.4 Results

The analysis was conducted on the reported cases of 1227 diarrhea and 1280 ARI. The proportion of households representing urban and rural residents ~~is~~ was11% and 89 %, respectively

(Table 7.1). Many of the respondents (50.7%) reported household sizes of 4-6 followed by households of 7 or more (38.8%). The average household size for the reported cases was 6.02 ± 2.28. The distribution of respondents by asset-based wealth status showed a difference of about 9.5 % between the top and bottom quantiles. About 11% of the respondents were engaged in polygamous marriages; they were in their prime reproductive ages (20-34) with a median age of 19.2 years. Overall educational attainment by both men and women was very low, with 66% of mothers and 51% of fathers having no education during the survey. A total of 1227 (11.8%) mothers reported at least one under-5 child with a diarrhea episode in the two weeks preceding the survey, and a total of 1280 (11.3%) mothers reported at least one under-5 child with an ARI episode.

Tables 7.2 and 7.3 present the results of the bivariate (unadjusted effects) and multivariable (adjusted effects) analysis of care-seeking for diarrhea episodes and ARI, respectively. The odds of diarrheal care-seeking decrease by 33% for non-working mothers compared to those working outside the home (AOR =0.672, 95% CI: 0.453-0.996). Fathers' literacy was significant in both models, where the likelihood of care-seeking increases when fathers have some education. Child's place of delivery, receiving postnatal checkup and getting at least one immunization services in the past determined the likelihood of care-seeking for ARI episodes, but not for diarrhea. For instance, mothers who delivered their child at home have a lower chance of taking their ill child to medical attention in case of ARI episodes compared to those who were born in health facilities (AOR = 0.551, 95% CI: 0.392-0.773). The odds of care-seeking for ARI episodes decrease by about 44% for those who never had postnatal checkup (AOR=0.548, 95%CI: 0.358-0.839) compared to those mothers who had a postnatal checkup. Mothers whose children did not receive immunization in the past are also less likely to seek care for children's ARI episodes compared to mothers whose children who had at least one immunization (AOR=0.475, 95%CI: 0.285-0.792).

Table 7.1: Descriptive statistics of mothers' care-seeking for their children's diarrhea and ARI episodes during the two weeks preceding the survey date in Ethiopia, 2016.

		Diarrhea (n=1227)	ARI (n=1280)
Characteristics	**n(%)**	**Yes (%)**	**Yes (%)**
Sex of the household head			
Male	9494(86.1)	449(41.3)	283(24.8)
Female	1529(13.9)	75(52.8)	66(47.1)
Residence			
Urban	1216(11.0)	74(58.7)	50(53.8)
Rural	9807(89.0)	450(40.9)	299(25.2)
Family structure			
Monogamous	9243(83.9)	451(43.5)	283(26.4)
Polygamous	1219(11.1)	42(35.3)	40(25.6)
Place of delivery			
Institution	1216(11.0)	200(52.2)	155(42.9)
Home	9807(89.0)	324(38.3)	194(21.1)
Religion			
Orthodox Christians	3772(34.2)	203(45.0)	138(29.2)
Other	7251(65.8)	321(41.3)	210(26.0)
Mothers work status			
Working	2988(27.1)	181(48.4)	135(34.7)
Not working	8035(72.9)	343(40.2)	214(24.0)
Postnatal check			
No postnatal check for most recent birth	9706(88.1)	98(50.0)	79(42.9)
Had post-natal check for most recent birth	1316(11.9)	426(41.3)	270(24.6)
Intimate partners violence			
No	2763(25.1)	112(38.6)	65(19.1)
Yes, low to high	8259(74.9)	412(44.0)	284(30.2)
Children ever born			
1-3	4836(43.9)	292(48.8)	172(30.8)
4-6	3732(33.9)	155(36.6)	107(24.7)
6+	2454(22.2)	77(37.4)	70(24.3)
Birth order			
First	2058(18.7)	110(44.0)	93(36.0)
Other	8965(81.3)	413(42.3)	255(25.0)
Household wealth			
Poorer and poorest	5156(46.8)	200(37.2)	129(23.1)
Medium	2280(20.7)	103(38.4)	75(24.0)
Richer and richest	3587(32.5)	221(52.4)	144(35.2)
Immunization			
Had at least one vaccination	9616(87.2)	477(43.4)	326(29.1)
Never had vaccination	1407(12.8)	47(36.4)	22(13.8)
Mothers' literacy status			
Literate	3739(33.9)	352(38.8	247(24.7)
Illiterate	7284(66.1)	172(53.9)	102(36.4)
Fathers literacy status			
Literate	5385(48.9)	290(44.0)	209(30.8)
Illiterate	5637(51.1)	234(41.1)	140(23.3)

Table 7. 2: Unadjusted and adjusted odds ratio for determinants of mothers' treatment-seeking behavior for diarrhea episode in Ethiopia, 2016 (n=1227).

Characteristics	**Unadjusted**		**Adjusted (Backward elimination)**	
	COR (95% Cl)	**p-value**	**AOR (95% CI)**	**p-value**
Sex of the household head				
Male				
Female	0.726(1.081-2.758)	0.022	2.182(1.143-4.164)	0.018
Family structure				
Monogamous				
Polygamous	0.447(.243-.824)	0.010	0.381(0.188-0.770)	0.007
Religion				
Orthodox				
Other	0.616(.440-.864)	0.005	0.545(0.367-0.808)	0.003
Women work status				
Working				
Not working	0.642(.454-.909)	0.012	0.672(0.453-0.996)	0.048
Intimate partners violence				
No				
Yes, low to high	2.086(1.378-3.157)	0.001	1.826(1.152-2.893)	0.010
Father's literacy status				
Literate				
Illiterate	0.679(0.486-0.949)	0.023	0.629(0.417-0.949)	0.027
Household wealth				
Poorer and poorest				
Medium	1.785(1.161-2.743)	0.008		
Richer and richest	1.562(1.072-2.277)	0.020		
Place of delivery				
Institution				
Home	0.604(0.429-0.851)	0.004		
Postnatal check				
Yes				
No	0.570(0.369-0.881)	0.011		
Children ever born				
1-3				
4-6	0.574(0.393-0.839)	0.004		
6+	0.678(0.431-1.065)	0.092		
Birth order				
First				
Other	0.773(1.527-1.133)	0.187		
Immunization				
Had at least one vaccination				
Never had vaccination	0.359(0.196-0.660)	0.001		
Mothers' literacy status				
Literate				
Illiterate	0.562(0.403-0.784)	0.001		
Residence				
Urban				
Rural	0.566(0.337-0.949)	0.031		
Wealth at community level (%)	1.285(1.075-1.536)	0.006		
Women education at the community level (mean years completed)	1.224(1.100-1.363)	0.000	1.192(1.055-1.347)	0.005

Table 7.3 Unadjusted and adjusted odds ratio for determinants of mothers' treatment-seeking behavior for ARI episode in Ethiopia, 2016 (n=1280).

Characteristics	Unadjusted		Adjusted	
	COR (95% CI)	p-value	AOR (95% CI)	p-value
Sex of the household head				
Male				
Female	2.286(1.569-3.331)	0.000	1.861(1.233-2.808)	0.003
Place of delivery				
Institution				
Home	0.341(0.258-0.452)	0.000	0.551(0.392-0.773)	0.001
Postnatal check-up				
Yes				
No	0.332(0.230-0.480)	0.000	0.548(0.358-0.839)	0.006
Intimate partners violence				
No				
Yes, low to high	1.998(1.457-2.740)	0.000	1.556(1.106-2.190)	0.011
Birth order				
First				
Other	0.522(0.381-0.716)	0.000	0.641(0.450-0.911)	0.013
Immunization				
Had at least one vaccination				
Never had vaccination	0.457(0.281-0.742)	0.000	0.475(0.285-0.792)	0.004
Father's literacy status				
Literate				
Illiterate	1.537(1.167-2.024)	0.002	0.672(0.504-0.896)	0.007
Household wealth				
Poorer and poorest				
Medium	0.951(0.678-1.334)	0.772		
Richer and richest	1.970(1.456-2.665)	0.000		
Type of family structure				
Monogamous				
Polygamous	1.141(0.839-1.550)	0.401		
Mother's literacy status				
Literate				
Illiterate	1.537(1.167-2.024)	0.000		
Women work status				
Working				
Not working	0.644(0.490-0.847)	0.002		
Children ever born				
1-3				
4-6	0.739(0.549-0.995)	0.046		
6+	0.787(0.558-1.109)	0.171		
Residence				
Urban				
Rural	0.246(0.150-0.404)	0.000		
Wealth at community level (%)	1.478(1.283-0.703)	0.000		
Women education at the community level (mean years completed)	1.191(1.098-0.292)	0.000		

Among the household and community variables, the odds of care-seeking increases in both diarrhea and ARI for female-headed households compared to male-headed households (AOR=2.182, 95% CI:1.143-4.164 and AOR=1.861, 95%CI: 1.233-2.808, respectively). The likelihood of care-seeking for diarrhea episodes decreases by about 62% in women living in polygamous households compared to those living in monogamous ones (AOR =0.38, 95% CI:0.0188-0.770). Mothers who experienced low to high domestic violence have increased the likelihood of care-seeking behavior by 1.83 and 1.56 times for their children's diarrhea and ARI episodes, respectively. Compared to followers of Orthodox Christianity, women from other religious faiths (Muslim, Catholic Christians, and others) have lower odds of care-seeking in case of diarrhea episodes (AOR =0.545, 95% CI: 0.367-0.808).

7.5 Discussion

The study shows that less than half (43%) of households sought medical care for diarrhea and barely over a third (35%) of households sought medical care for symptoms of ARI. Though the low reporting of care-seeking behavior is partly attributed to poor health infrastructure and poverty at the national scale, this study argued that the likelihood of seeking care for diarrhea and ARI is heavily determined by a set of predisposing and enabling factors at the individual level.

Among the predisposing characteristics of children, birth order is the only predictor significant for ARI-only. There is an inverse relationship between the birth order of the child and care-seeking during the ARI episode, suggesting that care-seeking declined for the second and subsequent births. The increased confidence mothers develop during subsequent births partly explains why many mothers did not seek medical attention for symptoms of diarrhea and ARI[20]. Interestingly, the analysis indicated more effects of fathers' education than mothers' education. The effect of fathers' education may stem from the fact that they usually have better jobs and/or that higher income to the families. As educated fathers can better-recognizing danger signs of childhood illnesses, there is no doubt it motivates the

household to seek medical help. It is usually the mother's responsibility to take the child to health facilities. The historical mortality-education researchers of the twentieth century [21,22] reported the effect of successful completion of primary schooling or functional literacy as enough to promote child health and survival. A study in India found that even after controlling for assets owned by the household, the probability of seeking care increases with the educational qualification of the father [23]. Although the bivariate analysis showed a significant association between mother's education and the two outcomes, it turns out insignificant once other variables were included in the models. Previous studies documented that literate mothers have several advantages over illiterate ones with regards to the quality of childcare[24–26] as they generally tend to make aggressive use of health care services [26].

The effect of religion on care-seeking behavior agreed with earlier studies. A study in rural Ethiopia reported that Orthodox Christian households are more likely to seek modern health care and seek care earlier compared to Muslim-headed households [14]. Similarly, another local study on maternal health-seeking behavior based on the Ethiopian DHS found that Muslim women are less likely to seek postnatal care compared to Orthodox Christian women[27]. In the present study, which is nation-wide, mothers from Orthodox Christianity were more likely to seek treatment for diarrhea episodes.

There are few studies conducted to assess the effects of polygamous family structure on health-seeking for childhood morbidities. After controlling for household wealth and maternal education, our result suggests significant adverse effects of mothers in polygamous marriages on care-seeking during diarrhea episodes. One pioneer study on polygamy in Africa reported that being in a polygamous household has little impact on the likelihood of children receiving medical treatment for fever or diarrhea[28]. On the contrary, Arthi and Fenske (2018) reported that polygyny is negatively associated with a range of indicators of early life care in the Nigerian DHS [29]. They also pointed out that competition between wives with the same husband leads to relative inefficiency in resource production

and consumption compared to hypothetically more harmonious monogamous unions, in turn reducing child health [29]. In 2012, Henrich, Boyd, and Richerson [30] further reiterated that polygamous men usually prefer to divert their resources into accumulating additional wives rather than into raising existing offspring.

Another striking finding of the present study is the positive association between mothers' experiences of Intimate Partner Violence and treatment-seeking for both diarrhea and ARI. Consistent with this finding, a recent study in Bangladesh [31] reported that infants of mothers exposed to different forms of family violence had 26% to 37% higher incidence of diarrhea, thus most sought care. In another study in India, treatment-seeking was most prevalent in women who had been exposed to a combination of physical, sexual, and emotional abuse (48.8%) [32]. Given the fact that most Ethiopian women have poor education and low autonomy, it aggravates the likelihood of women experiencing different forms of domestic violence.

The study clearly reiterated that the use of basic maternal and child services (institutional delivery, postnatal care, and basic immunization) makes significant differences in the likelihood of developing care-seeking behavior for ARI but not for diarrhea. Studies in other developing countries reported that fever and ARI were more frequently treated at a facility, while diarrhea was usually treated at first at home [33,34]. The use of the simple and standard treatment for diarrhea treatment (ORS or HRS) remains suboptimal in many countries including Ethiopia. In a recent study in Tanzania, for instance, almost all children (99 %) treated at home received ORS or RS)[33]. Some previous studies have indicated the continuum effects of attending ANC and delivery on subsequent use of health facilities. They claimed that these basic health services are commonly used as an opportunity for health promotion [35]. Thus, women who attended ANC/delivery/ postnatal care services can easily acclimatize to the health facility environment [36]. This may help them avoid unnecessary fear and stress related to the utilization of

childcare and related services. In Ethiopia, the eight basic vaccination services are provided at both the conventional health facilities and through occasional village campaigns. Such campaigns are also usually used to counsel and educate women about signs and symptoms of common childhood illnesses and the risks associated with them.

Strength and limitations

As the study was conducted based on nationally representative data, the generalizability of the current study to a wider population group is a major strength. Further, the factors analyzed in this study have not been addressed much in previous studies, and hence, sheds light on possible interventions to improve child health and survival in Ethiopia. However, certain limitations warrant careful interpretation of the results of the study. First, care-seeking was examined for only two common childhood morbidities (diarrhea and ARI) due to data limitations. Second, childhood morbidity is season dependent. A longitudinal study may be more suitable to provide data covering different seasons. Third, the DHS system generated the morbidity data based on mothers' reports of their children's health in the past two weeks preceding the survey. The responses could be biased as they depend on mothers' perceptions of reality than on clinical examination, and hence, might have introduced some reporting bias and recall bias, creating either under-reporting or over-reporting of childhood illnesses. Due to a lack of data, the present study did not address some of the factors that significantly affect health-seeking behavior such as socio-cultural taboos and prevalence of traditional healthcare in the environment, accessibility to service, the trust in healthcare providers, and prior beliefs concerning the treatment of the illness, and perception of the severity of illness.

7.6 Conclusion

Our study indicated that a substantial proportion of Ethiopian women did not seek health care for their children's diarrheal and ARI conditions. More coordinated efforts should be made to ensure equitable access to health care services focusing on low-income households and mothers of poor education. Strengthening partnerships with public facilities, private health care practitioners, and community-based organizations would help further improve access to the services. Promoting continuous community-level health education should be more crucial areas of concern for rural health extension workers and program administrators in Ethiopia.

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CHAPTER EIGHT

MULTIPLE ANTHROPOMETRIC AND NUTRITIONAL DEFICIENCIES IN YOUNG CHILDREN IN ETHIOPIA: EFFECTS OF MATERNAL CHILDCARE PRACTICES

The paper is under review in BMC Pediatrics as Nigatu Regassa Geda, Cindy Xin Feng, Carol J. Henry, Rein Lepnurm, Bonnie Janzen, Susan J. Whiting(2020). Multiple anthropometric and nutritional deficiencies in young children in Ethiopia: A multi-level analysis based on nationally representative data.

I contributed to the study design and conceptualization of the study, entire data analysis, data interpretation and drafted the manuscript.

8.1 Abstract

Background: In Ethiopia, child undernutrition and anemia are major public health concerns, resulting in increased childhood morbidity and mortality. Despite progress made to reduce the prevalence of malnutrition (especially stunting) from 50% in 2000 to 38% in 2016, little is known about the magnitude and risk factors for concurrent low indices of body composition in Ethiopia.

Methods: Analysis for this study was based on a total sample of 9218 children aged 6-59 months drawn from the Ethiopian Demographic and Health Survey (EDHS) conducted in the year 2016. The study used two outcome variables: a Multiple Nutrition Deficit (MND) index formed by combining stunting, underweight, wasting and anemia status, and a concurrent stunting and anemia (CAS) index. Two mixed effect regression models, Poisson and Logistic, were used to identify the key risk factors of the two outcome variables, respectively**.**

Results: The proportion of stunted (length-for-age), underweight (weight-for-age) and wasted children (weight-for-length) was 38%, 25.2% and 9.4%, respectively. About 58 % of the children were anemic.

The prevalence of concurrently stunted and anemic children was 24.8%. Our results showed that the risks of multiple nutritional problems were determined by a range of individual, household and behavioral factors including sex of the child, age of the child, birth order, parity, parental education, religion, household wealth index and type of family structure. The proximate variables (hygiene and sanitation score, feeding practice, and child health service utilization score) were also found to exert a strong influence on the risk of multiple nutritional deficiencies.

Conclusions: This study underscores the importance of improving household hygiene and sanitation conditions, promoting proper feeding and diet diversity. Allocation of resources to educate parents (especially women) could improve children's nutritional status through increased income for accessing nutritious food and health services, changes in autonomy and decision making.

Keywords: Anemia, inequalities, undernutrition, stunting, wasting, underweight

8.2. Introduction

Worldwide undernutrition restricts fetal growth causing stunting and wasting; furthermore, micronutrient deficiencies are responsible for the annual death of 3.1 million children under five years of age [1]. It is estimated that 45% of deaths among children under 5 years of age are linked to undernutrition (WHO,2018). Stunting is a chronic form of malnutrition, a result of long-term nutritional deprivation and defined as height-for-age < -2 standard deviation of the World Health Organization growth standard median[2]. Wasting represents thinness, i.e., weight-for-height < -2 SD, and underweight reflects low body mass relative to chronological age, i.e., weight-for-age <-2 SD [2]. Globally, 159 million and 50 million children are affected by stunting and wasting, respectively[3]. In Sub Saharan Africa, the prevalence of underweight, stunting and wasting in children under five was 21%, 40% and 9%, respectively [4].

Studies show that undernourished children are less productive physically and mentally, have increased susceptibility to infections, and are at risk of early death[5–7]. Victora et al. reported that poor early childhood growth (stunting) in the first two years of life or poor foetal growth in pregnancy results in irreversible effects including short stature at maturity, lower educational attainment, reduced earnings as adults and offspring with low birth weights[8].

Previous studies around the world reported the heightened risk of mortality for children with multiple nutrition deficits[9–11]. For instance, a child who is both wasted and stunted is 12 times more likely to die than a child who is either wasted or stunted[12]. Clustering of nutrition problems could occur at country, household, or individual levels, and there is considerable overlap of risk factors, particularly in the basic and underlying determinants[1,9,13]. Studies indicated that anemia and stunting share many of their basic and underlying risk factors[9,14]. Suboptimal feeding and poor hygiene & sanitation practices

for children result in a higher likelihood of childhood illnesses, which are often immediate causes of many negative health outcomes [9,15].

In Ethiopia, in 2012, the prevalence of stunting, underweight and wasting among under-5 years of age children were reported as 44.4 %, 28.7 % and 9.7 %, respectively [16]. As of 2016, 38% of children under-5 years of age were stunted. Stunting in children was higher in rural areas (40%) than in urban areas (25%)[17]. About 58% of under-5 children in Ethiopia were anemic[17]. Despite the significant progress made by the Ethiopian government in reducing the unacceptably high prevalence of stunting and anemia among under-5 children, these problems continue to need attention. A recent assessment by the International Fund for Agricultural Development/IFAD confirmed that Ethiopia has huge systematic inequalities in -undernutrition of children both within households and community levels[18].

The very few studies conducted on this subject in Ethiopia are limited to investigating the determinants of one of the three types of child malnutrition (i.e., stunting, wasting or underweight), and most of which were conducted using micro-level data [10,19,20]. Nevertheless, children are likely to be affected by double or even multiple forms of nutritional problems, which have not been investigated well [9,11]. For instance, a child could be underweight, stunted and anemic at the same time, driven by underlying and unobserved risk factors. This undoubtedly poses significant challenges to child survival[9,10,21]. A study by Shimelis and colleagues[9] was the only study on a nationally representative data reporting considerable co-occurrence of anemia and stunting (CAS) in Ethiopia [9]. This study, however, addressed only children 6-23 months of age and did not address undernutrition in its entirety.

The present study aims to examine inequalities and risk factors of multiple occurrences of undernutrition and anemia among children of age 6-59 months in Ethiopia based on nationally representative data.

8.3 Methods and materials

8.3.1 The study context

The most recent estimate of the World Bank report[22] indicates that Ethiopia has a population of 109 million, making it the second-most populous nation in Africa after Nigeria[22]. According to the report, the country is one of the poorest, with an annual per capita income of $790 [22]. Administratively, Ethiopia is a Federal Democratic Republic with nine autonomous Regional States, each divided into zones, districts and sub-districts/ kebeles [23]. Agriculture has been the main driver for the fast-growing Ethiopian economy, responsible for 85% of total employment[18]. Although the rapid economic growth is attributed to the enhancing productivity of agriculture, particularly of crop production but chronic malnutrition (stunting) of children remains unacceptably high. Considering the new Sustainable Development Goals (SDGs), nutrition has been recognized as a major need for sustainable development[18].

The government of Ethiopia has developed various development plans and strategies to increase food security, improve nutrition and reduce poverty[23–25]. The National Nutrition Program II targeted implementation of both nutrition sensitive and non-nutrition sensitive interventions to significantly improve maternal and child nutrition in the country.

8.3.2 Data sources

We used data from the Ethiopian Demographic and Health Surveys (EDHS) for 2016. The 2016 survey is one of a series of nationally representative samples, conducted for the fourth time since 2000. The EDHS are cross-sectional data containing comparable household and individual information about sociodemographic characteristics and health indicators such as maternal and child health and nutrition. The EDHS surveys have been carried out nationally by the Central Statistical Agency (CSA) under the guidance of the Ministry of Health (MOH). The data were extracted from children's' file containing

entries for under 5 children. Infants below six months of age were excluded since EDHS did not collect data on hemoglobin level for this age group. A total of 9218 children aged 6–59 months were extracted from the dataset for final analysis.

8.3..3 Ethical clearance

The EDHS surveys are well-established, nationally representative data and respected global initiatives conducted with appropriate permission from the Ethiopian government and informed consents. Approval to access the datasets was obtained through online registration to ICF International (http://dhsprogram.com/data/Access-Instructions). ICF International (U.S.) and the Central Statistics Authority (Ethiopia) granted permission for the use of EDHS. Ethical approval was also received by the University of Saskatchewan, Behavioral Research Ethics Committee.

8.3.4 Variables and measures

The Ethiopian Demographic and Health Surveys collected information on the health and nutritional status of children. Undernutrition of children was measured using height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) z-scores. The z-scores then were categorized into stunted (HAZ < -2 z-scores), under-weight (WAZ< -2 z-scores) and wasting (WAZ< -2 z-scores), respectively, indicating growth retardation [2]. This is a standard cut-off point proposed by the WHO to measure undernutrition [2,26]. Anemia status was defined by hemoglobin < 11 g/dL[15], and the measure was adjusted for altitude, but not for inflammation.

The present study used two different outcome variables: the number of four possible nutritional problems and concurrent stunting and anemia (CAS). In the primary analysis, a coding of 1 was used if a child had any of the three anthropometric deficits (stunting, underweight, wasting) or anemia and "0" if the child experienced no nutritional problems. For the secondary analysis, concurrent anemia and stunting (CAS) were used as the outcome variable. For the CAS, 1 represented if a child was both

anemic and stunted the same time, and 0 otherwise. Children concurrently stunted and anemic were defined as having HAZ < −2 and hemoglobin < 11 g/dL.

The selection of the explanatory variables was made based on the review of literature, availability of the variable in the data set and statistical plausibility. The factors influencing multiple anthropometric deficit and CAS were broadly classified as maternal and child characteristics (maternal education, autonomy, maternal parity, maternal age, child's age, child's sex, child's birth order); household factors (the type of family structure, religion, household wealth); child care practices (feeding practices, child health service utilization score, hygiene and sanitation practice score); and community-level variables (mean maternal education and wealth at cluster level, and type of residence).

Scores were constructed for some of the potential predictors by combining different variables. For instance, the hygiene and sanitation score was measured by combining responses of household ownership of facilities that ensure hygienic separation of human excreta from human contact (which include flush or pour-flush toilet/latrine, piped sewer system, septic tank, pit latrine, Ventilated Improved pit (VIP) latrine, pit latrine with slab and composting toilet)[27], hand washing and access to drinking water. The value for hygiene and sanitation score ranged between 0-6. Child health service utilization score was constructed from six dichotomous responses (Antenatal Care/ANC, delivery care, postnatal care, vitamin A, iron supplementation and deworming pills), each coded as 0 or 1. Adding these values for each respondent yields a score ranging between 0 to 6. Diet diversity score (DDS) was measured based on the consumption of the seven food groups (0=no, yes=1) according to the WHO's IYCF guidelines [28]. These food groups are: (i) grains, roots, and tubers; (ii) flesh foods (meat, fish, poultry and liver/organ meats); (iii) legumes and nuts; (iv) vitamin A rich fruits and vegetables; (v) eggs vi) dairy products (milk, yogurt, cheese); (vii) other fruits and vegetables[28]. The DDS score was

obtained by summing up the binary responses, and the dietary diversity score ranges from zero to seven, where a higher score represents the higher level of diet diversification.

Household wealth was used as a proxy to household income and was estimated in the DHS with an asset-based index that combined information about ownership of consumer goods and housing quality. It was sorted into three categories for purposes of analysis: poorer, middle, and richer. Similarly, maternal autonomy was measured based on five responses related to her decision making on important household purchases, childcare and mobility. The remaining explanatory variables (such as sex and age of the child, family structure, breastfeeding, and frequency of access to media) were used as coded in the original data.

As the DHS data file does not provide complete information about malaria inflammation, the present study did not include this variable in the CAS analysis. Also, underweight status was included in the count of multiple nutritional deficit outcome variable despite it is viewed as a composite index of stunting and wasting. This was also true for previous studies conducted using the DHS data set[9].

8.3.5 *Statistical analysis*

We analyzed the data using STATA version 12[29]. All analyses were weighted for the sampling probabilities and considered the stratification and clustering nature of the data. Descriptive analysis was used to examine the characteristics of the study sample.

The DHS data are clustered i.e., mothers are nested within households, and households are nested within clusters; as such, mothers within the same cluster may be more like each other than mothers in the rest of the clusters. This violates the assumption of independence of observations across the clusters, and hence, limits the use of conventional regression[30]. For the present analysis, the enumeration areas/EAs were used as clustering women respondents. Mixed-effects Poisson regression was used (for the count outcome variable) and mixed- effect logistic regression model (for CAS) to test

the effect sizes of individual, household, and community factors. Multicollinearity between the potential predictors was checked using tolerance test, variance inflation factors. To achieve a parsimonious model, a bivariate analysis was firstly conducted, and all potential predictors which statistically associated with the outcomes with a p-value<0.20 were subsequently included in the multivariable analysis. The Akaike Information Criterion (AIC) was used as model selection criteria. In the final model, a p-value of <0.05 was used to define statistical significance. The model fit was checked using the ratio of Deviance and Degree of Freedom i.e., Deviance/ DF[31].

8.4. Results

8.4.1 Characteristics of the participants and nutritional status

Table 8.1 summarizes the characteristics of the 9218 participants and the distribution of children by nutritional status. The sex distribution of children shows that 51.6% were males and 48.4% females. Most of the respondents (53.8%) were in the main childbearing ages of 24-34 y. The proportion of those in the age groups 15-24 and 34+ was 20.8 % and 25.4%, respectively. The mean age of mothers was 29 years (with SD of 6.6). About 11% of the children were living in rural areas. Most of them were from parents with a Muslim background (40.6%) followed by Orthodox Christian (35%). Two-thirds of the mothers and about 50% of fathers had no education, only 6.8% and 11.2% of mothers and fathers were in secondary and above levels, respectively. A little more than half of the respondents live in medium-size households (4-6 members), and there is still quite a good proportion of them (39.2%) living in the largest size households (7+ members). A greater proportion (46.8%) of the children were living in the poorer households compared to those living in richer households (32.2%). (see Table 8.1).

Table 8.1 further presents the distribution of the proportion of children by the nutritional status of children. The computed overall prevalence of undernutrition (stunting, underweight and wasting) and

anemia among the study participants (6-59 months) were high by any standard: stunting (40.7%), underweight (25.2%), wasting (9.4%) and anemia (57.6%).

It is noted that child stunting and underweight were higher among male children compared to females; 43% for stunting and 27% for underweight in males compared to 37.7% and 23.2% in females. There was no sex difference in wasting or anemia prevalence. The prevalence of child undernutrition was much higher in rural areas, and the difference was more pronounced for stunting and underweight. Compared to Orthodox Christian and other religions, children from Muslim households were more prone to experiencing underweight, wasting and anemia, but not stunting. There are noticeable differences in nutritional problems across maternal education groups; for example, all prevalence are highest among children of mothers with no education. There is a notable consistent decline in the prevalence of stunting, wasting, underweight and anemia as we move from the poorest/poorer to the richest/richer wealth groups. For instance, stunting declined from 27% among the poorest/poorer quantile to 9.5% for the richest/richer category.

Table 8.1 Proportion of under-5 children stunted, wasted, underweight and anemic by selected background characteristics, Ethiopia.

Characteristics	Stunting n (%)	Underweight n (%)	Wasted n(%)	Anemic n= (%)
Sex of the child				
Male	1931(43.4)	1209(27.1)	421(9.4)	2534(57.7)
Female	1575(37.9)	965(23.2)	388(9.3)	2345(57.5)
Place of residence				
Urban	262(28.4)	134(14.5)	80(8.7)	424(49.4)
Rural	3244(42.2)	2040(26.5)	729(9.5)	4455(58.5)
Age of mother				
15-24	813(37.9)	490(22.7)	221(10.3)	1106(62.9)
25-34	1920(36.8)	1234(23.6)	487(9.3)	2661(57.9)
34+	947(39.9)	590(24.8)	261(10.9)	1115(52.3)
Religion				
Orthodox	1281(43.1)	748(25.1)	232(7.8)	1384(47.5)
Muslim	1365(39.2)	918(26.4)	387(11.1)	2314(67.5)
Others	859(39.9)	507(23.5)	190(8.8)	1180(55.3)
Education of mothers				
No education	2511(43.8)	1663(28.9)	592(10.3)	3331(58.6)
Primary level	873(37.8)	447(19.4)	179(7.8)	1295(56.9)
Secondary and above	123(821.7)	63(11.2)	38 (6.7)	252(48.8)

Education of husband				
No education	1964(45.0)	1292(29.5)	457(10.4)	2542(58.7)
Primary	1278(38.7)	744(22.5)	279(8.4)	1876(57.3)
Secondary and higher	263(28.1)	137(14.6)	74(7.9)	460(52.8)
Household size				
1-3 members	346(44.0)	204(26.0)	76(9.7)	472(61.5)
4-7 members	1764(39.7)	1078(24.2)	372(8.4)	2412(55.3)
7+	1396(41.3)	891(26.3)	361(10.6)	1995(59.7)
Wealth index				
Poorest	1879(46.8)	1268(31.5)	457(11.3)	2505(63.0)
Poorer	742(40.5)	441(24.1)	170(9.3)	980(53.8)
Middle	886(32.0)	464(16.8)	182(6.6)	1393(52.0)

8.4.2 Multiple nutritional deficit and CAS

As stated in the methods section, the first outcome variable was measured by combining the four nutritional problems. It is a count variable, ranging from 0 to 4, which indicates the number of nutritional problems a single child experienced. The outcome variable has a positively skewed distribution with a large proportion of zeros.

In the secondary analysis, concurrent anemia and stunting (CAS) is the outcome of interest since the prevalence of children concurrently stunted and anemic was the highest (24.8%.) compared to other pair-wise co-occurrences of the nutritional problems (Figure 8.1), such as the concurrent stunted and underweight (20.2%.), Children concurrently wasted and anemic, and wasted and underweight were each much lower (6%). Other possible co-occurrences (such as wasting and stunting; underweight and anemia) were insignificant (not shown in the figure). The prevalence of concurrent stunting and anemia varied across population groups (Table 8.5).

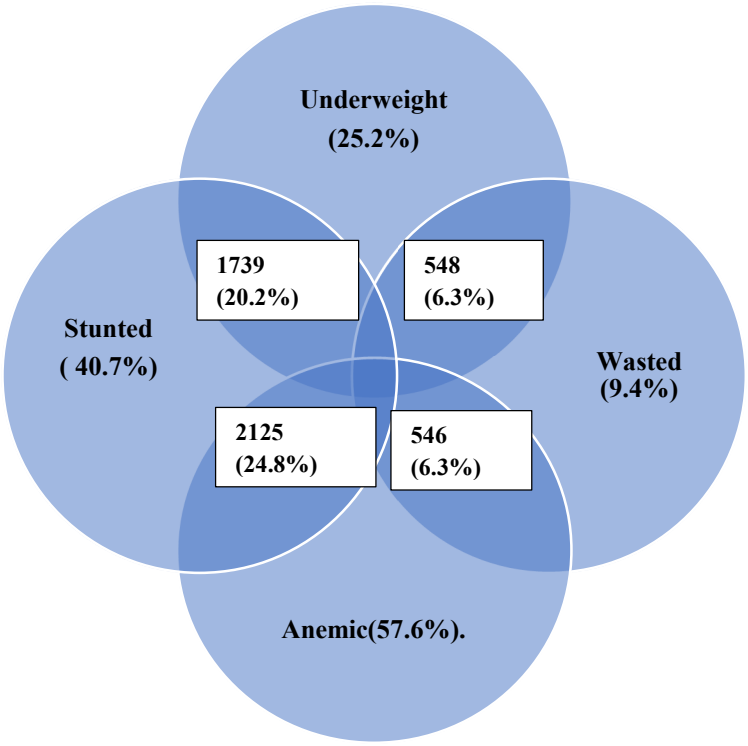

Figure 8.1: Concurrent nutrition deficit and CAS

8.4.3 Bivariate associations

In Table 8.2, the results of the chi-square analysis show a strong significant association between considered exposure variables and the outcome variable, i.e., concurrent stunting and anemia. The table contains both background variables and childcare practice variables. Similarly, Table 8.3 presents bivariate mixed effect Poisson regression for multiple nutrition deficiency by background and some childcare practice variables. Those variables in the two bivariate analyses with p-value<0.2 will be entered into the multivariable mixed effect regression analysis in Table 8.4 and Table 8.5.

Table 8.2 Results of bivariate (Chi-square) analysis for the association between the explanatory variables and concurrent stunting and anemia (CAS), Ethiopia.

Characteristics	No CAS	CAS	Chi-square (p-value)
Maternal and child characteristics			
Sex of the child			
Male	3251(73.4)	1180(26.6)	16.57(0.000)
Female	3191(77.2)	944(22.8)	
Age of the child			
6-23 months	2262(76.7)	687(23.3)	20.93(0.000)
24-35 months	1297(71.1)	526(28.9)	
Above 35 months	2884(76.0)	911(24.0)	
Child's birth order			
First	1163(77.1)	346(22.9)	3.45(0.033)
Second and above	5279(74.8	1779(25.2)	
Age of mothers			
15-24	1266(71.8)	497(28.2)	16.41(0.000)
24-35	3504(75.5)	1138(24.5)	
35+	1673(77.3)	490(22.7)	
Education of mothers			
No education	4167(72.8)	1553(27.2)	69.63(0.000)
Primary level	1788(78.2)	499(21.8)	
Secondary and above	488(87.0)	73(13.0)	
Education of fathers			
No education	3173(72.9)	1182(27.1)	54.46(0.000)
Primary level	2491(75.8)	797(24.2)	
Secondary and above	779(84.3)	145(15.7)	
Wealth index			
Poorest	2792(69.9)	1202(30.1)	126.50 (0.000)
Poorer	1407(76.9)	423(23.1)	
Middle	2244(81.8)	500(18.2)	
Type of family structure			
Monogamous	5445(75.6)	1757(24.4)	1.43(0.220)
Polygamous	672(72.6)	253(27.4)	
Religion			
Orthodox	2335(79.1)	617(20.9)	36.64(0.000)
Others	4107(73.2)	1507(26.8)	
Never breast fed the child			
No	6204(75.2)	2043(24.8)	3.45(0.150)
Yes	239(74.7)	81(25.3)	

Table 8.3: Bivariate mixed-effects Poisson regression for the predictors of multiple nutritional deficiencies, Ethiopia.

		95 % CI for RR		
Characteristics	**RR**	**Lower**	**Upper**	**p-values**
Sex of the child				
Male				
Female	0.926	0.891	0.963	0.000
Child's age				
0-23 months				
24-35 months	1.001	0.951	1.055	0.960
36-59 months	0.769	0.737	0.804	0.000
Child's birth order				
First				
Second and above	0.703	0.668	0.741	0.000
Age of mother				
15-24				
25-34	0.762	0.724	0.802	0.000
35+	0.863	0.812	0.916	0.000
Education of mother				
No education				
Primary level	1.037	0.984	1.094	0.174
Secondary and above	0.916	0.833	1.007	0.069
Education of father				
No education				
Primary level	0.923	0.878	0.970	0.002
Secondary and above	0.993	0.925	1.066	0.853
Religion				
Orthodox				
Others	0.864	0.798	0.935	0.000
Intimate partners violence/IPV				
Yes				
No	1.005	0.956	1.057	0.835
Wealth index				
Poorer/poorest				
Middle	0.915	0.856	0.978	0.009
Richer/richest	0.824	0.772	0.879	0.000
Parity				
0-3				
4-6	0.736	0.702	0.771	0.000
6+	0.674	0.638	0.713	0.000
Breast feeding				
Never				
Breast feed	0.703	0.635	0.779	0.000
Intake of Iron supplement				
Yes				
No	1.045	0.967	1.131	0.261
Diet diversity score	0.943	0.924	0.962	0.000
Child health service score	1.127	1.107	1.147	0.000
Water, hygiene, and sanitation	1.099	1.075	1.125	0.000
Mean maternal education at cluster level	0.976	0.950	1.003	0.082

8.4.4 Multivariable mixed effect regression analysis for multiple nutritional problems

In Table 8.4, the Poisson regression for multiple nutritional deficits (stunting, underweight, wasting, and anemia) is presented. The table portrays the Rate Ratios (RR) along their respective confidence intervals and p- values. Fourteen variables appeared to be associated with the outcome variables (the number of nutritional problems a child was reported to have) significantly. The model fit statistics show that the model is non over dispersed and the Poisson regression model is appropriate for the present analysis. The random effect is also significant (p=000), showing considerable between group/ cluster variations. The covariate effect is interpreted as: for every one-unit increase in the covariate, and the covariate has a multiplicative effect of exp(b)(denoted as RR) on the expected mean of number of conditions.

Among the maternal and child factors, eight of them appear as significant predictors of multiple nutritional problems. This includes the sex of the child, age of the child, birth order, parity, maternal age, maternal education, paternal education, and wealth index. Holding everything else fixed, the expected mean of nutritional problems decreased among male children by 8% (RR=0.925, 95% CI:0.877-0.975) compared to females. The expected mean of multiple nutritional challenges increases as the child's age increases. The expected mean is 2.03 and 1.56 times higher for children in the age group 24-35 months and 35+, respectively. Holding everything else fixed, the expected mean of nutritional problems decreased among children born in second and above rank by 24.5% (RR=0.755, 95% CI: 0.706-0.807). Keeping other variables fixed, it is noted that the expected mean of multiple nutritional problems significantly decreases by 26% and 39% as women's parity increases from parity 4-6 and 6+ children, respectively. There is a clear decline in the expected mean of multiple nutritional problem as the education of mothers increases. The expected mean is lower by 10% and 28% for mothers with primary and secondary education respectively, compared to the reference category. Similarly, the

expected mean decreases by 6% for fathers with primary level education (RR=.938; 95% CI:0.891-0.988). Among the household variable, a significant decline in the expected mean was observed as household wealth increases: children living in households with medium wealth and richer/richest status experience 9% and 16.5% lower risk, respectively, compared to the reference category.

Among the childcare/ behavioral factors, four variables have become significant determinants of the outcome variable. The expected mean of multiple nutritional deficiencies decreases by 11% for breastfed children compared to those never breastfed (RR= 0.894, 95% CI:0.801-0.998). For everyone unit increase in diet diversity score of a child, the expected mean decreases by about 3% (RR=0.972, 95% CI: 0.953-0.992). The expected mean appeared to increase by 1.1 times for unit increase in the score of child health service utilization and hygiene and sanitation score.

Table 8.4: Multivariable mixed-effects Poisson regression for the predictors of multiple nutritional problem, Ethiopia.

		95 % CI for RR		
Characteristics	**RR**	**Lower**	**Upper**	**p-values**
Random-effects Parameters				
Cluster/ EAs	0.249	0.213	0.292	0.000
Fixed effect				
Sex of the child				
Male				
Female	0.906	0.869	0.944	0.007
Child's age				
0-23 months				
24-35	2.031	1.911	2.160	0.000
36-59	1.556	1.461	1.657	0.000
Child's birth order				
First				
Second and above	0.755	0.706	0.807	0.000
Age of mother				
15-24				
25-34	1.009	.948	1.074	0.777
35+	1.389	1.274	1.513	0.000
Education of mother				
No education				
Primary level	0.896	0.847	0.949	0.000
Secondary and above	0.721	0.649	0.801	0.000
Education of father				
No education				
Primary level	0.938	0.891	0.988	0.016
Secondary and above	0.998	0.924	1.079	0.970
Religion				
Orthodox				

Others	0.938	0.866	1.015	0.113
Parity				
0-3				
4-6	0.741	.698	0.786	0.000
6+	0.613	0.566	0.664	0.000
Breast feeding				
Never				
Breast feed	0.894	0.801	0.998	0.046
Diet diversity score	0.972	0.953	0.992	0.007
Child health service score	1.099	1.079	1.121	0.000
Sanitation score	1.080	1.036	1.126	0.000
Mean maternal education at cluster level	0.978	0.953	1.004	0.103
Constant	0.128	0.105	0.156	0.000
Variance for only random effect model: Number of groups/clusters: 589 Deviance/DF= 1.53	.0327	0.283	0.377	0.000

Note: the covariate has a multiplicative effect of exp(b), which is denoted as RR, on the expected mean of number of nutritional deficiencies.

In Table 8.5, results from mixed-effect logistic regression analysis on predictors of concurrent stunting and anemia are given. The significant predictors included four maternal and child health characteristics (sex of the child, age of the child, maternal and paternal education), two household-level predictor (religion and household wealth index), one behavioral factor (hygiene and sanitation score) and one community-level factor (mean maternal education at cluster level).

In the adjusted analysis, holding everything fixed, the odds of CAS decreases by 17% (AOR=0.826; 95%CI:0.736-0.927) for male children compared to female children. The likelihood of concurrent stunting and anemia is 6.548 times higher for children aged 24-35 months and 8.152 times for children aged 35+ months compared to the younger children aged (less than 24 months). As expected, maternal education resulted in a significant association with the outcome variable. The likelihood of concurrent stunting and anemia decreased by 36% for mothers having secondary plus education, compared to those with no education. Similarly, the incidence of CAS decreased by about 20% for children with fathers having secondary and higher education.

Children from parents of other religions were 1.37 times more likely to experience CAS (AOR=1.34, 95%CI: 1.172-1.610) compared to those from Orthodox Christian. The likelihood of a child having CAS significantly decreased as household wealth increased. Children living in rich and richer

/richest households had significantly lower chance of having concurrent stunting and anemia (AOR=0.732; 95%CI: 0.614 -0.872 and AOR=0.636; 95%CI:0.536-.0754). The likelihood for a child to experience CAS increased by 1.10 times for every unit increase in improper hygiene and sanitation score.

Table 8.5 Multivariable mixed effect logistic regression for the risk factors of concurrent stunting and anemia, Ethiopia.

			95% CI for AOR		
Random effect	**% stunted and anemic n(%)**	**AOR**	**Lower**	**Upper**	**P-value**
Cluster/ Enumeration areas	NA	0.261	0.182	0.373	0.000
Fixed effect parameters					
Sex of the child					
Male	944(22.8)				
Female	1180(26.6)	0.826	0.736	0.927	0.001
Child's age (months)					
0-23	129(12.5)				
24-35	1085(29.0)	6.548	5.259	8.152	0.000
36-59	911(24.0)	4.288	3.432	5.358	0.000
Age of mother					
15-24	497(28.2)				
24-35	1138(24.5)	0.951	0.818	1.1053	0.513
35+	911(24.0)	0.854	0.7126	1.023	0.086
Education of mother					
No education	1553(27.2)				
Primary level	499(21.8)	0.880	0.757	1.023	0.098
Secondary and above	73(13.0)	0.640	0.479	0.856	0.003
Education of father					
No education	1182(27.1)				
Primary level	797(24.1)	0.884	0.769	1.014	0.079
Secondary and above	145(15.7)	0.805	0.649	0.999	0.049
Religion					
Orthodox	617(20.9)				
Others	1507(26.8)	1.374	1.172	1.610	0.000
Wealth index					
Poorer/poorest	1202(30.1)				
Middle	423(23.1)	0.732	0..614	0.872	0.000
Richer/richest	500(18.2)	0.636	0.536	0.754	0.000
Breast feeding					
Yes	2043(24.8)				
Never	81(25.3)	0.935	0..694	1.258	0.656
Diet Diversity Score/ DDS	1(0)*	0.971	0.919	1.027	0.304
Sanitation score	2(1)*	1.118	1.009	1.240	0.033
Health service utilization score	1(2)*	1.005	.956	1.057	0.833
Mean maternal education at cluster level	4.3(2.6)*	0.937	0.898	0.979	0.004
Constant	-	0.081	0.052	0.126	0.000
Variance of the random-effect only model	-	0.376	0.285	0.495	0.000

* Median and Interquartile range

8.5. Discussion

The present study has primarily aimed at examining the factors associated with the degree of overlap between three anthropometric measures (wasting, stunting and underweight). The study has also aimed at assessing the key risk factors associated with co-occurrence of stunting and anemia among children aged 0-59 months in Ethiopia based on nationally representative data. It is noted that the proportion of children stunted, underweight and wasted was 38%, 25% and 9%, respectively. About 58 % of the sample children were anemic. The prevalence of children concurrently stunted and anemic was 24.8%.

The findings indicate that a considerable proportion of children (about 65.4%) had at least one nutritional deficiency in the form of stunting, underweight, wasting or anemia. Those having two or more deficiencies account for close to 33%. The prevalence of CAS is also high (24.8%). Though studies on multiple anthropometric deficits are very rare, the available evidence suggests that the problem exists across several countries with poor child health and nutrition interventions. A recent estimate of the prevalence and burden of children concurrently wasted and stunted confirmed a prevalence of > 5% in 9 of the 84 countries studied[32]. Similarly, a considerable proportion of multiple anthropometric deficits was reported by a study based on data from 51 countries for three nutrition deficiencies (stunting, wasting, and underweight)[33]. The high proportion of multiple nutritional deficiencies is of a great public health concern as it has huge impacts on the likelihood of child health and survival. In this regard, Myatt and colleaguesreported a strong interaction effect of wasting and stunting on mortality, suggesting that a common mechanism may link wasting and stunting to an increased risk of death[33]. Similarly, a study based on data drawn from 10 countries reported evidence of considerable excess mortality by children who are concurrently wasted, stunted, and underweight[34]

The expected mean of multiple nutritional problems was determined by a range of individual, household, and behavioral factors. The three proximate variables (hygiene and sanitation score, feeding practice and child health service utilization score) were found to exert a strong influence on the expected mean of multiple nutritional deficiencies. Similarly, the mixed effect logistic regression witnessed a significant association between eight background variables and CAS. Among the three key childcare practices, only hygiene and sanitation score had a significant influence on CAS. The type of risk factors of CAS identified in this study have some resemblance to the recent findings of Shimeles and colleagues, which used the same data set. [9] Sex of the child, diet diversity, household wealth, and parental educational level were significant determinants in both studies. However, the study was based on only children of 6-23 months and primarily focused on assessing the dietary and non-dietary associated factors[9]. The following discusses those explanatory variables which are common to both models.

The findings showed that female children are less prone to multiple anthropometric deficiencies and CAS compared to males. Consistent with this finding, studies around the world found that boys were significantly more likely-to-be-concurrently wasted and stunted than girls[32]. A study on concurrent wasting and stunting based on DHS data of Senegal [35] found that boys were at higher risk of being concurrently wasted and stunted than girls (RR = 1.61), which changes rapidly with age. Contrary to this finding, a recent study in Sri Lanka reported that female children had significantly higher rates of underweight and stunting compared to male [36]. The lack of a gender differential in adverse growth-stunting in Bangladesh was attributed to the absence of intra-household gender bias in feeding and health care for children [37]. The inconsistent findings could arise from variations in the sample size, method of analysis and seasonality of the data collected. However, the finding warrants the importance

of considering child's gender during case finding and management/intervention of multiple anthropometric deficits.

It is also noted that the likelihood of multiple nutritional deficits and CAS increases as the age of the child increases. This finding agreed with studies conducted in Ethiopia and in Central Africa Republic[38,39] and other developing countries [40]. The studies claimed that stunting is less common in early infancy as most childrenare breastfed[38–40]. The risk of impaired linear growth increases as breastfeeding is discontinued without adequate complementary feeding and with poor diet diversity[38,41]. The effect of religion on early childcare and the nutritional status of children may be explained as noting that some religious practices and beliefs have an adverse influence on the consumption of some healthy foods, child feeding practices of mothers and dietary intake of children during early ages [36].

The expected mean of multiple nutritional problems and odds of CAS significantly decreased by a considerable amount as we compare children residing in households with the poorest wealth quantiles to those in the richest quantiles. It is difficult, however, to compare these findings to other studies as wealth is measured differently. The few studies conducted in low-income countries across the different continents, based on asset-based wealth index, have inconsistent conclusions. For instance, a study in Thailand showed that underweight and stunting measured by Concentration Index (CI) were least equitably distributed among the lowest income groups [42]. Another study conducted in Brazil showed a decreasing trend of stunting inequality as well as an overall malnutrition rate with wealth[43]. Contrary to these findings, a study in Mexico reported that household poverty is not a necessary condition for children to experience anthropometric deficits [44]. A study in Ecuador found no evidence to indicate any relationship between economic inequality and the nutritional status of children[45].

Remarkable inequalities were found in the expected mean of multiple nutritional deficiencies and CAS based on parental education. Children born from parents with at least a primary level of education

had little chance of experiencing multiple nutritional deficiencies compared to those born from non-educated parents. The finding is consistent with earlier studies conducted in different parts of Ethiopia [46–49]. Recent studies in other parts of the world reached a similar conclusion[50,51]. It is well known that a minimum education provides women with a general awareness of how to utilize available resources for the improvement of their own nutritional status and that of their families. Education may also help mothers be informed about the nutritional values of food and understandings of child physical and mental growth [36]. Education may enable women to make independent decisions, and to have greater access to household resources that are important to nutritional status[52]. The presence of maternal autonomy is one of the most common and plausible explanations about the positive impacts of education on nutritional status. A gender analysis study in eastern parts of Indonesia where women are known to suffer from marginalization, reported the presence of very high levels of chronic child undernutrition (58% stunting and ~33% underweight)[53]. Maternal marginalization and depreciation generally pass through a wide range of pathways to affect child health outcomes. Poor autonomy may affect gender roles and intra-household food distribution, both of which may have a subtle impact on the nutrition of both women and young children[54].

While maternal education appears to exert a stronger influence on multiple nutritional deficiencies and CAS, the present study also showed a small but detectable role for paternal education. This is not surprising as some studies around the world have reported that educated fathers are more involved with issues of diet/ nutrition and parenting behaviors, which contribute to the overall health and well-being of their young children [55,56]. Additionally, educated fathers provide a higher household income, more freedom and supports, higher social status and stability, and more opportunities for their wives and children [57,58].

Positive associations were found between water and sanitation condition and multiple nutritional deficiencies. This result was not a surprise since more than half of the households in the current survey reported open defecation and very poor access to water. Open defecation is more pervasive in rural areas. Similar results were obtained in several studies conducted in developing countries. For instance, a study in India found that the prevalence of undernutrition among children in low standard households increases twice as much as for children living in high standard households[59]. Unsanitary conditions are more aggravated by poor access to improved water sources and latrines. Studies conducted in Sri Lanka, Sudan and Philippines reported that improved water and better-quality sanitation facilities resulted in significant improvement in health conditions of children [36,60,61]. A national survey in India underscores that caregiver's reported practice of washing their hands with soap after defecation was associated with a 14% reduced risk of stunting among children aged 0–23 month[62]. The implication of this finding is that nutrition interventions should contain a framework broader than nutrition-specific interventions, by adequately addressing the combined water, household sanitation and personal hygiene. The implication of this finding is that nutrition interventions should contain a framework broader than nutrition-specific interventions, by adequately addressing the combined water, household sanitation and personal hygiene.

The mixed-effect regression further showed two additional childcare variables (breastfeeding and diet diversity score) having a significant association with CAS. Mothers who never breast-fed had a child with a higher likelihood of experiencing CAS. There is ample accumulated evidence showing the important role of breast feeding in the prevention of different forms of childhood malnutrition and micronutrient deficiencies[63,64]. More specifically, exclusive breastfeeding up to six-month of age has profound biological effects and important consequences on health and nutritional outcomes of children[63,64]. The immunological properties of breast milk contribute to ensuring adequate nutritional status, proper growth and develop morbidity prevention capacity in child body [65].The late introduction

of complementary feeding and unacceptably low diet diversity score in Ethiopia (>90%) might have exacerbated the high prevalence of CAS.

In relation to breastfeeding, it is noteworthy to mention the strong significant association between diet diversity and multiple nutritional deficiencies. The expected mean of multiple nutritional deficiencies decreases by about 3% for every one-unit increase in diet diversity. Since the present study indicated unacceptably low diet diversity (i.e., only 5% of the children consumed >4 food groups) and the overall intake of animal protein was low, most of them may have become at higher risk of micronutrient deficiencies that can lead to chronic malnutrition and stunting. The reported poor diet in most Ethiopian households is mainly due to a very high level of household hunger due to poor access or poor utilization or both[66,67]. Consistent with this finding, a recent study in Ghana reported that dietary diversity causes improvements in child health among under five-year-old [68]. Studies in other African countries such as Burkina Faso [69] reached a similar conclusion. Since dietary diversity was measured over a one-day recall period, the result should be interpreted cautiously. However, the finding implies the need for more thorough studies on the sociocultural and physical barriers to food consumption/diet diversity.

Strength and limitations

The current study increases our understanding of the socioeconomic inequalities in multiple anthropometric deficiency and anemia among children in Ethiopia. The findings could prove useful on a national scale in assessing the progress in our fight against child undernutrition and serve as an important resource for the planning, targeting, monitoring, and evaluating of future health promotion programs. The study also has some methodological limitations worth mentioning. First, the DHS survey employed a cross-sectional design, where data on the exposure and outcomes were collected at a specific point in time. Second, because data were collected from mothers/caregivers, most of whom had no

education, there are possibilities of omission, under-reporting, or improper reporting of important information. Under-reporting of these characteristics may generate inflated estimates and /or misclassification bias. The fact that the EDHS data set did not contain complete information on malaria inflammation, the findings on CAS could be compromised since malaria infection is one key determinants of anemia status.

8.6. Conclusion

This study provided evidence for the unacceptably high prevalence of stunting, anemia and CAS with substantial socioeconomic disparities in Ethiopia. Given the fact that children with multiple anthropometric deficits and anemia are at a heightened risk of mortality, the risk factors identified in the present study will help prioritize child survival interventions. The study underscores the importance of improving parental education, household wealth, hygiene and sanitation conditions, promoting feeding practice and child health service utilization. Also, any nutrition-sensitive and specific intervention should consider child's characteristics such as his/her age, gender, and birth order. Concerned regional and local leaders should allocate resources to increase access to nutritious food and health services for the poorest of the poor. More coordinated actions are recommended in terms of prevention, case-finding, and treatment of children with multiple nutritional challenges.

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CHAPTER NINE

MAJOR FINDINGS, POLICY IMPLICATIONS AND FUTURE WORK

9.1 Major findings

The main objective of this research was to examine the disparities in three health practices/interventions in the care of children (i.e., child feeding practices, child health service utilization and hygiene and sanitation practices) and their implications for reducing two prominent outcomes in the health of children (child survival and undernutrition) in Ethiopia based on nationally representative data.

This thesis explored various interdependent components of inequalities in the health of children in Ethiopia based on nationally representative data. Chapters 4, 5 and 6 are considered as intermediate core variables (i.e. feeding practice, child health service utilization and hygiene and sanitation) affecting health and survival for children, which are thought to be the ultimate outcomes in this study. It was noted from the presentations made in chapter 4-6, the intermediate core variables are influenced by a range of individual, household, and community variables. The intermediate core variables were, in turn, found to be key players in the ultimate outcomes. The results presented in the entire chapter collectively help in the development of policies and inform health care professionals improving the overall quality of life.

Chapter 4 was primarily designed to assessing the key factors associated with IYCF practices in Ethiopia based on data extracted for children 6-23 months of age. The study was meant to explore feeding practices within the critical windows of the first 1000 days of life which is very critical period for human development[1,2]. The analysis clearly reiterated that about 80% of the children aged 6-23 months in Ethiopia had very poor or poorer IYCF scores. This clearly indicates the existence of poor adherence to WHO recommended feeding practices as most were found to be suboptimal compared to

guidelines for international applications [3,4]. Such unacceptably poor feeding practices at this early and critical stage in life, could have resulted in high level of co-occurrence of nutritional deficits discussed in chapter 8.This study also provided several noteworthy findings regarding the predictors of the infant and young children's feeding practices in Ethiopia. Age of the child, mother's education, father's education, maternal work status, and the number of children ever born by mothers were the individual-level variables most strongly associated with IYCF practices. Among the household-level variables, household wealth, access to radio and the number of other under five children in the household significantly predicted IYCF practices. Health service utilization and type of residence were important service related and community-level predictors of IYCF practices in Ethiopia. Chapter 4 provides a more complete picture of IYCF practices in Ethiopia in comparison to the majority of previous studies that were based on a single outcome indicator (usually Diet Diversity Score/DDS)[5,6], and almost all previous studies were conducted based on data collected at district or sub-district levels.

Chapter 5 provided a detailed account of the use of health services in the care of children. One of the most important contributions of this part of the thesis is that the outcome variable (child health service utilization) was constructed from six key health services where each service use was viewed as a continuum of actions where attendance of one will affect the likelihood of adhering to the next type of service followed by the next service. Findings from this study indicated that the use of any of the six components of health service was very low by any standard, resulting in overall low utilization scores. For instance, it is noted that only a third of the most recent pregnancies had at least 4 ANC visits, only 26% of last births occurred in health facilities and only 12% received postnatal care services. The intake of the three micronutrients was also unacceptably low. The reported rate was lower than the average for sub-Saharan Africa (42.9%)[7]. The analysis further reiterated the significant positive impacts of ANC utilization (>4 antenatal visit), which occurs first in six health service types, on the continuum of

utilizing delivery and post-natal care services. The finding strengthened our general belief that if women get access to ANC services during her pregnancy, she is more likely to give birth at the health institution. Equally important is that adherence to both ANC and institutional delivery were combined to contribute the greatest effect on the likelihood of mothers' utilization of postnatal care services in the first two months after delivery.

In Chapter 6, the paper on household hygiene and sanitation considered households as the unit of analysis to determine the core predictors of WaSH+ at the micro level in Ethiopia. Reviews of studies conducted in other parts of the world indicated that household WaSH+is key pillars in the health and survival of children in Ethiopia[8–10]. Ethiopia is one of the Sub-Saharan African countries with the lowest prevalence of combined hygiene and sanitation practices[11], where 60 to 80 % of communicable diseases are still caused by the poor hygiene, access to safe water and sanitation services [12]. The analysis in this paper has thus primarily provided detailed accounts of the main reasons for poor household level WaSH+ practices in Ethiopia. The findings confirmed that more than half of the households have very poor or poor sanitation and hygiene status as defined by a composite score based on four indicators (access to water, hygiene, household pollution and access to toilet facilities). The study also found that there is substantial socioeconomic, demographic, and regional inequalities in the household environment and WaSH+ practices among households in Ethiopia. As most previous studies in Ethiopia[13–18] have considered a single indicator of hygiene and sanitation as an outcome variable and most of them are conducted using small local samples, the present study represents an important piece of work to provide a complete picture of household WASH in the country. Also, as Ethiopia is currently implementing Community Led Total Sanitation (CLTS), the findings based on the combined WaSH+ practices can be used as input for monitoring and evaluation of progress at the national level.

In Chapter 7, which deals with health-seeking behaviors for two key childhood disease (ARI and diarrhea), the prime purpose was to explain most mothers do not seek health care during an episode of diarrhea and ARI. The two health issues are causes of concern for Ethiopia as it contributes about 28% of deaths of under five children in the country[19]. Most of these lives could be saved through affordable treatment measures at health facilities[20]. Interestingly, the present study shows that only about 43% and 35% of households sought medical care for symptoms of diarrhea and ARI. The finding further witnessed substantial socioeconomic inequalities in health-seeking behavior. Seeking health care generally declined for the second and subsequent births, among Muslim-headed households and for mothers residing in polygamous households. Households with higher IPV are more likely to experience a higher likelihood of care-seeking in the present study. Reviews of previous studies indicated that such households are more prone to diarrhea and ARI episode [2122]. The core intermediate variables: ~~i.e~~ utilization of the basic maternal and child services (institutional delivery, postnatal care, and basic immunization), were found to be strong determinants of the likelihood of developing care-seeking behavior.

The paper dealing with multiple anthropometric and nutritional deficiencies was instrumental in broadening our understanding of the main predictors of co-occurrence of arthrometric deficit in a single child. It is noted that the proportion of children stunted, underweight and wasted was 38%, 25% and 9%, respectively. About 58 % of the sample children were anemic. The prevalence of children concurrently stunted and anemic was 24.8%. The chapter further reported that the incidence rate for multiple nutritional problems is determined by a range of individual, household, and behavioral factors. The three proximate variables (hygiene and sanitation score, feeding practice and child health service utilization score) were found to exert a strong influence on the incidence rate of multiple nutritional deficiencies.

Overall , the aforementioned findings have successfully established the connections between three key sets of childcare practices (feeding, health service utilization and sanitation and hygiene) and key SDG health outcome indicators (health seeking and nutritional morbidities), which are rarely investigated in previous studies. The contribution of the analyses conducted in this research to the body of existing literature boils down to two points:

a) Child health care practice variables are linearly combined in single measures, making it possible to assess what factors shape each and how their combination impacts the health of children in Ethiopia. Child health care practices form a continuum of actions where attendance of one will affect the likelihood of obtaining the next service Previous studies in this subject in general picked one or two childcare measures (such as diet diversity, breastfeeding, antenatal care utilization, micronutrient intake…etc) to examine either the determinants or impacts on under five mortality. Thus, this study is helpful in providing a complete picture of the relationship between actual practices and outcomes.
b) Child health as a comprehensive outcome measure. Guided by the Mosley and Cohn framework, the analysis has brought several factors impacting child health and survival in Ethiopia. As a core child health outcome, the present study examined the clustering/occurrence of two or more nutritional deficiencies in a single individual. For instance, studies on concurrent stunting and anemia (CAS) are limited despite the availability of a large body of literature on each of anemia and stunting. The prevalence of both anemia and stunting is very high in Ethiopia, and their co-occurrence would be even more detrimental for child health and survival in the country.

The concluding public health message is that identification of risk factors in poor childcare practices (IYCF, child health service utilization and proper hygiene and sanitation) should be the priority concern in improving child health and survival in Ethiopia.

9.2 Policy implications

This research work in its entirety, and each individual chapter, provides useful information to regional and national health- nutrition program planners/implementers regarding the health of children. The overall policy implications of the study could be outlined under the following five headings:

a) Despite progress being made in improving infant and young child feeding practices in Ethiopia following the introduction of the national nutritional program in 2004[23], the country is still experiencing one of the poorest feeding practices at any standard. Given that the first two years is the time span during which faltering of growth is most prevalent and the period when the process of becoming stunted almost completes, Ethiopia should pay more attention to this critical period and implement both nutrition sensitive and specific interventions. It is extremely important for concerned authorities at regional and national levels to ensure proper implementation of the recently revised (2013) National Nutrition Program at all levels.

b) The unacceptably low rates of most health service components (ANC, delivery care, postnatal care, micronutrient intake) explained substantial disparities in health outcomes of children. If Ethiopia is to meet the SGD goal 3 (improving maternal and child survival), more efforts should be made by local and regional governments in addressing the main challenges related to poor maternal motivation to use around health care services. Strengthening partnerships with public facilities, private health care practitioners, and community-based organizations would help further improve access to health services. Promoting continuous community-level health

education should be crucial-for rural health extension workers and program administrators in Ethiopia. At the individual level, increasing women's empowerment and participation in their households and communities appeared to be one of the most plausible means to achieve control over their own health and of their child.

c) Given that nearly two-thirds of under-five mortality in Ethiopia is caused by hygiene and sanitation related factors, reductions in childhood morbidities and under five mortality would largely depend on the country's ability to promote the importance of hygiene and sanitation practices. Experiences of other countries indicate that aggressive and continuous community engagement and behavioral change communication strategies could significantly improve knowledge, attitude and practices on basic hygiene and sanitation. The fact that poor sanitation is more common among resource-poor households and regions, reducing the rural-urban and regional disparities in access to sanitation infrastructure and economic opportunities should also be a priority concern.

d) The higher multiple anthropometric deficits may potentially result in a heightened risk of mortality and the country may have difficulty in reducing the current high under five mortality. The study strongly recommends more coordinated actions in terms of prevention, case-finding, breast feeding and diet diversity for treatment of children with multiple nutritional challenges. Since Ethiopia is a predominantly agrarian society, promoting a pro-nutrition agriculture, narrowing the huge gender gaps in employment, education, intrahousehold resource(food) distribution and autonomy will contribute significantly to improving the poor feeding practices.

e) The overall findings of the study strongly suggest that future reductions in inequities in the key child health outcomes (undernutrition and mortality) would largely depend on the country's

ability to significantly improve the desirable behaviors pertaining to the three core intermediate variables (child feeding practices, health service utilization and improving household WASHpractices) or decreasing their key risk factors. In almost all the analysis, maternal education, wealth and living contexts (such as polygamous family structure, access to health services, autonomy and decision making, etc.) appeared to be significant determinants of both the intermediate and ultimate outcomes. Given more than two-thirds of mothers did not have any formal education and a substantial proportion of them do not participate in gainful work, it is very important for Ethiopia to improve its basic education and women's employment. This will empower mothers to better access healthcare services and become informed decision-makers in matters related to their own and their children's health. Further, more attention should be given to a child's living context (those living in rural areas, those living with fathers of poor education; live in households with mothers having poor autonomy).

9.3 Future work

As alluded in the preceding chapters, the EDHS survey employed a cross-sectional design, where data were collected at a specific point in the life of the respondents. This has limited the analysis to focus on associations between the exposures and outcome of interest but cannot infer causality. Further, the present analysis looked exclusively at the different components of child health in terms of quantity and did not address quality issues, mainly due to data limitations. For example, chapters 4 and 5 have dealt with the feeding frequencies and health service utilization scores and did not consider the quality of care (such as quality of feeding, quality of ANC visits or delivery services,etc.). Future research should generate and examine how well the services are provided and children's' health are managed in the continuum of care as they grow older. A cohort analysis would be invaluable in corroborating the

present findings and provide more clarity to the multiple possible effects examined in the present study. Investing in national level longitudinal/time series data would help Ethiopia to address changes in behavior, practices and health outcomes across years and socioeconomic groups. The present study selected certain risk factors (such as domestic violence, paternal education, maternal autonomy, and family structure) whose impacts on child health and survival were rarely reported in previous studies conducted in Ethiopia. More rigorous studies are needed to examine the detailed account of these variables under different sociocultural settings.

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