

DETERMINANTS OF CONTINUUM OF CARE FOR MATERNAL,
NEWBORN AND INFANT HEALTH IN SIX REGIONS OF
ETHIOPIA

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ETHIOPIA

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Original Papers

Paper I: Mohammed S, Worku A, Girma E. Receiving quality antenatal care service increases the chance of maternal use of skilled birth attendants in Ethiopia: Using a longitudinal panel survey. *PLoS One*. 2022 Dec 22;17(12):e0279495. doi: 10.1371/journal.pone.0279495. PMID: 36548352; PMCID: PMC9778501.

Paper II: Mohammed S, Worku A, Girma E. Home-based optimal newborn care practice and associated factors among mothers in Ethiopia: a community-based longitudinal panel survey. *BMJ Open*. 2023 Jul 10;13(7):e070999. doi: 10.1136/bmjopen-2022-070999. PMID: 37429684; PMCID: PMC10335513.

Paper III: Mohammed S, Worku A, & Girma E. Level of completion of a continuum of age-appropriate infant feeding practices and barriers among breastfeeding mothers in Ethiopia: a mixed methods study. *BMC Public Health* 24, 340 (2024).

Acronyms and Abbreviations

ANC: Antenatal Care

CI: Confidence Interval

CSD: Caesarian Section Delivery

CSA: Central Statistical Agency

EAs: Enumeration Areas

EBF: Exclusive Breastfeeding

ENBC: Essential Newborn Care

GEE: Generalized Estimating Equation

GPS: Geographical Positioning System

HEWs: Health Extension Workers

HDSS: Health and Demographic Surveillance Sites

HSTP-II: Health Sector Transformation Plan-II

IRR: Incidence Rate Ratio

IYCF: Infant and Young Child Feeding

MPH: Masters of Public Health

MSE: Mean Square Error

ODK: Open Data Kit System

OR: Odds Ratio

PNC: Postnatal Care

PMA: Performance Monitoring for Action

QUAN: Quantitative

QUAL: Qualitative

SNNP: Southern Nations Nationality People

SBA: Skilled Birth Attendant

SDGs: Sustainable Development Goals

SPH-AAU: School of Public Health, Addis Ababa University

TPB: Theory of Planned Behavior

UNICEF: United Nations Children Funds

WHO: World Health Organizations

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Executive Summary

Background: Ethiopia continues to have unacceptable high rates of maternal and childhood mortalities, mainly due to preventable causes related to pregnancy, childbirth, and inadequate infant care practices. The continuum of care has become as a fundamental program strategy for improving maternal and child health and lowering maternal and child mortality rates. Unlike previous studies, we used a wider scope of continuum of care in our study, focusing on pregnancy, childbirth, postnatal (newborn care), and infants under one year old, whereas previous studies focused on pregnancy, childbirth, and postnatal care within 48 hours. Successful program implementation to improve the continuum of care requires a better understanding of where gaps exist in seeking and practicing care during pregnancy, delivery, post-delivery, and childhood, as well as the factors that contribute to these gaps.

Therefore, the specific objectives of this study were to: 1) assess influence of quality antenatal care (ANC) on the continuum of maternal use of skilled delivery service following any ANC visit; 2) determine the level of home-based optimal newborn care and associated factors, and 3) determine the level of completion of the continuum of age-appropriate infant feeding practices and associated barriers in six Ethiopian regions.

Methods: We used data from Performance Monitoring for Action (PMA) Ethiopia panel survey (2019-2021). In the first and second study objectives, respectively, a total of 1,511 postnatal women and 860 mothers of neonates were included to generate estimates. A rate ratio, or an odds ratio, with 95% CI were used to measure the association between exposure and outcome variables. Generalized estimating equation Poisson and logistic regression models were used to account for clustering nature of data and potential confounders, using Stata vers.16 software.

A sequential explanatory mixed methods design (independent quantitative study followed by qualitative study) was used to determine the level of continuum of age-appropriate infant feeding practices and associated barriers. In the quantitative (QUAN) analysis, a total of 1755 mothers of infants were included to generate estimates. Then, a qualitative (QUAL) study was conducted with 14 mothers to explore their age-appropriate infant feeding practices, using an in-depth interview guide and analyzed, using a thematic approach. Results from both QUAN and QUAL data were integrated, described under the identified thematic areas, and interpreted concurrently.

Results: This study showed that women who received better quality ANC services had 20% higher chance to continue to use skilled birth attendant, compared to women who received low quality ANC service (adjusted IRR = 1.20, 95% CI = 1.11, 1.31). The level of home-based optimal newborn care practice was 8.7%, with 95% uncertainty interval ranged from 6 to 11%. The study also showed that the chance of home-based optimal newborn care practice decreased by 69% among rural resident mothers, compared to urban resident mothers (adjusted OR = 0.31, 95%CI= 0.15, 0.61). This study showed 13.96% (95% CI: 12.4 to 15.6%) of mothers practiced a complete continuum of age-appropriate infant feeding. Results from both quantitative and qualitative data showed that mothers' complete continuum of age-appropriate infant feeding practice was influenced by their level of income, knowledge, and attitude towards optimal infant feeding, as well as by important others, including husbands, grandmothers, and health workers.

Conclusion: From this study we conclude that continuity of maternal use of skilled birth attendant was influenced by the quality of ANC services they received during pregnancy. Also, only less than 15% mothers practiced optimal newborn care and age-appropriate infant feeding. Mothers home-based optimal newborn care practices were influenced by their area of residence. Similarly, mothers optimal infant feeding practices were influenced by their area of residence, level of knowledge and attitude towards infant feeding, income or access to food, and health workers or family members.

Findings from this study implies that maternal use of skilled birth attendant can be improved by providing quality ANC service during subsequent ANC visits. Similarly, to improve optimal newborn care and infant feeding practices, collaborative efforts are needed to strengthen mothers' education on the health benefits of optimal maternal, newborn and infant care and design and promote strategies to improve household access and affordability to health services and diverse food.

Key words: Antenatal care components, Skilled birth attendant, place of delivery, home-based newborn care, essential newborn care, age-appropriate infant feeding, exclusive breastfeeding, complementary feeding, Ethiopia.

1. Introduction

1.1 Background of the study

The continuum of care for maternal, newborn and child health refer to an integrated service delivery for mothers and children from pre-pregnancy to delivery, postnatal period and childhood by families and communities, and health facilities through outpatient services. Also, the continuum of care connects care giving between households and health facilities to reduce maternal, newborn and child deaths (1). Evidence has shown that increasing the coverage of pre-conception, antepartum, intrapartum and postpartum services along the continuum of care by a modest amount (10% every 5 years), and by the amount needed to achieve universal coverage (to 95%) of these interventions could avert 71% of neonatal deaths, 33% of stillbirths and 54% of maternal deaths per year by 2025 (1,2).

The World Health Organization (WHO) envisions a world where every pregnant woman and newborn receives quality care along the continuum of care since pregnancy-related complications and mortalities remain unacceptably high. Antenatal care (ANC), for example, provides an opportunity to identify any pre-existing women's medical, obstetrical and social factors, to monitor weight again and assess nutritional status, to identify those risk factors arising during current pregnancy, and to ensure a safe transition to positive labor and birth (3,4). WHO and United Nations children funds (UNICEF) strongly advise the global community to accelerate efforts to reach the global Sustainable Development Goals (SDG) targets of less than 70 maternal deaths per 100, 000 live births and targets of less than 12 neonatal deaths per 1000 live births by 2030 (1,5). However, maternal and child mortality remain a significant health problem in low- and middle-income countries, including Ethiopia. The highest maternal, neonatal and under-five mortality rates are in Sub-Saharan Africa and in South Asian countries (1,6).

The global estimates for the year 2020 report indicated that there were 287,000 maternal deaths occur worldwide. Of those, nearly 70% (202,000) of deaths occurred in Sub-Saharan Africa countries(5,7). Similarly, an estimated 7,000 newborn babies died every day worldwide as a result of causes that could have been easily preventable, with basic health care services; such as, provision of quality antenatal and postnatal health care, appropriate nutrition and clean water for the mother and the baby by well-trained providers (8). The 2019 UNICEF report indicated that 52

million under-5 children will die between 2019 to 2030. From those under-5 deaths, half of the deaths will be newborns, if basic maternal and child health care services utilization and quality continue unimproved (9). Different factors have influenced to ensure pregnant women receive adequate antenatal care (ANC), deliver in health facilities with assistance, and receive adequate postnatal care (PNC) from a skilled health worker (10). According to Anderson behavioral model, individual's health care services utilization is determined by societal, health services system, and individual level factors (11).

Therefore, the aim of this study was to assess determinants of continuum of care for maternal, newborn and infant health in six regions of Ethiopia, to generate practical recommendations for evidence based maternal and child health care practice.

1.2 Statement of the problem

The continuum of care has become one of the key program strategies for improving maternal and child health, and reducing maternal and child deaths. The term “continuum of care” for maternal, newborn, and child health usually refers to continuity of care throughout the lifecycle- (adolescence, pregnancy, childbirth, post-delivery, and childhood) (12). Unlike previous studies, we used a wider scope of continuum of care in our study, focusing on pregnancy, childbirth, postnatal (newborn care), and infants under one year old, whereas previous studies focused on pregnancy, childbirth, and postnatal care within 48 hours (13,14).

A previous study reported that from a total of 4,693 women who booked for antenatal care visits in Ethiopia, nearly 45% dropped from the recommended number of ANC, 47% from institutional delivery and 87% from postnatal care visit. In the same study, only 7% of women received complete continuum of care(15). In Ethiopia, more than 42% of pregnant mothers with four or more ANC visit didn't deliver through the assistance of skilled birth attendants (16,17). The reason for mothers not to use skilled birth attendance after any ANC visit was unclear and not well-studied (16,18).

Likewise, the reasons for mothers suboptimal newborn and infant care practices are not well explored. In Ethiopia, only about 49% of mothers practiced appropriate neonatal care (19), and significant proportions of home delivered newborns in Ethiopia had bathing during the first 24 hours of life (74.7%), application of butter and other substances to the cord (19.9%) and discard of the colostrum milk (44.5%) (20). However, the Lancet neonatal health series suggests that 15 to 32% of neonatal deaths can be prevented through promotion of some essential practices: clean home delivery, hygienic cord care, thermal care, early and exclusive breastfeeding and care seeking for illness (21). Similarly, a field trial conducted in rural India reported that home-based neonatal care is acceptable, feasible, and reduced neonatal and infant mortality by nearly 50% among malnourished, illiterate and rural population (22).

Appropriate infant feeding practices are essential for attaining and maintaining proper nutrition and health (23), but feeding behaviors are suboptimal even in richest households and influenced by cultural factors and poor knowledge regarding adequate diet for children (24). Evidence has reported that human breast milk alone can meet the nutrient needs of full-term and normal birth

weight infants during the first six months of life, and vitamin deficiencies are also rare in exclusive breast-feeding (EBF) infants if mother is well-nourished or her diets are not deficient(25–27).

In Ethiopia, infant exclusive breastfeeding proportion declines with age from 74% in 0-1 months to 36% in 4-5months in 2016 (16,18). Inappropriate infant feeding practices are characterized by too early or too late introduction of complementary foods, infrequent feeding, and poor hygiene and feeding methods, and poor child-care practices (23). Studies showed that early introduction of complementary feeding is associated with harmful effects, including food allergies, possibility of choking, decrease in breast milk intake and childhood illness and stunting (27–29). In addition, delayed introduction of complementary feeding is associated with infant foods acceptance problem, difficulties learning to eat at later ages, and anemia(26,27,29).

As a result of that, experts concluded that potential health benefits of waiting until six months to introduce complementary foods outweigh any potential risks since both early and late introduction of complementary feeding are associated with high risk of childhood malnutrition (25,27–32).

Understanding of where the gaps are in seeking and practicing care along pregnancy, delivery, after delivery and childhood, and what factors contribute to these gaps is very important to design or adapt behavioral change interventions regarding maternal use of skilled services, and newborn and infant care at home and care-seeking (33). Therefore, the aim of this study was to assess determinants of continuum of care for maternal, newborn and infant health in six regions of Ethiopia, to generate practical recommendations for evidence based maternal, newborn and infant health care practices.

1.3 Rationale for the study

Ethiopia still has unacceptable high rates of maternal and childhood mortalities, mainly due to preventable causes related to pregnancy, childbirth, and suboptimal newborn and child care practices. In 2021, Ethiopia planned to reduce the maternal mortality ratio by 31% in 2024/25, which means reducing it from 401 to 279 per 100,000 live births. Likewise, the country planned to reduce infant and neonatal mortalities by 26% and 37% in 2024/25 (from 47 and 33 to 35 and 21 per 1000 live births), respectively, by improving the use and quality of basic maternal, newborn, and infant health care interventions (16).

In countries like Ethiopia where health care facilities are inaccessible to most mothers of neonates, and more than two-third of the neonate are born at home, essential newborn and infant care interventions are recommended (17,20,22,34,35). As a result of that, Ethiopia has brought an alternative option to avail the necessary essential newborn and infant care services that could be provided by health extension workers at health post or household level (17,20,22,34,35).

Nevertheless, in order to improve the utilization of skilled services by mothers, as well as the practices of optimal newborn and infant care, valid and reliable data is required.

Therefore, studies that explain influence of multilevel factors on continuum of maternal and newborn healthcare, and infant feeding practices are important to generate practical recommendations to improve maternal use of skilled services, newborn care and infant feeding practices in the study settings.

1.4 Literature review

1.4.1 Continuum of maternal use of skilled delivery after ANC visit

Studies have indicated that more than three-fourths of maternal deaths occurred during child delivery or within 24 hours after delivery in developing countries, due to hemorrhage, hypertension, ruptured uterus and sepsis(5,16,18,36,37), yet majority of those deaths could have been prevented, if mothers had used skilled birth attendant(38). Study conducted in Tanzania reported 81% of mothers used skilled birth attendant (39). Similarly, studies conducted in Ethiopia reported a prevalence of 29% and 32% maternal use of skilled delivery, respectively (20,40).

The underlying barriers of maternal use of skilled delivery can be categorized as predisposing factors (sociodemographic and set of beliefs towards behaviour), enabling factors (economic or transport or service access barriers), and quality of maternal health care services (11).

Study conducted in Tanzania indicated that maternal use of skilled birth attendant was higher among women who had 4 or more ANC visits and above secondary education, but maternal use of skilled birth attendant was lower among women who had more children, and walked more than 30 minutes to access the health facility (39). Similarly, study conducted in southern Ethiopia reported that maternal use of skilled birth attendant was higher among women who were residing in urban settings, with secondary and above education, walked less than 1-hour to access the health facility and with good knowledge of pregnancy danger signs (40).

Other studies conducted in northern and southern Ethiopia reported that maternal use of facility delivery was higher among women who had access to facility that has readiness to provide ANC services (adequate staffing, drugs and equipment, diagnostics and competent health providers) (41,42).

A number of studies reported that odds of maternal use of skilled birth attendance after any ANC visit was higher among women who received main ANC services (4,41,43,44). However, definition of measures of antenatal care components varies from country to country (45–48). A recent study reported that more women are seeking antenatal services than skilled assistance during childbirth, however it is unclear why this gap occurred (4).

Previous studies have reported that the odds of maternal use of skilled birth attendant increased by 30 to 50%, if women had blood pressure measurement, and gave urine and blood samples as part

of antenatal care services(43,47). Similarly, other studies conducted in Ethiopia reported that the chance of completion of continuum of care was higher among women who received blood pressure measurement, information on pregnancy complication and tetanus injection services compared to those who did not completed (15,49).

Study conducted in northern Ethiopia reported that maternal completion of continuum of care was higher among women who received quality ANC components, compared to women who received poor quality ANC (41). However, there was inconsistency among the studies in reporting factors influencing maternal use of skilled delivery or continuum of maternal care in general (20,39,40,49). The previous works has also missed to look at influence of some important factors, like husband support on maternal use of skilled birth attendant, which may confound the association between other factors and maternal use of skilled birth attendant assessment(15,49,50). Besides, some of the studies conducted in Ethiopia defined use of skilled birth attendant different from the WHO standard definition of skilled delivery. The authors considered health extension workers as skilled birth attendant (15,49).

The other thing, previous studies were at risk of recall bias: women were enquired to respond service utilization before several months or years preceding the surveys. Therefore, women might have difficulty to remember or identify the number of ANC visit, components of ANC service received, and type of health professional who provided the skilled service. In addition, the studies were different in choosing the measure of effect size to assess the relationship between independent and outcome variables. The authors used odds ratio as a measure of association between independent and outcome variables, regardless of the proportion/probability of the outcome and the type of design used. In addition, almost in all of the reviewed studies the traditional logistic regression model was used to assess and adjust cofounding variables without accounting the cluster (kebele) level variability of the data. Also, the studies used complex sampling designs, but did not weight the individual data, which might affect the reliability and generalizability of the findings (41,42,49,50).

Therefore, methodologically well-designed study which can address the previous literature gaps is important to generate reliable and valid evidence on effect of quality of ANC components on maternal use of skilled birth attendant after any ANC visit for evidence based maternal health care decision making.

1.4.2 Level and factors associated with optimal newborn care

Studies conducted in developing countries, including Ethiopia reported low prevalence of mother's optimal essential newborn care practice, which ranged between 10-50% (19,51–54).

Study conducted in northern Ghana reported that less than 1 percent (0.2%) of neonates had safe cord care, 5.2% of neonates had optimal thermal care, and nearly 50% of neonate had adequate feeding practice (54). Similarly, studies conducted in Southern and Northern Ethiopia reported that 24% and 23% of mothers had optimal essential newborn care practice, respectively (51,52). Study conducted in northern Ethiopia also reported that significant proportion of mothers had suboptimal newborn care practices: 64% of mothers applied butter on the umbilical stump of their infant; 54% of them did not initiate breastfeeding within an hours of delivery; and 35% of them practiced newborn bathing before 24 hours (51).

Several institution-based studies were conducted to identify factors influencing optimal essential newborn care practice among mothers in developing countries including Ethiopia, but only limited studies were conducted to identify factors influencing optimal essential newborn care practice among mothers who had home deliveries (19,51–54).

Previous institution-based studies reported that the odds of optimal essential newborn care practice was higher among mothers who were urban residents, counseled about essential newborn care (ENBC), had immediate postnatal checkup, had formal education, had 4+ ANC visits, received advice on ENBC, had good knowledge of newborn danger signs, and had exposure to media (radio) (19,51–54). Another study conducted northern Ghana indicated that mothers optimal essential newborn care practice was higher among mothers who had good knowledge of newborn danger signs (>4 danger signs) (54). Another study conducted in northern Ethiopia also reported that the odds of good essential newborn care practice was higher among mothers who were educated, counseled during delivery and postpartum, had good knowledge of newborn care, and had good knowledge of newborn danger signs (55). Similarly, another study conducted in northern Ethiopia reported that mothers' good essential newborn care practice was higher among mothers who were married, educated, and had good knowledge on essential newborn care (56).

However, limited studies have identified factors associated with optimal essential neonatal care practice among mothers who had home deliveries. A qualitative study conducted in Ethiopia reported that mothers who had home delivery were commonly practiced suboptimal newborn care (57). Similarly, study conducted in Southern Ethiopia reported that optimal essential newborn care practice was lower among mothers who did not initiate ANC during pregnancy; not got any advice on essential newborn care; being rural resident mother; and with poor knowledge of newborn danger among women who gave birth at home (51).

The studies that were conducted either in the community or health facilities had methodological limitations: women were enquired to respond about an event that occurred 12 months or more back preceding the surveys. Therefore, women might have difficulty to remember or identify the type of newborn care provided or practiced. In addition, the studies were different in choosing the measure of effect size to assess the relationship between independent and outcome variables. The authors used odds ratio as a measure of association between independent and outcome variables, regardless of magnitude of the proportion/probability of the outcome. In addition, the authors of the studies used the traditional logistic regression model to assess and adjust confounding variables without accounting for cluster (kebele) level variability of the study data, especially in community-based studies. Moreover, the authors used complex sampling designs, but did not weight the individual data, which might affect the reliability and generalizability of the findings(19,51–54).

Therefore, designing methodologically sound study that can identify factors influencing optimal essential newborn care practice especially among women who had home deliveries in Ethiopia is very important for better behavioral interventions planning (optimal newborn care & improve health seeking behavior) for communities.

1.4.3 Prevalence of continuum of age-appropriate infant feeding practice

Evidence has showed that human breast milk alone can meet the nutrient needs of full-term and normal birth weight infants during the first six months of life, and vitamin deficiencies are also rare in exclusive breast-feeding infants if mother is well-nourished or her diets are not deficient(25,26,58). After 6 months of infant age: it is difficult for breastfed infants to meet their nutrient needs as nutritional requirement of infant's increase with age and breastfeeding alone is no longer sufficient to fulfill the daily energy requirement for them. Therefore, to bridge the gap between nutritional requirement and amount obtained from breast milk, timely and adequate complementary feeding (in amount, frequency and using a variety of foods) is recommended for target infants, aged 6-23 months (25,26,58).

Previous works reported a varied prevalence of exclusive breast feeding (EBF) and timely initiation of complementary feeding practice, which ranged from none to 88%, and 34% to 83%, respectively(44–48, 60–66). However, the combined prevalence of continuum of age-appropriate infant feeding practice was not estimated.

Studies conducted in Zimbabwe and rural India reported that 36% and 49% of mothers practiced EBF, respectively(60,61). The India study also reported that 23% of mothers initiated breastfeeding within 1-hour of delivery and about 28% of mothers practiced EBF (62). Studies conducted in Ethiopia reported that 59% and 79% mothers EBF practice (67,68). Another study conducted using Alive & Thrive project in Ethiopia reported that 88% prevalence of EBF among infants less than six months of age (59).

Studies conducted in northern and southern Ethiopia reported 47%, 83% and 34% of mothers timely initiated complementary feeding, respectively (63–65). Another study conducted in Benishangul Gumuz regions of Ethiopia reported that about 62% of mothers timely started complementary feeding. This study also reported that about 24% of children had good dietary diversity and about 33% of children fed with appropriate meal frequency (71). Similarly, another study conducted in Northern Ethiopia reported that 63% of mothers timely initiated complementary feeding (72). Studies conducted in northern and Eastern Ethiopia reported that about 63% and 61% of mothers timely initiated complementary feeding (73,74).

Evidence has showed that inappropriate infant feeding practices contributed for nearly half of deaths in under-5 children in Sub-Sahara African countries, including Ethiopia (6). Inappropriate infant feeding practices and their consequences are major obstacles to countries sustainable socioeconomic development and poverty reduction. Furthermore, malnourished children who survive are more likely sick and suffer life-long consequences of impaired development (23).

Globally, more than a third of infants are not exclusively breastfed during the four months of life; complementary feeding frequently begins too early or too late, and foods are nutritionally inadequate and unsafe (23). The same report indicated that global rates of continued breastfeeding dropped from 74% at 1 year of age to 46% at 2 years of age, and nearly a third of infants 4-5 months old are already fed solid foods, and only about 28% of children 6-23 months receiving at least a minimally diverse diet. Studies conducted in South East and southern Ethiopia reported that 52% and 49% of mothers did not timely start breastfeeding after delivery, respectively (69,70). Similarly, another study conducted in Southwest Ethiopia reported that 38% of mothers EBF at the first month of infant, which dropped to 10% at age of 6 months (66).

1.4.4 Determinants of continuum of age-appropriate infant feeding practice

Several studies were conducted to identify factors associated with mothers' timely initiation of breastfeeding, EBF and timely initiation of complementary feeding (43–48,61,67–74). However, determinants of completion of continuum of age-appropriate infant feeding practice are not studied in Ethiopia.

Study conducted in Southern Ethiopia reported that the odds of timely initiation of breastfeeding was higher among women residing in urban area and got postnatal counseling (69). Another study conducted in Southern Ethiopia reported that mothers chance of optimal breastfeeding practice was lower among mothers with formal education, lower ANC visits, lack of knowledge and lack of counseling about EBF (70). A systematic review conducted in Ethiopia indicated that mothers' odds of exclusive breastfeeding was higher among mothers with above primary education, with medium household income and being married, but exclusive breastfeeding was lower among mothers with high parity, no access to media exposure, and no paternal formal education (75). Other studies conducted in Ethiopia and Zimbabwe indicated that mothers' odds of exclusive

breastfeeding were higher among mothers who were married, gave birth at health facility, had economic independence and received breastfeeding counseling during pregnancy (59,60).

A study conducted in rural Kenya reported that the chance of mother's early cessation of exclusive breastfeeding was lower among mothers who had knowledge of breastfeeding; and had positive beliefs: about the impact of exclusive breastfeeding on child, perception of impact of exclusive breastfeeding on mother, and perception of acceptability of EBF by important others (76). Similarly, theory based study conducted in India reported that the odds of pregnant women EBF intention was higher among pregnant women who had good exclusive breastfeeding knowledge, had positive attitude, had supportive norm and greater perceived control (77). This study also reported that mothers' odds of exclusive breastfeeding was higher among mothers who were in higher age group, had more ANC visit and had no-formal education, and mother's common reason for non-exclusive breast feeding was mother's feeling of did not have enough milk. Another study conducted in India reported that term babies were more likely to be breastfed exclusively for six months than pre-term babies(62). This and another study reported that mothers chance of exclusive breast feeding was higher among women who had ANC visit, and completed vaccination (61,62).

Previous works also reported that mothers' timely initiation of complementary feeding was higher among mothers who were housewife by occupation; had better knowledge of complementary feeding; had higher educational, and postnatal care checkup (63–65). A study conducted in northwest Ethiopia reported that mothers' timely initiation of complementary feeding was higher among mothers who were housewife, had good knowledge about complementary feeding, and attended postnatal checkup (79). Another study conducted in Benishangul Gumuz region's of Ethiopia reported that the odds of timely initiation of complementary feeding was higher among mothers who were urban resident, and had postnatal checkup (71). Other studies conducted in Northern Ethiopia reported that the odds of timely initiation of complementary feeding was higher among mothers who were educated, had ANC visit, birth preparedness and had institutional delivery (72,79). Institution based study conducted in eastern Ethiopia reported that the odds of timely initiation of complementary feeding was higher among mothers who had male child (74).

A study conducted in southwestern Nigeria reported that the odds of mothers appropriate infant feeding practice was higher among mothers who had 4+ ANC, attended child welfare clinic and home being their workplace (80). Similar, study conducted in Nigeria indicated that mothers age-

appropriate infant feeding practice was higher among mothers who had higher education level (81). A systematic review study conducted in India indicated that mothers age-appropriate infant feeding practice was enabled or facilitated by mother's socioeconomic status and antenatal care visits during pregnancy. On contrary, low socioeconomic status and less frequent ANC visit were barriers to practice age-appropriate infant feeding (82).

Several studies were conducted mainly to identify factors associated with either timely initiation of breastfeeding, or exclusive breastfeeding or timely initiation of complementary feeding (43–48,61,67–74), but the prevalence and factors influencing mother's continuum of infant feeding practice was not studied in Ethiopia.

There was inconsistency among these previous studies in reporting factors influencing either timely initiation of breastfeeding, EBF or timely initiation of complementary feeding. Also, these studies were at risk of recall bias: mothers were enquired to respond an event occurred several months preceding the surveys. The studies used complex sampling designs, but did not weight the individual data, and also some used convenient sampling technique, which both might affect the reliability and generalizability of the findings

Therefore, conducting study that can estimate the prevalence of mother's completion of continuum of age-appropriate infant feeding practice and identify factors influencing the continuum of feeding practice by addressing previous literature gaps is very important to generate reliable and valid evidence for better infant health care interventions.

1.3.5 Research conceptual framework

Continuum of maternal and newborn care, and optimal infant feeding practices are affected by different factors as it is shown in the conceptual framework below. According to Andersen behavioural model the factors are categorized as individual (pre-disposing factors, enabling factors and perceived benefit), societal and health system related factors. The independent variables in the following conceptual framework are adapted from a service utilization behavioral model, continuum of care model and a conceptual framework developed to measure antenatal quality of care(11,47,83–85) (**Figure 1**).

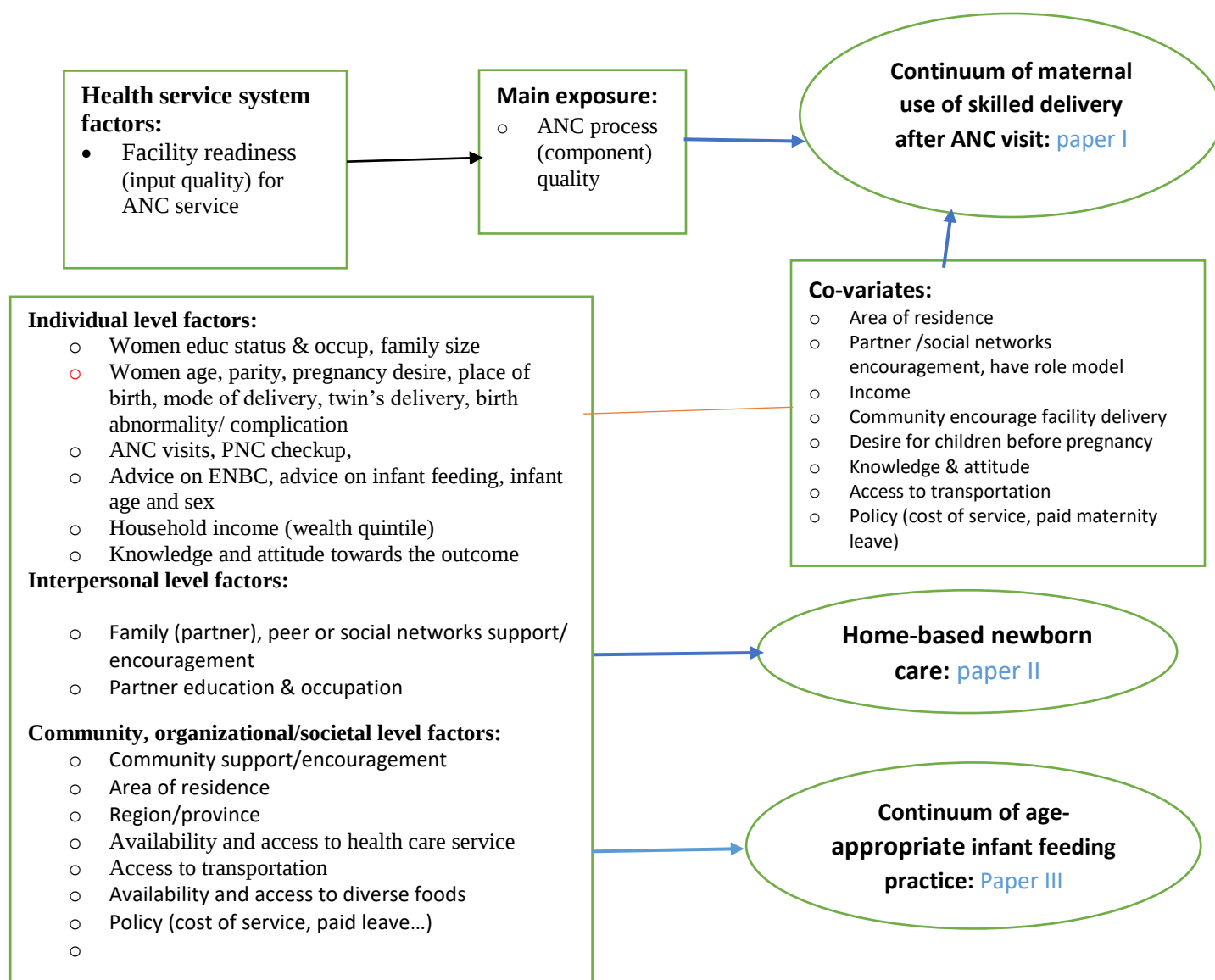


Figure 1: A research conceptual framework adapted from Andersen behavioral (15) and Continuum of care models and other published related literatures.

1.5 Research questions

- What is the level of home-based optimal newborn care practice among mothers in Ethiopia?
- What is the level of completion of continuum of age-appropriate infant feeding practice among breastfeeding mothers in Ethiopia?
- What factors influence completion of continuum of age-appropriate infant feeding practice among mothers in Ethiopia?
- Why pregnant women do not continue to use skilled birth attendant after any ANC visit in Ethiopia?
- What factors are associated with home-based optimal newborn care practice in Ethiopia?

1.6 Study objectives

1.6.1 General objective:

- To assess level and determinants of continuum of care for maternal, newborn and infant health in six regions of Ethiopia, 2022.

1.6.1.1 Specific objectives:

1. To evaluate the influence of quality antenatal care on continuum of maternal use of skilled delivery service after any ANC visit in six regions of Ethiopia.
2. To determine the level of home-based optimal newborn care practice and its associated factors among mothers in six regions of Ethiopia.
3. To determine the level of completion of continuum of age-appropriate infant feeding practices and associated barriers among breastfeeding mothers in six regions of Ethiopia.

2. Methods and materials

2.1 Quantitative studies

2.1.1 Study settings

Ethiopia is facing a triple burden of diseases (communicable and noncommunicable diseases and injuries) affecting all age groups, with a disproportionately higher burden among children and women of reproductive age. In 2019, maternal and neonatal conditions, communicable diseases, and malnutrition accounted for 58% of disability-adjusted life years. To address the socioeconomic and environmental determinants of health, Ethiopia's government has strengthened partnerships with key local and international institutions and stakeholders, such as in maternal and child health, nutrition, and water, hygiene and sanitation programs. In Ethiopia, health services are delivered through a network of health facilities organized in a three-tier scheme. Primary health care units: In Ethiopia, primary care services are provided primarily through 17,550 health posts and 3,735 health centers, particularly in rural areas. The Health Extension Program, offers 18 basic healthcare packages including family health, health promotion and prevention of disease, hygiene, and environmental sanitation. However, there is still a concern about the quality of care and service use (16).

The current quantitative study was conducted using the performance monitoring for action Ethiopia (PMA-Ethiopia) longitudinal panel survey datasets. PMA-Ethiopia survey was conducted in six regions that collectively represent 90% of the population in Ethiopia, namely, Addis Ababa, Oromia, Amhara, Tigray, the former Southern Nation Nationality People (SNNP) and Afar regions. The details of PMA-Ethiopia project design and settings can be accessed from the published PMA-Ethiopia project protocol (86).

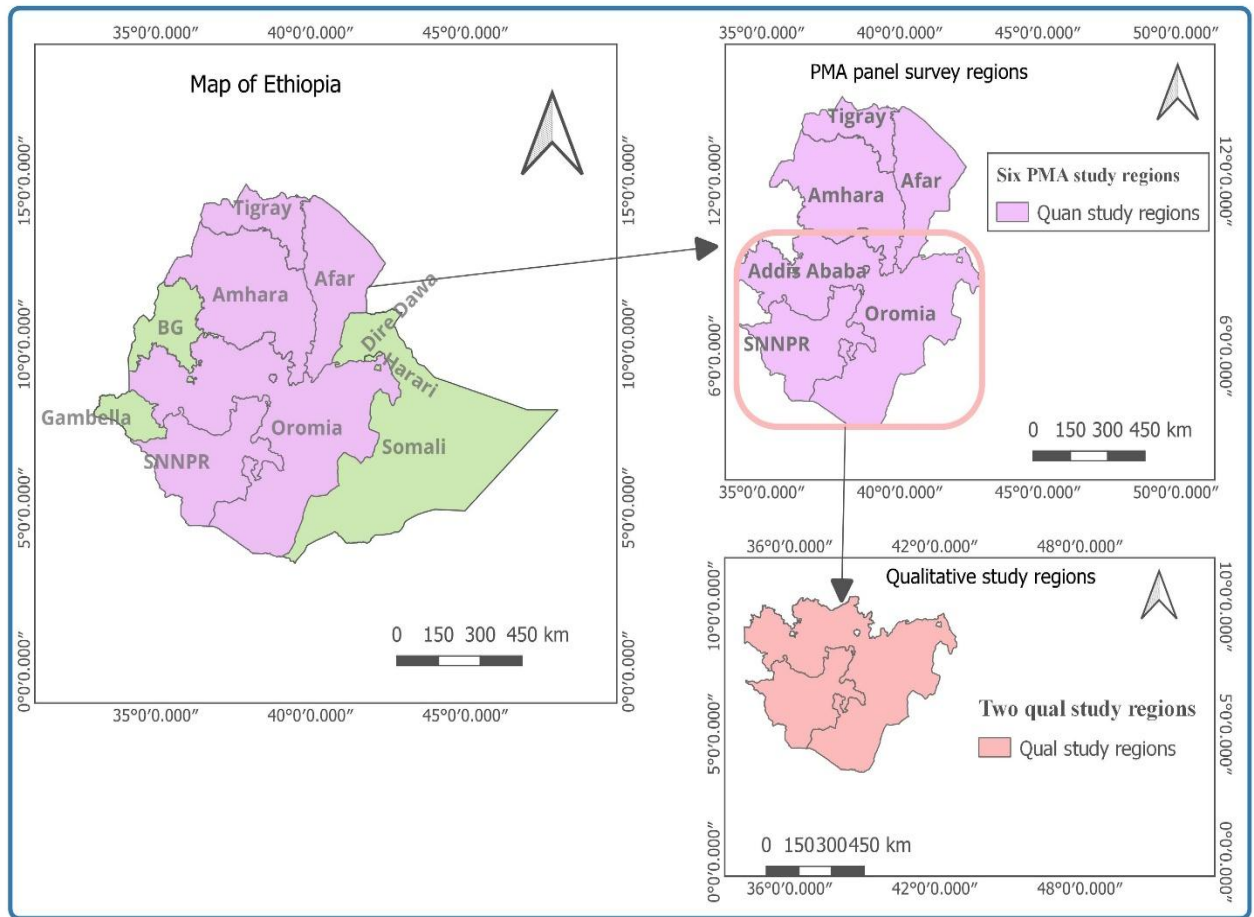


Figure 2: Map of the study area (the PMA study was conducted in selected enumeration areas in six regions of Ethiopia, and the qualitative study was conducted in two regions of Ethiopia).

2.1.2 Study designs

In PMA-Ethiopia, longitudinal panel survey design was used to generate data on maternal healthcare, newborn and infant care practices. In this panel survey, women were screened for pregnancy (self-identified as current pregnant) and enrolled, regardless of their gestational age, from 217 enumeration areas (EAs) in six regions of the country in three to four weeks period. Then, women expected date of delivery was estimated and followed after delivery at 6-weeks, 6-months and 1-year to understand the trends of health seeking behavior, utilization and quality.

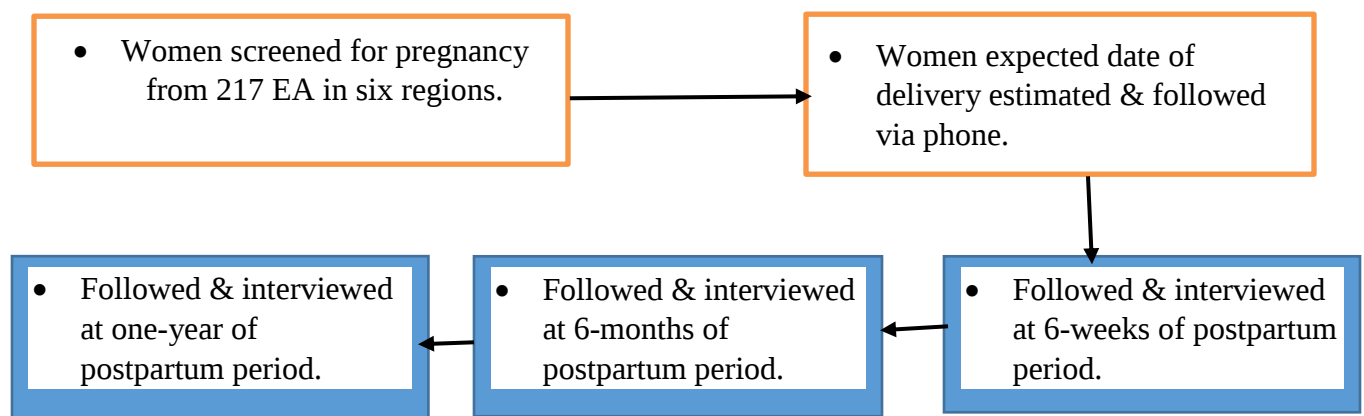


Figure 3: PMA study participant enrolment and follow up procedures.

Therefore, a longitudinal panel survey analysis was conducted using the Performance Monitoring for Action-Ethiopia (PMA-Ethiopia) 2019-21 datasets to assess influence of quality of ANC components (process) on maternal use of skilled delivery, and determine the level of home-based optimal newborn care and associated factors in the study settings.

A **sequential explanatory mixed methods design** (independent quantitative study followed by qualitative study) was used to determine the level of continuum of age-appropriate infant feeding practices and barriers. First, using quantitative (QUAN) data from PMA-Ethiopia, we estimated the level of completion of the continuum of age-appropriate infant feeding practice and associated factors among breastfeeding mothers. Then, a qualitative (QUAL) study was conducted to further explore factors that influence mothers' infant age-appropriate feeding practices.

2.1.3 Source and study population

For the 1st study objective, the source population were all reproductive age group women in the six regions at the time of enrolment. Whereas, the study population were all postnatal women who were enrolled during pregnancy and interviewed between 6 and 8 weeks of postpartum period and received any ANC service from skilled attendants from selected enumeration areas in the regions.

For the 2nd study objective, the study population were all neonates whose mother was enrolled during pregnancy, gave birth at home and interviewed between 6-8 weeks of postnatal period.

For the 3rd **study objective**, the source population were all under-one year infants whose mother was enrolled during pregnancy in the six regions during the PMA project period, from 2019-21. Whereas, the study population were all under-one year infants whose mother was enrolled during pregnancy and breastfed, and interviewed at 6 weeks, 6 months and 1 year about infant feeding practice from selected enumeration areas in the six regions during the PMA project period, from 2019-21.

2.1.4 Inclusion and exclusion criteria's

In the first study objective, women who had any ANC visit, and who had completed the follow up and interview were included in the final analysis. In the second study objective, neonates whose mother gave birth at home, and had completed the follow up and interview were included in the analysis, considering place of delivery as a confounding variable. In the third study objective, infants whose mother had completed the follow up and interview were included in the final analysis. Twins or multiples infants, or infants with congenital anomaly were excluded from the 2nd and 3rd study objectives analysis.

2.1.5 Sample size determination and sampling technique

In PMA Ethiopia panel survey a sample size between 2, 500 and 3,000 pregnant women were needed to detect a 5% difference between groups for majority of maternal and newborn health indicators. Based on previous PMA-2020 round data and assumptions made, the prevalence rate of majority of maternal and newborn health indicators in Ethiopia were significantly less than 50% and only 10% of women age 15-49 years were pregnant, hence, between 25,000 and 30,000 women were screened for pregnancy from 217 EAs to achieve the current estimated sample size. In

selected households, all pregnant women aged 15-49 were enrolled, and they were followed and interviewed after delivery during postnatal period (87).

2.1.6 Sample size estimation for each study objective

The required sample size for quantitative study objectives was calculated using Stata 16 software, considering the following parameters: assuming 10% outcome difference between exposed and unexposed has public health significance (detectable change), the baseline level (proportion) of outcome in exposed/unexposed groups (key indicators) chosen from studies in the setting, assume 5% level of significance (five percent chance that the observed change in the outcome/behavior could have occurred by chance), and 80% power (the probability that a study will detect a change in outcome/behavior of a specified magnitude, if such a change did in fact occur).

The required sample size for each study objective was inflated by design effect (DE=1.5) and incompleteness rates (10%) . Further, as those researches were conducted using the PMA-Ethiopia dataset, the sample adequacy was checked, using the power approach to estimate final sample size and power (>80%), given the total sample size for each study objective from PMA datasets (**See table 1**).

Table 1: Sample size and power estimation for each study objective given the total sample size.

Study design (outcome)	Main exposure variables	% of outcome in unexposed grp	Expected frequency	Design effect	Required sample size	Current total available Sample in PMA dataset
Longitudinal panel survey (use of skilled delivery..)	Quality ANC care (appropriate ANC content) (No)	61 (47)		1.5 (87)	1,162	1,511 mothers had any ANC visit. (88).
Longitudinal panel survey (optimal essential newborn care)	Optimal newborn care practice	-	24	1.5	462	860 mothers delivered at their own home. (88)
	Knowledge of newborn danger signs (yes)	28 (51)		1.5 (89)	831	
	Area of residence (urban)	10 (51)		1.5	597	
	Received ANC service (Yes)	17 (51)		1.5	807	
Panel survey (completion of continuum of age-appropriate infant care)	Timely initiated complementary feeding (yes)	-	35	1.5 (89)	716	1,755 breastfeeding mothers
	Exclusive breast feeding (yes)	-	88	1.5	478	
	postnatal care visits (No)	31 (65)	-	1.5	1,190	
	Breast feeding counseling during pregnancy (No)	16 (59)	-	1.5	860	

The PMA- Ethiopia panel survey employed stratified, two-stage cluster sampling design to select enumeration areas (clusters) and households from both urban and rural areas of the six regions. In the first stage, enumeration areas (EAs) were selected randomly with probability proportional to size from the national central statistical agency (CSA) sampling frame, which contains information about the EAs location, type of residence (urban, rural) and the estimated number of households in each EA. At the second stage, 35 households per cluster were selected and all pregnant women aged 15-49 in the selected households were enrolled and interviewed.

To address the 1st study objective, all women in the PMA dataset who had any skilled ANC visit were included in the analysis. To address the 2nd study objective, all neonates whose mother gave birth at home were included in the analysis. To address the 3rd study objective, all under-one year infants whose mother had breastfed were included in the final analysis.

2.1.7 Quantitative data collection

In PMA-Ethiopia panel survey, a structured and standardized enrolment and follow up forms were used to interview mothers to get information about maternal, newborn and infant related health care. In the PMA panel survey, data were collected, using Open Data Kit (ODK) system using, tablet computers by trained field workers. In PMA Ethiopia data on household location, housing and sanitation practices, economy and asset ownership, sociodemographic status and reproductive health details were collected during baseline census by trained field workers. Mothers and infants were visited and interviewed at 6-weeks, 6-months and 1-year of postpartum periods by trained female community health extension workers. The data collection was supervised by trained MPH professionals.

2.1.8 PMA procedures during follow-up visits/interview

During subsequent round visits made by PMA research staffs, data on maternal, newborn and infant health care services utilization during antenatal, delivery and postnatal periods were collected by using similar structured questionnaire.

2.1.9 Measurement and Operational definitions

2.1.9.1 Outcome variables

Skilled delivery is defined as mothers' receipt of skilled assistance during delivery by skilled attendant. Skilled birth attendant is defined as "an accredited health professional such as Midwife/Nurse, medical doctor/health officer who has been educated and trained to proficiency in the skills to manage normal (uncomplicated) pregnancies, childbirth, and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns (90). To determine skilled delivery, women were asked a question of "did you deliver by a skilled attendant?", and "type of professional skilled birth attendant."

Essential newborn care: defined as a care provided to every newborn by mothers, which include cord care, thermal and feeding care.

Optimal newborn care practice: to measure optimal newborn care practice a composite score of the three components (safe cord care, optimal thermal care and optimal feeding) were used and categorized into binary outcome. Those mothers provided the three services were categorized as

practiced “optimal newborn care”, otherwise categorized as practiced “sub-optimal newborn care” (8,16–18,21).

Safe cord care: defined as cord tie and cut with a new or boiled blade plus no-substance applied to the cord stump, except medically indicated medications like chlorhexidine (18, 21). Then, a safe cord care practice was given a score of 1 if mother practiced both as per the recommendation, or else zero.

Optimal thermal care: defined as baby wrapped after birth plus baby bath after 24 hours of birth (18, 21). Optimal thermal care practice was given a score of 1 if the mother did optimally as per the recommendation.

Optimal feeding practice: defined as mother initiated breastfeeding within an hour after delivery plus no additional feeding (no pre-lacteal) given other than breastmilk (18, 21). Optimal feeding practice was given a score of 1 if the mother did as per the recommendation.

Continuum of age-appropriate infant feeding: in this study, completion of the continuum of age-appropriate infant feeding was generated and constructed from mothers’ responses on the time of initiation of breastfeeding after birth, EBF until 6-months of age, and timely initiation of complementary feeding at six months of age, and dietary diversity (baby received food made from animal source and plant source foods) (78,89). Finally, completion of continuum of age-appropriate infant feeding was treated as a binary outcome and defined as “complete” if a mother practiced the four services, or “incomplete” if none or not practiced either of the four services.

2.1.9.2 Independent variables

The PMA Ethiopia questionnaire captured sociodemographic and reproductive details of the mothers, including women age, women educational and employment status, women economic decision making power, area of residence, household wealth quintile, religion, region/province, family size, parity and pregnancy desire, autonomy for health care decision making, husband and community encouragement to use maternal and child health care services. Pregnancy related data on receipt of ANC services (ANC components), delivery related data on mode of delivery, type of birth attendant, place of delivery, receipt of advice on essential newborn care practice, receipt of advice on infant feeding practice, and PNC checkup within 2 days after delivery were collected. Newborn and infant related data on cord care, thermal care, breastfeeding, complementary feeding

and dietary diversity were collected. Also, newborn and infant characteristics data on newborn's sex, age, twins' delivery and congenital anomalies were collected.

Antenatal care service quality: in this case we have used the Donabedian approach to define antenatal care process quality (how services are delivered, organized and used). The Donabedian health care evaluation framework has four dimensions (input/structure/resources, process/activity, output and outcome) (45). Therefore, considering ANC components as a process, we have assessed ANC components quality influence on maternal use of skilled birth attendant, SBA as an outcome.

The ANC service quality was determined by giving scores to 13 ANC services the women received during pregnancy (4,47,48). The reliability of these ANC services was checked and reliability coefficient is greater than 0.7 ($\alpha = 0.756$). The score ranged from 1 to 13, and the value 11 gave a 75th percentiles. Then, women were classified as received better quality ANC service if they received more than the 75th percentiles of ANC service. The quality score was divided into above '75th percentile' and below '75th percentile', and reported as 'better' and 'low' quality ANC service, respectively (93,94).

The household wealth quintile was determined by giving scores based on the number and kinds of consumer goods they own, source of drinking water, type of toilet facilities and flooring materials. The score was derived using principal component analysis, and then households' wealth index was divided into quintiles according to the wealth score as "lowest", "lower", "middle", "higher" and "highest"(18).

2.1.10 Quality Assurance in the quantitative study

In PMA Ethiopia project, data collection tools were developed and pre-tested prior to use. Data were collected by trained field workers. Mobile devices for data collection were GPS enabled to monitor the location of field workers. Supervisors conducted visits on a random sample of households to validate data collector performance. Supervisors also checked and verified data before syncing to the server. The data manager monitored the quality of data and gave feedback to field workers. In case of an error at the time of data entry, pop-up warnings were triggered to the user prompting the user to resolve issues prior to saving the record.

2.1.11 Quantitative data management and analysis

The quantitative data were formally requested and downloaded from the PMA Ethiopia website (95–98). Then, data were cleaned and prepared for merging, using Stata ver.16 software. The baseline and the follow-up visits datasets were merged, using study participants unique identity number (participant ID). The appropriate sample was restricted based on the design and inclusion criteria to address study objectives. Description of the study participants, unweighted and weighted (sampling weight) frequency, by sociodemographic characteristics were computed and presented using tables.

Poisson and logistic regression models were fitted to estimate the effect of exposure variable/s on maternal use of SBA, and optimal newborn and infant care practices respectively. First, separately, unweighted and weighted Poisson and logistic regression models, respectively, with robust variance were fitted to account for effect of the complex sampling design used by the study. Then, the mean square error (MSE) value of each model was computed, using the formula ($MSE = Bias^2 + StdErr^2$ where, $bias = (weighted\ estimate - unweighted\ estimate)$) and compared. The MSE of the unweighted poisson and logistic regression model was smaller than the MSE of the weighted poisson and logistic regression model. As a result of that, in all models unweighted estimates were considered better to present, assuming unweighted estimates likely to be closer to the true population estimates than weighted estimates.

Then, as we had a clustered data (correlated data), generalized estimating equation (GEE) Poisson or logistic regression models were fitted to account for the correlation of observations within an enumeration area (cluster), as appropriate. The full GEE Poisson or logistic regression models were fitted by adjusting the effect of a potential confounder variables, as appropriate. The multicollinearity of the independent variables were checked. Incidence rate ratio (IRR) or odds ratio (OR) with 95% confidence interval (CI) were computed to measure the association between the exposure and outcome variables, as appropriate.

2.1.12 Ethical considerations in the quantitative study

The study proposal was reviewed and approved by Institution Review Board of College of Health Sciences, Addis Ababa University (protocol number- 027/22/SPH). PMA Ethiopia project office was requested access to the necessary datasets with the appropriate data dictionary to address the

three study objectives. Data requisition concept note that can explain the study purpose, objectives and study variables was submitted (See annex 11.3.2). The researchers have respected and complied to the PMA-Ethiopia data use and share policy by not sharing to third person who is outside the current research team. Data received from PMA Ethiopia is password protected; however, PMA has shared de-identified individuals data, which insure anonymity of individual study participant identity.

2.2 Qualitative study

2.2.1 Study settings

The qualitative study was conducted in selected kebeles (the smallest administration unit in Ethiopia) in Butajira Rural Health Program area of School of Public Health in Addis Ababa University and the rural community attachment site of Saint Paulo's Hospital Millennium Medical College in two regions (former SNNP and Oromia regions). As per the quantitative survey results (low outcome level), three regions, including, Afar, Tigray and Amhara should have been selected for the qualitative study, but not selected due to the serious security problems in these regions during the study period. However, there was not statistical significant difference on the outcome level, especially between selected regions (SNNP and Oromiya regions) and excluded regions (Tigray and Amhara). The study participants were mothers who had under one year of infant in these regions during the data collection period.

2.2.2 Study design

To address the third study objective, descriptive exploratory QUAL study was conducted to further explore barriers of continuum of age-appropriate feeding practices, following the QUAN data analysis.

2.2.3 Study population

In the QUAL study, the source population were breastfeeding mothers of under one-year infants in selected areas. Whereas, the study population were breastfeeding mothers of under one-year infants in selected areas during the study period, and who fulfilled inclusion criteria.

2.2.4 Sample and sampling technique

In the qualitative study, 14 participants were selected from urban and rural kebeles of an institution HDSS or community attachment sites in two regions (SNNP and Oromia) using criterion purposive sampling technique. Based on expert suggestions to take into account a sample size to maintain point of saturation in in-depth interviews, the final sample size for this study was determined. The eligible participants in each kebele were selected in collaboration with health workers in study set-ups.

2.2.5 Qualitative data collection

First, an in-depth interview guide was prepared in English to explore mothers' early initiation of breastfeeding after childbirth, exclusive breastfeeding in the first six months of age, the introduction of complementary foods such as solid, semi-solid or soft foods at six months of age and dietary diversity (78,99). Then, the interview guide was translated into Amharic and Affan Oromo Languages by fluent speakers of both languages. Then, back translated to English by another fluent speakers of both languages, to check for consistency. The data were collected, using the interview guide by the principal investigator (Ph.D. student) and experienced MPH holder (Affan Oromo speaker). In-depth interviews were convened at the participant's home or compound where there was unlikely to be interruption or excessive noise interference and convenient for participants. Interviews commenced with introductions and clarifications about the purpose and procedures of the interview. Interviews were conducted in Amharic or Afan Oromo (as required) for 15 to 25 minutes. The interviewer introduced and guided the interview discussion (kept the interview focused and managed interview time). Field note taking and audio recording of the in-depth interviews was done parallelly. Then, field notes expansion was done on the same day after each interview.

2.2.6 Quality control in the qualitative study

The interview guide was checked by research supervisors(mentors) for clarity and formatting of the questions, and was pre-tested with two purposively selected mothers who are residing outside the study site. Following pre-testing, the study guide and time was amended.

In this study, credibility was maintained by diversifying the study participants in terms of area of residence, age and occupation. To maintain transferability, efforts were made to obtain detailed

responses using appropriate probes, and to ensure conformability (minimize researcher bias), care was taken by the researcher not to introduce the researcher's prior experience in all data processes (data collection, transcription, analysis and interpretation). To ensure dependability, pre-tested interview guide was used and efforts were made to build trust among participants, and the interview guide was reviewed by investigator and supervisors.

2.2.7 Qualitative data analysis

Verbatim transcription was done based on audio records and field notes by the principal investigator and MPH holder, immediately after qualitative data collection process was completed. The interview data (transcripts) were cleaned for errors through repeated readings and translated into English language. A content-driven theme approach (thematic approach) was used. Codes were created from the interview data itself, following an inductive coding approach. Then, codes were applied to the text. Characteristics are coded and reduced into core categories (themes), using Atlas.ti7 software and themes (context formulated) were described.

2.2.8 Ethical considerations for the qualitative study

The qualitative study was conducted after getting ethical approval from the School of Public Health research ethics committee and the College of Health Sciences institutional review board, Addis Ababa University (reference number: 027/22/SPH) respectively.

Qualitative data were collected after getting permission from concerned offices in SNNP and Oromia regions. As study participants were infants who were incapable of giving informed consent, written informed consent was sought from their mothers after the study aims and benefits were explained. Similarly, written informed consent was obtained from the same mothers of infants for their participation, too. Mothers were approached in a language they were comfortable with (Amharic or Afan Oromo). Mothers were guaranteed confidentiality by not showing their identity to anyone other than members of the research team. Mothers were informed that their participation was based on their willingness, and they could withdraw from the study at any time without affecting their relationship with the research team.

2.3 Dissemination plan

The findings of the study were presented to the scientific community at School of Public Health during PhD Seminar weeks. Moreover, manuscripts were published in international reputable peer-

reviewed journals. A dissertation book (monograph) is prepared and submitted to the School of Public Health, College of Health Sciences, Addis Ababa University. It will be presented and defended in the presence of examination board. Finally, an evidence brief will be prepared (to communicate key findings), and will be delivered to the maternal and child health lead executive office at the Ministry of Health of Ethiopia.

2.4 Summary of study objectives and methods

Table 2: summary of the study objectives and methods

Objectives	Population	Study design	Included sample	Sampling technique	Data source	Major outcome	Analytic methods
1) Effect of quality of ANC components on maternal use of skilled delivery	Postnatal mothers with any ANC visit	Longitudinal panel survey	1,511	Multistage cluster sampling	Mothers interview	Use of skilled delivery	GEE Poisson regression model
2) Level of home-based optimal newborn care and associated factors	Mothers with home delivered newborn	Longitudinal panel survey	860	Multistage cluster sampling	Mothers Interview	Optimal newborn care practice	Proportion, & GEE logistic regression model
Level of completion of continuum of age-appropriate infant feeding practice and associate factors in Ethiopia: A mixed method study.							
3) Level of completion of continuum of age-appropriate infant feeding practice and associated factors in Ethiopia.	Breastfeeding mothers of under-one infant	Longitudinal panel survey	1,755	Multistage cluster sampling	Mothers interview	Completion of continuum of age-appropriate infant feeding	Proportion, & GEE logistic regression model
4) Explore factors that influence completion of continuum of age-appropriate infant feeding practice	Breastfeeding mothers of under-one infant	Descriptive exploratory study	14	Purposeful sampling with maximum variation sampling procedure	Mothers interview	Continuum of age-appropriate Infant feeding practice	Thematic analysis approach

3. Results

3.1. Continuum of maternal use of skilled attendant after ANC visit in six regions of Ethiopia

3.1.1. Sociodemographic characteristics of antenatal care attendant women

For this study, a total of 1, 511 women who had at least one ANC visit during their pregnancy were included from six regions of Ethiopia (**Table 3**).

About 42% of the women were from Oromia region, followed by Amhara (25.3%) and SNNP (19.6%) regions. Nearly three-fourth (73.7%) of the study participant women were from the rural part of the regions. Higher proportions (33.1%) of women were in age categories between 25-29 years followed by about 23% were in age categories between 20-24 years old. Nearly ninety-eight percent of the study participant women were married or in-union. Nearly 17% of the women had no desire for children before they became pregnant. More than 53% of women in the study settings had first time ANC visit at more than 4 months of their pregnancy.

Table 3: Sociodemographic characteristics of antenatal care attendant women in six regions of Ethiopia (n=1,511), 2019-21.

Sociodemographic characteristics	Weighted percent	Weighted N	Unweighted N
Region			
Tigray	8.4	127	321
Afar	0.4	6	27
Amhara	25.3	382	322
Oromia	42.3	639	377
SNNP	19.6	296	307
Addis Ababa	4.0	61	157
Area of residence			
Urban	26.3	397	688
Rural	73.7	1,114	823
Women Age (in years)			
15-49	9.9	150	122
20-24	23.1	349	364
25-29	33.1	500	521
30-34	18.4	278	276
>=35	15.5	234	228
Marital status			
Currently married/in union	97.7	1,477	1, 467
Not in union	2.3	34	44
Desire for children before became pregnant			
Wanted to have a baby	73.8	1,115	1,175
Had mixed feelings about to have a baby	9.0	136	133
Did not want to have a baby	17.2	260	203
Time of first ANC initiation			
<= 4 months	47.0	710	825
>4 months	53.0	801	686
Number of times women received ANC from health care provider			
Less than 4 ANC visits	56.4	853	699
>= 4 ANC visits	43.6	658	812
Household wealth index			
Lowest quintile	17.1	258	207
Lower quintile	16.5	250	178
Middle quintile	20.6	312	245
Higher quintile	21.6	326	283
Highest quintile	24.2	365	618
Religion			
Orthodox	41.9	633	806
Muslim	34.7	525	390
Protestant	21.3	322	295
Other*	2.1	31	20

*Catholic, Wakefta, traditional

3.1.2. Continuum of care for maternal health among women who booked for ANC during 2019-21

This study showed that from a total of 1,511 women who booked for ANC visits in six regions of Ethiopia (**figure 4**), nearly 59% continued to the recommended number of 4 or more ANC visits, 40% continued to use skilled birth attendant, after 4+ ANC visits, and 3% continued postnatal care within two days, after adequate number of ANC visits and skilled delivery. In this study, only nearly 2% of women had complete continuum of care, as per the recommendation.

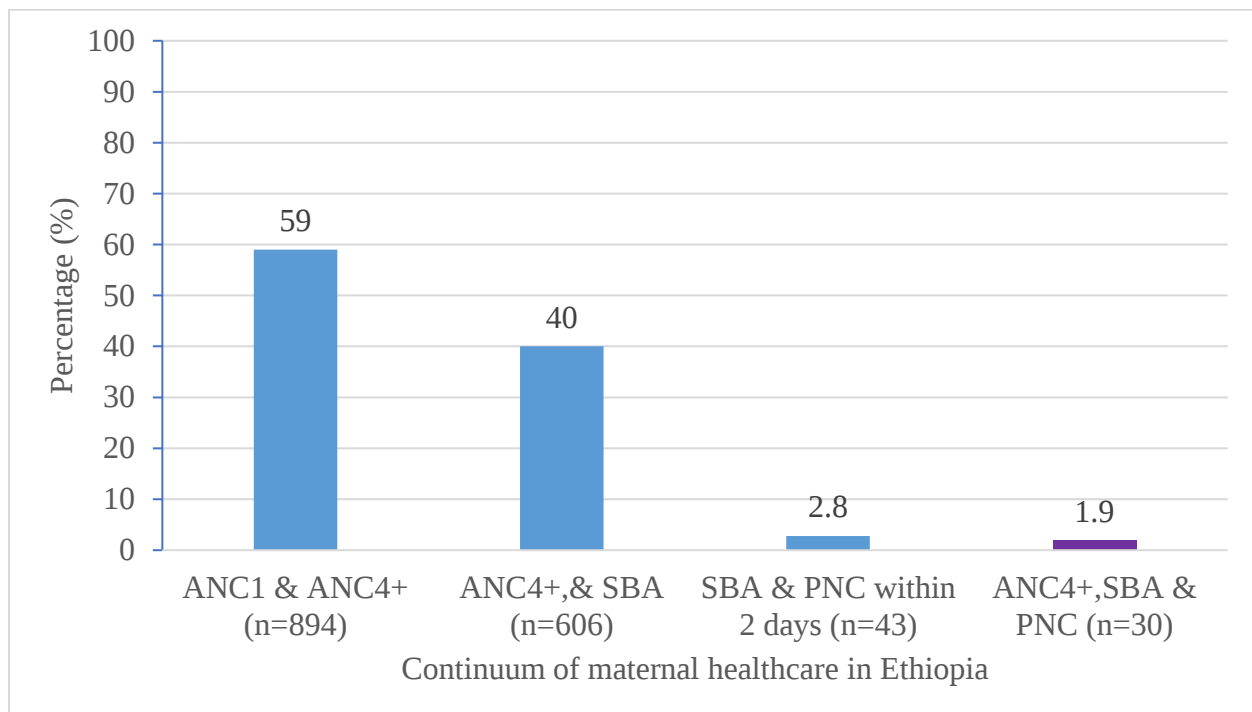


Figure 4 : Continuum of care for maternal health among women who booked for ANC in six regions of Ethiopia, 2019-2021(N= 1,511).

3.1.3. Quality ANC service utilization among pregnant women during 2019-21

In this study, 13 ANC services used to define quality of ANC, received by women during their pregnancy (**table 4**). Women classified as received better quality ANC service if they received more than the 75th percentiles of ANC service. Therefore, based on this classification, 39% (95% CI: 36-42%) of women received better quality ANC service.

Table 4: Variables for antenatal care quality index among women in six regions of Ethiopia, 2019-21.

Type of service received	Frequency (%) (n=1, 511)
Received better quality ANC service	590 (39.05)
Blood pressure measured as part of ANC	1, 390 (91.9)
Weight measured as part of ANC	1, 343 (88.9)
Blood sample taken as part of ANC	1, 314 (86.9)
Urine sample taken as part of ANC	1, 017 (67.6)
stool sample taken as part of ANC	532 (35.2)
Given tetanus injection during this pregnancy	1, 023 (67.9)
Received nutrition information during ANC visit	712 (47.1)
Discussed transport for delivery during ANC	985 (65.3)
Discussed place of delivery during ANC visit	1, 098 (72.7)
Discussed during ANC visit: delivery by skilled birth attendant	1, 069 (70.8)
Discussed during ANC visit: place to go if experience danger signs	727 (48.2)
HIV tested as part of ANC	1, 161 (78.2)
Syphilis tested as part of ANC	187 (12.4)
Scale reliability coefficient (alpha = 0.756)	

3.1.4. Influence of quality ANC service on maternal use of skilled birth attendant after any ANC visit: 2019-2021 (Paper I)

This study showed that about 54% of the women (with 95% CI ranged from 51-57%) used skilled birth attendant during their current baby delivery (**Table 5**).

The rate of maternal use of skilled birth attendant was 20% higher among women with better quality ANC service, compared to women who received low quality ANC service (adjusted IRR = 1.20, 95% CI = 1.11, 1.31).

In the analysis, the effect of some potential confounding variables was adjusted including partner discussion where to deliver, area of residence, desire for pregnancy and number of ANC visits. The rate of maternal use of skilled birth attendant was 32% higher among women who had discussion with their partner about place of delivery, compared to women who did not have discussion with their partner about their place of delivery (adjusted IRR= 1.32, 95% CI= 1.13, 1.54). Similarly, the rate of maternal use of skilled birth attendant was higher among urban resident women and women who had four or more ANC visits during pregnancy, compared to their counterparts, respectively.

Table 5: Effect of quality ANC service on maternal use of skilled birth attendant after any ANC visit in six regions of Ethiopia, 2019-21.

Variables	Use of skilled birth attendant (n=1,511)		Crude IRR (95% CI)	Adjusted IRR(95% CI)
	Yes (%)	No (%)		
Quality of antenatal care				
Better	398 (67.46)	192 (32.54)	1.25(1.13,1.38)	1.20(1.11, 1.31)*
Low	412 (44.73)	509 (55.27)	1.00	1.00
Discussed with partner where to deliver				
Yes	736 (59.64)	498 (40.36)	1.39(1.20,1.59)	1.32(1.13, 1.54)*
No	74(26.71)	203 (73.29)	1.00	1.00
Area of residence				
Urban	527(76.60)	161(23.40)	2.19(1.81,2.67)	1.89(1.57, 2.29)*
Rural	283 (34.39)	540 (65.61)	1.00	1.00
Number of ANC visits				
>=4 ANC visits	554(68.23)	258(31.77)	1.24(1.11,1.37)	1.15(1.04, 1.28)*
< 4 ANC visits	256(31.60)	443(63.38)	1.00	1.00
Desire for children before became pregnant				
Wanted to have a baby	662 (56.34)	513 (43.66)	1.15(1.01,1.32)	1.08(0.93, 1.25)
Mixed feelings about having a baby	74 (55.64)	59 (44.36)	1.24(1.04,1.47)	1.16(0.97, 1.39)
Did not want to have a baby	74 (36.45)	129 (63.55)	1.00	1.00

*statistical significance confidence interval

3.2. Home-based optimal newborn care practices and associated factors among mothers who gave birth at home in six regions of Ethiopia (Paper II)

3.2.1. Sociodemographic characteristics of study participants

In this study, a total of 860 mothers of neonates who gave birth at home were included from six regions of Ethiopia (**Table 6**).

About 47% of the mothers were from Oromia region, followed by SNNP (27.1%) and Amhara (17.4%) regions. Nearly, ninety-seven percent of the study participants mothers were from the rural part of the regions. More than fifty-five percent of the mothers didn't attend formal education, followed by about 39% of them who attended primary school. More than half (51.2%) of the mothers were assisted by their family members during delivery and followed by 32.9% of mothers were assisted by traditional birth attendants. Nearly 52% of the newborns were male by gender.

Table 6: Sociodemographic characteristics of mothers of neonates who gave birth at home in six regions of Ethiopia (n=860), 2019-21

Sociodemographic characteristics	Weighted percent	Weighted N	Unweighted N
Region			
Tigray	4.4	38	67
Afar	3.6	31	159
Amhara	17.4	150	135
Oromia	47.4	406	234
SNNP	27.1	233	261
Addis Ababa	0.1	2	4
Area of residence			
Urban	3.4	30	49
Rural	96.6	830	811
Education level			
No formal education	55.2	473	525
Primary	39.2	338	293
Secondary	5.6	49	42
Delivery Assistant			
No one assisted	9.8	85	76
Family member	51.2	439	386
Traditional attendant	32.9	283	344
Health extension worker	6.1	53	54
Baby gender			
Male	51.5	443	424
Female	48.5	417	436
Marital status			
Married/in union	97.1	832	835
Single	2.9	28	25
Women Age (in years)			
15-19	9.1	79	79
20-24	20.1	172	185
25-29	29.4	253	249
30-34	21.0	181	186
>=35	20.4	175	161
Religion			
Orthodox	28.9	249	237
Muslim	39.1	335	342
Protestant	29.9	256	262
Other*	2.1	20	11
Household wealth index			
Lowest quintile	32.8	282	299
Lower quintile	26.1	224	202
Middle quintile	22.3	191	184
Higher quintile	16.7	144	151
Highest quintile	2.1	19	24

*Catholic, Wakefta, Traditional

3.2.2. Level of home-based optimal newborn care practices among mothers who gave birth at home in six regions of Ethiopia

In this study, three essential newborn care services, including safe cord care, thermal care and feeding care, used to define mothers newborn care practice (**Table 7**).

The level of home-based optimal newborn care practice among mothers who gave birth at home was 8.7% with 95% confidence interval ranged from 6 to 11%. Separately, nearly 38%, 37% and 43% of the mothers practiced safe cord care, optimal thermal and feeding cares, respectively.

Table 7: The level of home-based newborn care practices among mothers who gave birth at home in six regions of Ethiopia (n=860), 2019-21

Variables	Response category	Frequency	Percentage (%)	95% CI range
Home-based optimal newborn care	Yes	75	8.72	6.9-10.8
	No	785	91.28	89.1-93.1
Safe cord care	Yes	325	37.79	34.5-41.1
	No	535	62.21	58.8-65.5
Optimal thermal care	Yes	314	36.51	33.2-39.9
	No	546	63.49	60.1-66.7
Optimal feeding practice	Yes	373	43.37	40.0-46.8
	No	487	56.63	53.2-60.0

3.2.3. Factors associated with home-based optimal newborn care practices

In this study, first the association between potential exposure and outcome variables was assessed **(Table 8)**.

During binary analysis, mothers' area of residence and household income were statistically significantly associated with mothers' optimal newborn care practice at a p-value less than 0.05, and mothers' area of resident remained statistically significant after adjusting the effect of a potential confounding variables using similar p-value cutoff.

The odds of home-based optimal newborn care practice reduced by 69% among rural resident mothers, compared to urban resident mothers, (adjusted OR = 0.31, 95%CI= 0.15, 0.61). This study also showed that before adjusting the effect of potential confounding factors, the odds of optimal newborn care practice reduced by 61% and 66% among mothers who had lowest and lower household income, respectively, compared to mothers who had highest household income.

Table 8: Assessment of factors associated with home-based optimal newborn care practice among mothers who gave birth at home in six regions of Ethiopia, 2019-21.

Variables	Optimal newborn care practice (n=860)		Crude OR (95% CI)	Adjusted OR(95% CI)
	Yes (%)	No (%)		
Area of residence				
Rural	60(7.40)	751(92.6)	0.26(0.14,0.47)*	0.31(0.15,0.61)*
Urban	15(30.61)	34(69.39)	1.00	1.00
Household wealth index				
Lowest	22(7.4)	277(92.6)	0.39(0.16,0.96)*	0.77(0.28,2.13)
Lower	14(6.9)	188(93.1)	0.34(0.13,0.87)*	0.71(0.25,1.95)
Middle	15(8.2)	169(91.8)	0.40(0.16,1.01)	0.74(0.27,1.98)
Higher	18(11.9)	133(88.1)	0.60(0.25,1.45)	1.02(0.42,2.47)
Highest	6(25.0)	18(75.0)	1.00	1.00
Parity				
<5 live births	31(11.5)	232(88.5)	0.71(0.46,1.07)	0.94(0.56,1.58)
>=5 live births	46(7.6)	781(92.4)	1.00	1.00
Women age category				
15-19	4(5.1)	75(94.9)	0.46(0.17,1.22)	0.53(0.18,1.54)
20-24	11(5.9)	174(94.1)	0.51(0.25,1.02)	0.49(0.22,1.10)
25-29	21(8.4)	228(89.6)	0.72(0.41,1.28)	0.73(0.38,1.38)
30-34	19(10.2)	167(89.8)	0.94(0.53,1.66)	0.87 (0.48,1.55)
>=35	20(12.4)	141(87.6)	1.00	1.00
Number of ANC visits				
>=4 ANC visits	65(8.6)	695(91.4)	0.99(0.51,1.94)	0.84(0.43,1.64)
< 4 ANC visits	10(10.0)	90(90.0)	1.00	1.00
Educational level				
No formal education	44(8.4)	481(91.6)	0.81(0.35,1.88)	--
Primary	25(8.5)	268(91.5)	0.66(0.27,1.61)	--
Secondary	6(14.3)	36(85.7)	1.00	
Visited/seen HEW during pregnancy				
Yes	26(9.8)	240(90.2)	1.03(0.64,1.66)	--
No	49(8.2)	545(91.8)	1.00	--

*statistical significance confidence interval.

3.3. Level of completion of a continuum of age-appropriate infant feeding practices and its barriers among breastfeeding mothers in Ethiopia (Paper III)

In this study, the quantitative and qualitative data were analyzed concurrently, and the findings are integrated in this section (**Table 11 & figure 4**).

3.3.1. Socio-demographic characteristics of quantitative study participants

In the quantitative study, a total of 1,755 mothers of infants were included from six regions of Ethiopia (**Table 9**).

The majority of the study participants were from Oromia (44%), SNNP (22.5%), and Amhara (22.0%) regions. Over two-thirds of the study participant mothers (78.2%) were from the rural parts of the regions. Nearly ninety-six percent of the study participant mothers were married, and nearly forty-two percent of them had never attended formal education, followed by 39.1% attending primary school.

Table 9: Socio-demographic characteristics of mothers of infants in six regions of Ethiopia (n=1,755), 2019-21.

Socio-demographic characteristics	Weighted percent	Weighted N	Unweighted N
Region			
Oromia	44.2	776	443
SNNP	22.5	395	414
Amhara	22.0	388	324
Tigray	6.1	106	282
Addis Ababa	3.7	64	171
Afar	1.5	26	121
Area of residence			
Rural	78.2	1,373	1,066
Urban	21.8	382	689
Marital status			
Currently married/in union	95.8	1,682	1,657
Not in union	4.2	73	98
Education level			
No formal education	42.6	747	663
Primary	39.1	686	633
Secondary	11.2	197	260
Vocational & higher	7.1	125	199
Household wealth index			
Lowest quintile	20.9	366	291
Lower quintile	19.3	340	259
Middle quintile	20.3	356	277
Higher quintile	19.7	345	329
Highest quintile	19.8	348	599
Women Age (in years)			
15-19	9.0	158	133
20-24	23.7	416	424
25-29	31.2	547	580
30-34	19.5	343	350
>=35	16.6	291	268
Religion			
Orthodox	37.7	659	806
Muslim	34.9	610	511
Protestant	26.0	456	421
Other*	1.4	30	17
Baby gender			
Male	51.5	904	895
Female	48.5	851	860

*Catholic, Wake-feta, Traditional

3.3.2. Level of completion of the continuum of age-appropriate infant feeding practice among mothers in six regions of Ethiopia

In this study, four infant feeding indicators, including timely initiation of breastfeeding, EBF, timely introduce complementary food and dietary diversity, used to define continuum of age-appropriate infant feeding by mothers (**Table 10**).

This study showed that 13.96% (95% CI: 12.3 to 15.7%) of mothers practiced a complete continuum of age-appropriate infant feeding, that means practiced optimal breastfeeding and complementary feeding. Approximately 47% of mothers practiced optimal breastfeeding (initiated breastfeeding within an hour after delivery and practiced EBF up to six months). Similarly, nearly one-fifth of mothers practiced optimal complementary feeding (introduced complementary food at 6 months of infant age and practiced dietary diversity). Over eight percent of mothers did not practice any optimal feeding.

Table 10: level of completion of the continuum of age-appropriate infant feeding practices among breastfeeding mothers in six regions of Ethiopia, 2019-21.

Variables	Frequency (N=1755)	Percentage (%)	95% CI range
Practiced a complete continuum of age-appropriate infant feeding (yes)	245	13.96	12.3-15.7
Initiated breastfeeding within an hour after delivery (yes)	1135	64.67	62.4-67.0
Practiced exclusive breastfeeding (EBF) up to 6 months (yes)	1240	70.65	68.4-72.8
Introduced complementary food at 6 months of infant age (yes)	1,089	62.05	59.7-64.4
Practiced dietary diversity (yes)	549	31.28	29.1-33.6
Practiced optimal breastfeeding (yes)	820	46.72	44.3-49.1
Practiced optimal complementary feeding (yes)	355	20.23	18.3-22.2
Did not practice any of optimal feeding (yes)	147	8.37	7.2-9.8

3.3.3. Factors that influence the continuum of age-appropriate infant feeding practice

During the binary analysis of the quantitative data, mothers' area of residence, educational level, household income level, and place of delivery were found to be statistically significantly associated with mothers' completion of the continuum of age-appropriate infant feeding practice at a $p < 0.20$ (**table 11**).

However, after adjustment for the potential confounders, none of the selected variables were statistically significantly associated with mothers' completion of the continuum of age-appropriate infant feeding practice at a $p < 0.05$.

Table 11: Assessment of factors associated with complete continuum of age-appropriate infant feeding practice in six regions of Ethiopia, 2019-21.

Variables	Age-appropriate infant feeding practice(n=1,755)		Crude OR (95% CI)	Adjusted OR(95% CI)
	Yes (%)	No (%)		
Area of residence				
Rural	136(12.8)	930(87.2)	0.82(0.59,1.14)*	0.95(0.56,1.59)
Urban	109(15.8%)	580(84.2%)	1.00	1.00
Educational level				
No formal education	67(10.1)	596(89.9)	0.69(0.45,1.05)*	0.75(0.46,1.19)
Primary	107(16.9)	526(83.1)	1.01(0.69,1.48)	1.05(0.70,1.58)
Secondary	40(15.4)	220(84.6)	0.97(0.63,1.49)	0.99(0.64,1.51)
Vocational & Higher	31 (15.6)	168(84.4)	1.00	1.00
HH Wealth index				
Lowest quintile	28(9.6)	263(90.4)	0.63(0.40,1.02)*	0.78(0.41,1.51)
Lower quintile	35(13.5)	224(86.5)	0.91(0.61,1.36)	1.08(0.60,1.92)
Middle quintile	41(14.8)	236(85.2)	0.88(0.59,1.30)	1.03(0.58,1.82)
Higher quintile	46(13.9)	283(86.0)	0.83(0.57,1.20)	0.95(0.59,1.51)
Highest quintile	95(15.9)	504(84.1)	1.00	1.00
Place of delivery				
Health facility	165(15.2)	917(84.8)	1.26(0.94,1.68)*	1.14(0.82,1.57)
Home	80(11.9)	593(88.1)	1.00	1.00
Number of ANC visits				
>=4 ANC visits	94(14.6)	550(85.4)	1.01(0.76,1.32)	0.89(0.67,1.20)
< 4 ANC visits	151(13.6)	960(86.4)	1.00	1.00
Women age (in years)				
15-19	18(13.5)	115(86.5)	1.04(0.62,1.73)	--
20-24	65(15.3)	359(84.7)	1.17(0.80,1.70)	--
25-29	78(13.4)	502(86.6)	0.98(0.68,1.42)	--
30-34	47(13.4)	303(86.6)	1.04(0.70,1.54)	--
>=35	37(13.8)	231(86.2)	1.00	--
Parity				
<5 live births	197(13.7)	1244(86.3)	0.91(0.67,1.21)	--
>=5 livebirths	48(15.2)	267(84.8)	1.00	--
Visited/seen HEW during pregnancy				
Yes	69(13.7)	435(86.3)	0.86(0.63,1.16)	--
No	176(14.1)	1,075(85.9)	1.00	--
Planned to feed other than breast milk in the first 6 months				
No	154(14.3)	926(85.7)	1.08(0.80,1.46)	--
Yes	91(13.5)	584(86.5)	1.00	--

*Statistical significance at p-value < 0.20

3.3.4 Barriers of completion of age-appropriate infant feeding practices

In this qualitative study, a total of 14 mothers of infants were interviewed to explore barriers of optimal age-appropriate infant feeding to complement interpretation of quantitative study findings (figure 5).

The qualitative findings showed that mothers optimal infant feeding practices were influenced by their low or limited source of income, their limited knowledge and attitude towards optimal feeding benefit and consequence, mother themselves and/or infant ill health status, important others (grandmother, husband, and health professional), price inflation, less access to food, and their workload or busy work conditions.

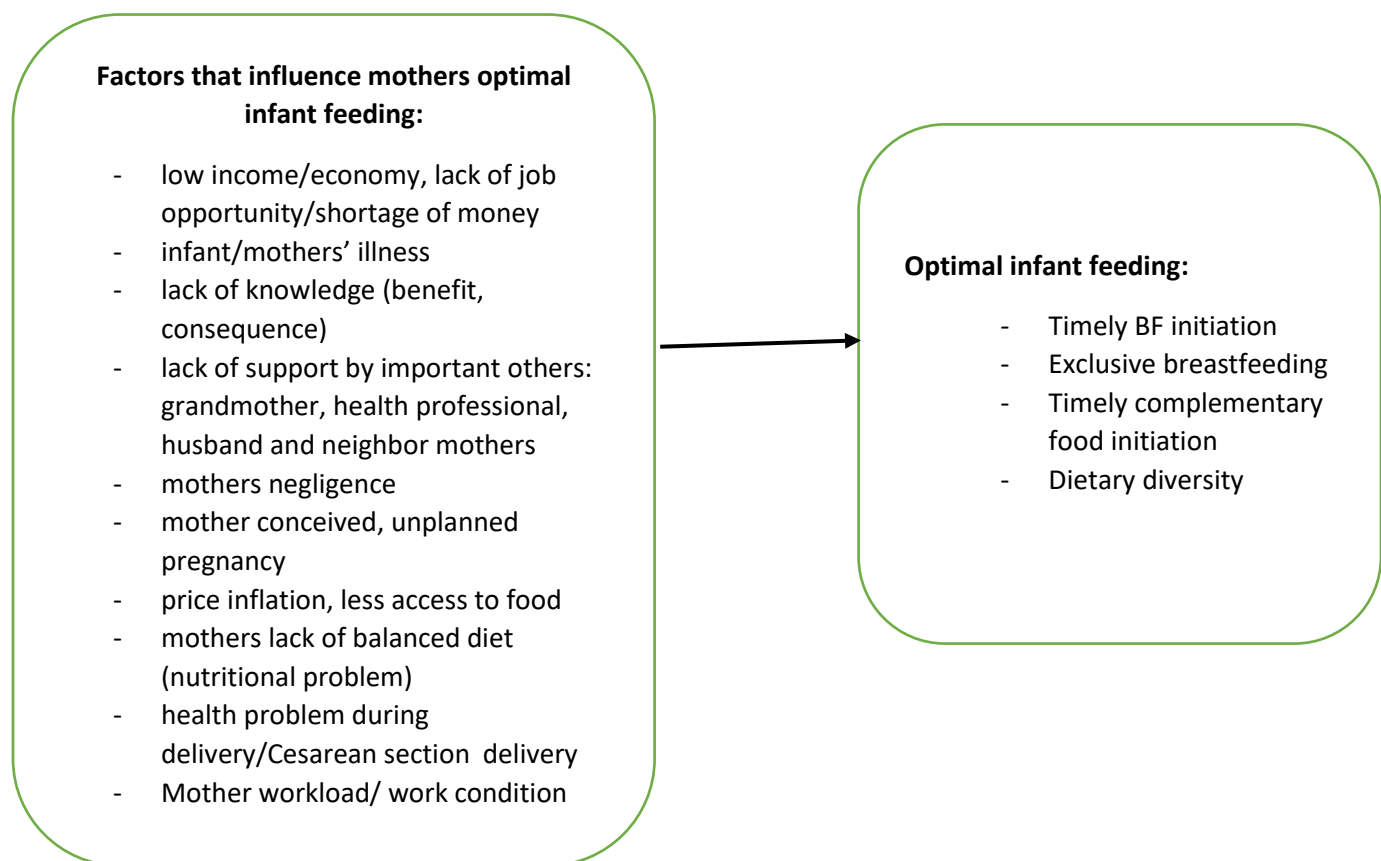


Figure 5: Factors influencing mothers' continuum of age-appropriate infant feeding practice in Ethiopia, 2022.

3.3.5 Integration of mixed method study findings

In this study, The Theory of Planned Behavior (TPB) was utilized as a framework to identify themes through the combination of quantitative and qualitative data (Table 11 & figure 5).

The results were then combined and explained in terms of the selected theme areas, which include background factors (socio-demographic and knowledge factors), perceived consequences, perceived social pressure and perceived behavioral control.

3.3.5.1 Background factors

The chance of completion of the continuum of age-appropriate infant feeding practice was 18% times lower among mothers of rural infants compared to mothers of urban infants (crude OR = 0.82, 95%CI= 0.59, 1.14). Similarly, the chance of completion of age-appropriate infant feeding practice was 31% times lower among mothers who did not attend formal education compared to mothers with vocational & higher education.

In the PMA survey, mothers' knowledge of age-appropriate infant feeding practices was not measured, but this variable was measured in the qualitative interview. Many of the participant mothers correctly described the content and benefits of age-appropriate infant feeding practices. This is illustrated by the statements:

“... the initial breast milk (colostrum) is important for infants and protects them from disease. It has benefits for the mother too: prevent breast pain, helps to have normal weight, and it also increases mother-child psychological attachment.” (mother, age 27 years)

“Breast milk is adequate until six months. It contains all the important things (nutrients) for the infant. After six months infants should get additional foods for their proper growth. Now I am feeding breast milk only. After six months, I have a plan to feed an additional variety of foods, like cerifam, carrot, potato, porridge and milk.” (Mother, 30 years)

In the qualitative interview, some mothers described that additional food mainly cow milk can be given to the infant at an earlier age. They thought breast milk is not enough or no problem with giving additional food (milk) before six months. This is demonstrated by the comments:

“I don’t think breast milk is enough up to six months. I gave cow milk after diluting it with water at the age of three months because my breast did not produce enough milk, and the child might get hungry. The child should exercise bottle feeding at the age of three months. So far my child does not have any health problems, as a result of early additional food introduction.” (Mother, 20 years age)

“Up to six months infants should be fed breast milk only, but if you are an employee you can start additional food starting from 5 months to fulfill the energy requirements of the infant. I have got this advice from doctors (health professionals). Up to now, I am at home and did not start any additional food, but after this month I will return to work, so I have to start additional food mainly cow milk as per the advice.” (Mother, 25 years old)

3.3.5.2 Perceived consequences

Similarly, in the PMA survey, the mother’s attitudes towards age-appropriate feeding practices was not measured, but this variable was measured in the qualitative interview. Many of the participant mothers correctly described the negative consequences of inappropriate infant feeding practices. This is illustrated by the statements:

“up to six months, a child should only feed on breast milk. If a child is given additional food before six months, many problems will occur. The child becomes at risk of infection (disease). For example, I started bottle feeding at the age of two months because of the two fasting months. This led my child to diarrheal diseases. She had loose stool five times a day. She was seriously sick. Then, I stopped bottle feeding and continued breastfeeding up to six months. Early bottle feeding affects their health, especially if there is a hygiene problem. The bottle may be contaminated by flies, but mother breast milk is clean and safe.” (Mother, 27 years age).

“If a child is not appropriately fed, the child’s growth and mental development will be compromised, and the child will not have a bright mind. The child also lacks strength. The other thing, is the child will be easily susceptible to disease and cannot resist disease.” (Mother, 30 years age).

“If an infant is not properly fed, their growth will be delayed, lack strength and be unable to walk. If they do not get a balanced diet, like, eggs, fish, vegetables, milk and others, their growth will be compromised. They become malnourished (wasted) and will not have bright minds. ... They may develop anemia and become at risk of disease.” (Mother, 24 years age)

3.3.5.3 Perceived social pressure

Compared to mothers who delivered at home, the chance of the completion of continuum of age-appropriate infant feeding practice was 26% times higher among mothers who delivered at a health facility (Crude OR=1.26, 95%CI= 0.94,1.68).

In the qualitative interview, some mothers described that important others including health professionals, husbands and grandmothers can positively or negatively influence child-feeding practices. This is reflected by the responses:

“We practice optimal feeding as per the health professionals advice during pregnancy visits and after delivery. They tell us how to care for and feed our children. They tell us to expose babies to morning sunlight for 10 minutes after delivery, and for how long the infant breastfeeds. Based on what we have heard we practice at home.” (Mother, 27 years age)

“A neighbor nurse professional (female) told me that it is possible (no associated problem) to give cow milk after diluting with water from the age of three months. The nurse herself is giving cow milk after diluting it with water. She has been giving cow milk since she works at a health office (Woreda health office) so that not convenient for her to breastfeed; however, she does not have enough milk (breast milk), like mine. To fulfill the child’s energy need, I should feed cow milk because we do not want our child to get hungry. ... In addition to breastfeeding, I start other foods feeding after six months of infant age. Up to one year, I feed the infant mainly rice and Endomi (processed fast food). Then, after one year I feed him what we family members eat.” (Mother, 20 years age)

“Mothers (Grandmothers) have a great role in child feeding practice. They tell you to give water and herbal medicine to prevent abdominal cramps, especially if the baby is crying. For example, my mother gave water to my baby at an earlier age and she developed

diarrhea. Then, I took her to a health facility and doctors (health professionals) identified Giardia and treated her.” (Mother, 27 years age)

3.3.5.4 Perceived behavioral control

The chance of completion of age-appropriate infant feeding practice was 37% times lower among mothers with the lowest household income compared with mothers with the highest household income.

The finding from the qualitative study showed that mothers may not practice optimal infant feeding, due to inconvenient work conditions and low income (lack of job opportunity/lack of money), price inflation and less access to food. This is reflected by the comments:

“optimal complementary feeding depends on what you have. If you have access, it is good to feed them different food items, like, eggs, meat, vegetables..., but if you don’t have access, you cannot do anything, what you can do is give what you have already.” (Mother, 24 years age)

“If you are expecting expense from a husband, you may not feed properly as he may give a small amount of expense (money). Our (mothers) being busy with activities may influence not to feeding properly. She may leave home early in the morning and return at night from work (employed or unemployed), so the child will not get breast milk or not be properly fed.” (Mother, 20 years age)

3.4. Summary of findings by specific objectives

Table 12 : *Summary of findings by specific objectives*

S. No	Objectives	Summary of main findings
1	Evaluate influence of receiving quality antenatal care service on maternal use of skilled birth attendants in Ethiopia	About 54% of women used skilled birth attendants during the current baby delivery (proportion = 53.6%, 95% UI = 51–56%) in Ethiopia. Nearly 39% of the women received quality (more than 75 th percentile) ANC service (proportion = 39.05%, 95% UI = 36–42%). The highest and lowest antenatal care services women received, respectively, were blood pressure measures (91.9%) and syphilis tests (12.4%). Women who received better quality ANC service were 20% more likely to use skilled birth attendants, compared to women who received low quality ANC service (adjusted IRR = 1.20, 95% UI = 1.11, 1.31).
2	Home-based optimal newborn care practices and associated factors among mothers who gave birth at home in Ethiopia	In Ethiopia, the level of home-based optimal newborn care practice was 8.7%, with a 95% uncertainty interval ranging from 6 to 11%. After adjusting for potential confounding factors, the area of residence remained statistically significantly associated with the mother's optimal newborn care practices. The chance of home-based optimal newborn care practice was 69% lower among rural resident mothers compared to urban resident mothers (adjusted OR = 0.31, 95% CI = 0.15, 0.61).
3	Level of completion of a continuum of age-appropriate infant feeding practices and associated factors among breastfeeding mothers in Ethiopia:	In Ethiopia, about 14% (proportion = 13.96; 95% CI: 12.4 to 15.6%) of mothers practiced a complete continuum of age-appropriate infant feeding. Over eight percent of mothers did not practice any optimal feeding. Nearly 47% of mothers practiced optimal breastfeeding, and one-fifth of mothers practiced optimal complementary feeding. Results from both quantitative and qualitative data showed that mothers' complete continuum of age-appropriate infant feeding practice was affected by their level of income, knowledge, and attitude towards optimal infant feeding, as well as by important others, including husbands, grandmothers, and health workers.

4. Discussion

4.1. Continuum of maternal use of skilled delivery service after ANC visit (Paper I)

Evidence has showed that poor quality of antenatal or delivery care received by women in low- and middle income countries is contributing to high levels of maternal mortality (100). Similarly, evidence suggest that maternal use of skilled birth attendant is the most important factor to reduce maternal mortality (101) because of more than three-fourths of maternal deaths occurred during child delivery or within 24 hours after delivery due to hemorrhage, hypertension, ruptured uterus and sepsis (5,16).

In this study, we primarily assessed the influence of quality ANC service on maternal use of skilled birth attendant after a women had any ANC visit. This study revealed that the rate of maternal use of skilled birth attendant was higher among women who received better quality ANC service, compared to women who received low quality ANC service. This finding was consistent with previous works that revealed women who received better or adequate ANC services were more likely to use skilled birth attendant, compared to women who received less quality ANC services (41,93,94,102). This suggests that provision of quality or adequate ANC service, which include advice on birth preparedness during pregnancy had a great role in promoting skilled birth attendant or institutional delivery. During ANC visit counselling women on benefit of delivery by skilled birth attendant and transport arrangement for delivery may lead to better utilization of skilled delivery (100).

The current study also revealed that rate of maternal use of skilled birth attendant was higher among women who had 4+ ANC visit, compared to women who had less than 4 ANC visit. This finding was consistent with the findings of studies conducted in Ethiopia and Tanzania (39,40), which indicated that women with 4+ ANC visit were more likely to use skilled birth attendant, compared to women who had less than four ANC visit. The possible explanation could be women with higher number of ANC visit during pregnancy may receive all essential ANC services in their subsequent visit, and this may lead to positive evaluation of ANC quality. The other possible explanation could be during ANC visit, women may get advice on health benefits of skilled delivery and consequences of unskilled delivery, and this may positively influence women to use skilled birth attendant.

The current study showed that women living in urban setting were more likely to use skilled birth attendant, compared to women living in rural setting. The finding was consistent with the findings of another study conducted in Ethiopia, which reported that maternal use of skilled birth attendant was higher among women who live in urban setting (40). The possible reason for urban residing women better use skilled birth attendant could be the fact that urban residing women may have better access to skilled services. Evidence has reported that women living in less than 1-hour distance from a health facility were more likely to use skilled services (39,40).

The current study also revealed that women who had partner support about place of delivery were more likely to use skilled birth attendant, compared to women who did not have partner support about place of delivery. The possible explanation could be partner who encourage or support skilled delivery may have better knowledge and favorable attitude towards health benefits of skilled delivery, consequences of unskilled delivery and the quality of services provided by a health facility. Evidence has indicated that women use of skilled service can be positively or negatively influenced by the acceptability of the quality of skilled service by their family and the community (100).

4.2. Level of home-based optimal newborn care and associated factors (Paper II)

Evidence has showed that 15 to 50 percent of neonatal deaths can be averted by exercising optimal newborn care practices, including: cord cutting with a sterile blade and hygienic cord care, baby bathing after 24 hours and give appropriate thermal care, early and exclusive breastfeeding and care seeking for illness (9,12).

In this study, we assessed the level of home-based optimal newborn care practices and associated factors among mothers who gave birth at home. This study revealed that the prevalence of home-based optimal newborn care practice was less than ten-percent in Ethiopia. This was lower than findings of previous works, which reported higher prevalence of optimal newborn care practice, which ranged from 10 to 50 percent (13–16,18). The higher proportion of optimal newborn care practice in the previous works could be due to the fact that majority of study participants in those studies gave birth at health facilities and they may have the chance to receive advice on optimal newborn care. Evidence has showed that mothers who received counseling about essential newborn care during delivery were more likely to practice optimal essential newborn care practices (21).

Previous studies reported that the odds of optimal newborn care practice was higher among mothers with highest income, had good knowledge of newborn care, had formal education and had 4+ ANC visits (13–15,18); however, in the current study, none of the assessed individual level (socio-demographic) factors were statistically significantly associated with mothers' optimal newborn care practice, but over three-quarters of mothers practiced suboptimal newborn care in different categories of individual level variables, including mothers age category, household income, educational status, parity, visit by HEW during pregnancy and ANC frequency. The possible explanation could be that the current study may be underpowered to identify potential factors, since only 75 mothers had optimal newborn care practices. When we stratify those 75 into different categories of the various variables, included in the final model, we may not get a significant result. The other possible explanation could be use of secondary data, which may miss data on some potential confounding variables, including knowledge and attitude towards optimal newborn care practice.

The current study also revealed that the chance of home-based optimal newborn care practice was 69% times lower among rural resident mothers, compared to urban resident mothers. This finding

is consistent with previous works which indicated that rural resident mothers practiced suboptimal newborn care (13–15,24). The possible explanation could be that rural resident mothers, especially women who gave birth at home may not get advice on essential newborn care or have inadequate knowledge of health benefit of optimal newborn care and the consequence of suboptimal newborn care. This is supported by evidence that optimal essential newborn care practice was lower among mothers who did not get any advice on essential newborn care or with poor knowledge of essential newborn care and with poor knowledge of newborn danger signs (13,14,25,26). Other evidence have showed that mothers who give birth at health facility are more likely to practice optimal newborn care practices (14,21). This could be due to the fact that women who give birth at health facility may get all the necessary newborn care support and advice by healthcare providers.

4.3. Completion of age-appropriate infant feeding practice and associated barriers (Paper III)

The World Health Organization recommended that mothers should initiate breastfeeding within an hour after birth, exclusively breastfeed up to 6 months, continue breastfeeding for 1 and more years, introduce semi-solid or soft foods at 6 months, prepare minimum dietary diversity (≥ 4 food groups), and give minimum meal frequency (≥ 3 meals in a day) to promote infant and child healthy growth (103).

The current study showed that less than 14% of mothers started and continued optimal age-appropriate infant feeding practices in Ethiopia. This shows that nearly nine in 10 mothers did not start and continue age-appropriate infant feeding practices as per the recommendations. Similarly, some in-depth interviewed mothers described that only breast milk feeding until six months is not enough to fulfill the energy requirements of the baby, and optimal complementary feeding practice mainly depends on the availability and access to diverse food items.

Although no previous study estimated the level of the complete continuum of age-appropriate infant feeding practices by mothers, some studies reported the level of exclusive breast feeding and timely initiation of complementary feeding practices by mothers separately, which ranged from 10 to 88% and 34 to 83%, respectively (15–17,19, 29–42). Similarly, studies conducted in Ethiopia and in urban slums in India reported that proportions of mothers who initiated breastfeeding within an hour after delivery ranged from 23 to 63% (62,70,104). Also, a study conducted in Ethiopia reported that about 24% of children had good dietary diversity, and about 33% of children were fed with an appropriate meal frequency (71).

The current study showed that none of the assessed background (socio-demographic) factors were statistically significantly associated with mothers' complete continuum of age-appropriate infant feeding practice; however, over three-quarters of mothers practiced suboptimal infant feeding in different categories of socio-demographic variables, including area of residence, household income, educational status, and place of delivery. The possible explanation could be that the current study may be underpowered to identify potential factors, since only 245 mothers had a continuum of feeding practices. When we stratify those 245 into different categories of the various variables included in the final model, we may not get a significant result. The other possible

explanation could be use of secondary data, which may miss data on some potential confounding variables, including knowledge and attitude towards optimal infant feeding practice.

In this study, the effect of mothers' knowledge and attitude on the completion of a continuum of age-appropriate infant feeding practice was not assessed due to the data limitations of the PMA survey. However, some in-depth interviewed mothers described that optimal infant feeding has several benefits, like helping children to have proper growth and mental development (a bright mind), getting strength and resisting diseases. Similarly, studies conducted in Ethiopia and Kenya reported that optimal exclusive breastfeeding and complementary feeding practices were higher among mothers who were knowledgeable about the timing and benefits of optimal child feeding (63,65,70,76). Also, a study conducted in rural Kenya reported that the chance of a mother's early cessation of exclusive breastfeeding was lower among mothers who had knowledge of breastfeeding and had positive beliefs about the impact of exclusive breastfeeding on children and their perception of impact of exclusive breastfeeding on mother (76).

The current study also showed that higher proportions of mothers who gave birth at health facilities started and continued age-appropriate infant feeding practices compared to mothers who gave birth at home. The possible explanation could be that mothers who gave birth at a health facility might receive counseling on optimal child feeding practices during pregnancy visits and delivery by health professionals. In some in-depth interviews, mothers described that important other, including health professionals, grandmothers, and husbands, have great influence on practicing age-appropriate infant feeding. Studies conducted in rural Kenya and India reported that the chance of exclusive breastfeeding was higher among mothers who had a positive perception of the acceptability of exclusive breastfeeding by important others and had a supportive norm (76,77).

The current study showed that nearly only 15 percent of mothers in all income categories practiced optimal age-appropriate infant feeding. This shows that mothers with no economic problems still practiced suboptimal feeding. The possible explanation could be mothers with higher income may have limited knowledge and attitude towards optimal infant feeding practices; however, economic problems may be a significant major barrier for mothers with lower household income. Some of the in-depth interview participants described that low income and less access to food can significantly influence mothers' age-appropriate infant feeding practices. This finding was in line

with studies conducted in Ethiopia and India, which reported that low socioeconomic status was a major barrier to practicing age-appropriate infant feeding (59,60,77,82).

5. Validity and generalizability

5.1. Internal validity

This study minimized the effect of chance by taking into account sufficient samples for each of its particular objectives. The sample size was determined taking into account significant variables and assumption. The six regions' sample enumeration areas were chosen, using the proper probability sampling technique. Questionnaires for data collection were pretested prior to the commencement of data collection.

Electronic data gathering tools were utilized by skilled data collectors to gather data. Also, the study is less susceptible to recall bias because of short recall data collection weeks considered and detail measurement of exposure (like, ANC components) and outcome (newborn and infant care practices) statuses. Being a longitudinal panel survey, the issue of reverse causality will not be a problem in this study. However, the study might be at risk of Hawthorne effect bias because of the study being a longitudinal panel survey study, but this may not be a problem in this study as misclassification is more likely to be non-deferential in the enumeration areas.

Appropriate statistical models and effect size metrics were applied in order to evaluate the relationship between exposure and outcome variables. The analysis took into account the potential influence of measured confounding variables.

5.2. External validity

To increase generalizability of findings, a representative sample was taken from six regions in the nation, where 90% the population resides, standardized data collection tools were used and appropriate statistical methods were used to account for the non-equal selection probability of study households within an enumeration area, and to account for within cluster (EA) correlations of outcomes.

6. Strengths and limitations of the study

The current study has the following methodological strengths and limitations.

- Adequate sample size was estimated by considering all important sample size determination inputs (parameters) and sampling design.
- The generalized estimating equation model was applied to account for clustering nature of the data by enumeration areas. Besides, the non-equal selection probability of the study participants within enumeration areas were accounted during the analysis to improve the representativeness of estimates.
- Data were collected using standardized detailed tools and the data collection process was strongly monitored. However, some of the study participant mothers might not have correctly remembered all the ANC services they received during pregnancy, and the optimal care they themselves provided to their newborn or infant, but this might not be a serious problem in this study estimates because of short recall period used and the recall problem might be non-differential among participants of the enumeration areas in the regions.
- In the Performance Monitoring for action project, there was no data on some important exposure variables (like, mothers' knowledge and attitude towards maternal use of SBA, facility readiness for delivery service, household distance from health facility or access to transportation, newborn and infant optimal care practices benefits and consequences), which might have confounded the true relationship between the exposure and outcome variables. However, in the mixed method study, the influence of those variables on age-appropriate infant feeding practice were explored qualitatively. Therefore, the qualitative study results may increase confident use of the quantitative study results by decision makers, and would trigger implication for further research to complete measurement of exposure variables in relation to the outcome/s.

7. Conclusion

From the current study we can conclude that,

- In Ethiopia, high proportions of mothers did not give delivery with the help of a skilled birth attendant during the study period. Mothers use of skilled birth attendant was significantly influenced by the quality of antenatal care service received by mothers during pregnancy.
- The level of optimal home-based newborn care practice was extremely low in Ethiopia. However, the practice was somehow better among urban resident mothers compared to rural resident mothers.
- The level of complete continuum of age-appropriate infant feeding was significantly low among breastfeeding mothers in Ethiopia, during the study period. Mothers age-appropriate infant feeding practice was influenced by individual and interpersonal level factors, including knowledge and attitude towards age-appropriate infant feeding, economic status, and social networks (family members and health professionals).

8. Recommendations

8.1. Policy level

- The Ministry of Health and each Regional Health Bureau should make sure quality antenatal care and skilled delivery services in healthcare institutions. Every health sector should devise strategies to increase mothers' access to and usage of skilled birth attendants.
- Health sectors at all level should collaborate with local stakeholders, including agricultural sectors and development partners, to strengthen mothers' education on health benefits of optimal maternal and infant care, design and promote strategies to improve household access and affordability to essential health care service and diverse food.
- Mothers of infants from low-income households should receive priority attention from decision makers and other concerned parties in order to increase their revenue source.

8.2. Health facility level

- Healthcare providers should ensure that women receive proper antenatal care, as well as educate and encourage women and their influencers to use skilled ANC and delivery services. They should also explain benefits of subsequent ANC visits and use of skilled birth attendants for the health of women and newborns.
- Healthcare providers should also educate and encourage mothers to practice optimal newborn and infant care by outlining the health benefits of optimal newborn and infant care and the consequences of practicing suboptimal infant care during their home visit or outreach service. Besides, they should counsel and support mothers in using health facilities for delivery of their babies.
- Health extension workers should counsel and motivate mothers, including their influencers on health benefits of skilled services, optimal newborn care and age-appropriate infant feeding, including proper breastfeeding, complementary feeding and dietary diversity, during their home visit.

8.3. Further research directions

- Using comprehensive and standard tools, it is important to further investigate multilevel factors that influence optimal newborn care and age-appropriate infant feeding practices.
- In-depth understanding of reasons for mothers not to use skilled birth attendant after adequate ANC visits through qualitative approach is also important.
- The World Health Organization (WHO) promotes for exclusive breastfeeding until six months of age, regardless of the women's nutritional or economic situation. The timing, adequacy, health benefits and consequences of extended exclusive breastfeeding should be studied extensively in poor countries with high malnutrition rates, such as Ethiopia.

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11. Appendices

11.1. Quantitative English questionnaire

Quantitative study Research checklist/ (questionnaire)

Region: _____. District _____. Cluster ID: _____. Household ID: _____. Women ID: _____. Newborn/infant ID: _____.			
Section 1: Socio-demographic characteristics of study participant			
S.no	Questions	Response categories	Skip pattern
101	Women age during the current baby pregnancy?	_____ years	
102	Women age at first birth?	_____ years.	
103	Area of residence?	1. Urban 2. Rural	
104	What is your religion?	1. Orthodox 2. Islam 3. Protestant 4. Catholic 5. Traditional 6. Wakefeta 7. Non-believers 8. Other (specify) _____ 9. No response	
105	What is your ethnic group?	1. Amhara 2. Oromo 3. Tigray 4. Sidama 5. Gurage 6. Afar 7. Silte 8. Other (specify) _____	
106	Women level of schooling have attended?	1. Never attended 2. Primary 3. Secondary 4. Technical & vocational 5. Higher 6. No response	
107	Husband level of schooling have completed?	1. Never attended 2. Primary	

		3. Secondary 4. Technical & vocational 5. Higher 6. No response	
108	Women employment status?	1. Homemaker 2. Farmer 3. Government employee 4. Merchant 5. Private employee 6. Daily laborer 7. Others specify-----	
109	Husband employment status?	1. Homemaker 2. Farmer 3. Government employee 4. Merchant 5. Private employee 6. Daily laborer 7. Others specify-----	
110	Are you currently married or living together with a man as if married?	1. Yes, currently married 2. Yes, living with a man 3. Divorced/separated 4. Not currently in union: widow 5. No, never in union 6. No response	
111	Current family size? (in number)	_____.	
Section 2: Housing characteristics and household possession			
S.no	Questions	Response options	
201	What is the main household source of drinking water?	1. Piped into dwelling/yard/plot 2. Water piped into public tap 3. Tube well/borehole 4. Protected dug well/spring 5. Rain water 6. Unprotected dug well/spring 7. Surface water 8. Other (specify)_____	
202	Time to obtain (fetch) water? (round trip)	1. Water on premises 2. Less than 30 minutes 3. 30 minutes or longer 4. Don't know	
203	What type of methods has used to treat water? (more than choice possible)	1. Boiling 2. Add bleach/chlorine 3. Strained through cloth	

		4. Filter 5. Let stand and settle 6. Other (specify)_____ 7. No treatment	
204	What type of toilet/latrine facility is used by the hh?	1. flush to piped sewer system 2. flush/pour flush to septic tank 3. flush/pour flush to pit latrine 4. ventilated improved pit latrine 5. pit latrine with slab 6. composting toilet 7. pit latrine without slab 8. other (specify)_____ 9. open defecation (no facility)	
205	Where is location of toilet facility?	1. In own dwelling 2. In own yard/plot 3. Else where	
206	What is the house flooring material?	1. Earth, sand 2. Dung 3. Wood/planks 4. Palm/bamboo 5. Ceramic tiles 6. Cement 7. Carpet	
207	What is the number of rooms used for sleeping?	_____.	
208	What is the main source of cooking fuel?	1. Electricity 2. Natural gas/biogas 3. Kerosene 4. Charcoal 5. Straw/shrubs/grass 6. Agricultural crop 7. Animal dung	
209	Which one of the following household effects are available? (multiple choice possible)	1. Radio 2. Television 3. Mobile phone 4. Watch 5. Computer 6. Non-mobile phone 7. Refrigerator 8. Table	

		9. Chair 10. Bed with cotton/sponge/spring mattress 11. Electric mitad 12. Kerosene lamp/pressure lamp 13. Other specify_____.	
210	What is frequent household means of transportation?	1. Bicycle 2. Animal drawn-cart 3. Motorcycle/scooter 4. Cart/truck 5. Boat with a motor 6. Bagag 7. Other (specify)_____.	
211	Does the household own agricultural land?	1. Yes 2. No	
212	Which farm animals does the household have? (multiple choice possible)	1. Cows 2. Bulls, or other cattle 3. Horses 4. Donkeys 5. Camels 6. Goats 7. Sheep 8. Chickens, or other poultry 9. Beehives 10. Other specify_____.	

Section 3: Maternal reproductive characteristics

S.No	Question	Response categories	Code
301	For how many times have you been live birth (parity)?	_____parity	
302	At the time you become pregnant, did you want to become pregnant then, did you want to wait until later, or did you not want to have any/any more children at all?	1. Then 2. Later 3. Not at all 4. No response	
303	Did you have autonomy for health care decision making?	1. Yes 2. No	
304	Did you have ANC visit during the current baby pregnancy?	1. Yes 2. No	
305	If “yes”, how many numbers of ANC visits did you have during the current baby pregnancy?	_____visits	

306	What was the time of first ANC visit during current baby pregnancy?	1. Less than 16 weeks of gestation 2. After 16 weeks 3. Don't remember	
307	As part of your antenatal care during this pregnancy were any of the following measured at least once:	1. Blood pressure measurement 2. Weight measurement 3. Give urine sample 4. Give blood sample 5. Tested for syphilis 6. Tested HIV 7. Tetanus toxoid injection 8. Deworming 9. Iron and folic acid supplement 10. Informed about birth preparedness 11. Informed about nutrition/diet 12. Informed about obstetrical complication 13. Other(specify)_____.	
308	During your antenatal care visit(s) was there any discussion about the following:		
308.1	Place of delivery?	1. Yes 2. No 3. Do not know 4. No response	
308.2	Delivery by a skilled attendant?	1. Yes 2. No 3. Do not know 4. No response	
308.3	Arrangement for transport for delivery?	1. Yes 2. No 3. Do not know 4. No response	
308.4	Where to go if experience of pregnancy danger signs? (<i>headaches, blurred vision, high blood pressure, edema, convulsion/fits, bleeding</i>)	1. Yes 2. No 3. Do not know 4. No response	
308.5	Did you receive any tablets that should be taken to prevent bleeding after delivery?	1. Yes 2. No	

		3. Do not know 4. No response	
308.6	As part of your antenatal care visits, did a healthcare provider talk with you about you nutrition or diet?	1. Yes 2. No 3. Do not know 4. No response	
308.7	What information or message did you receive during your pregnancy about nutrition or diet?	1. Eat more (quantity) 2. Eat a variety of foods/food rich with iron (quality) 3. Take iron containing tablets 4. Take preventive malaria treatment 5. Take deworming tablet 6. How much weight to gain weight 7. Regular exercise 8. How to manage nausea/vomiting 9. Reduce salt intake 10. Do not eat raw meat 11. None of the above 12. No response	
309	Did your partner encourage you to go to the clinic for antenatal care?	1. Yes 2. No, did not encourage 3. No, actively discouraged 4. No partner 5. Do not know 6. No response	
310	While you were pregnant, did you and your partner discuss where you planned to deliver?	1. Yes 2. No 3. Do not know 4. Partner not involved 5. No response	
311	How many months pregnant were you when the pregnancy ended/baby was born?	_____ months	
312	How many children were in this pregnancy? (eg twin or triplet?)	1. Single 2. Twin 3. Triplet+ 4. No response	
313	Where did you give birth?	1. Her home	

		2. Other home 3. Government hospital 4. Government health center 5. Government health post 6. Other public sector 7. Private hospital/clinic 8. Other private medical sector 9. NGO/faith-based health facility 10. Other 11. No response	
314	What are the reasons you did not go to a health facility for delivery?	1. Not necessary 2. Not understand that service is needed 3. Not customary 4. Cost too much 5. Too far 6. Transport problem 7. No one to accompany 8. No provider available 9. Baby came too fast 10. Providers mistreat women 11. Provider not competent 12. Sent home previously 13. Concern about privacy 14. Family did not allow 15. Better care at home 16. No know how to go 17. Not know where to go 18. For fear 19. Other 20. Do not know 21. No response	
315	Who assisted with delivery?	1. No one assisted 2. Doctor 3. Health officer 4. Nurse/midwife 5. Skilled attendant can't distinguish 6. Health extension worker	

		7. Health development army 8. Traditional birth attendant 9. Family member 10. Other 11. No response	
316	Was your delivery by caesarean, that is, did they cut your belly open to take the baby out	1. Yes 2. No 3. No response	
317	How long after delivery did the first check take place?	1. Minutes 2. Hours 3. Days 4. Do not remember 5. No response	
318	Now we are going to ask you a few questions specific to the baby that was just born?		
318.1	Was the cord tied before it was cut?	1. Yes 2. No 3. Do not know 4. No response	
318.2	What was used to cut the cord?	1. Surgical blade 2. New razor blade 3. Boiled blade 4. Bamboo strips 5. Scissor 6. Others 7. Do not know 8. No response	
318.4	Was anything applied to the cord after cutting it?	1. Yes 2. No 3. Do not know 4. No response	
318.5	What was applied to the cord after cutting the cord?	1. Chlorhexidine 2. Other antiseptic/savlon 3. Antibiotics(powder/ointment) 4. Spirit/alcohol 5. Gentian violet 6. Butter 7. Mustard oil with garlic 8. Chewed rice	

		9. Turmeric juice/power 10. Ginger juice 11. Petroleum jelly 12. Body/hair lotion 13. Cattle dung 14. Other 15. Do not know 16. No response	
318.7	Did the baby receive eye ointment following delivery?	1. Yes 2. No 3. Do not know 4. No response	
318.8	Did someone place the baby naked on your chest against your skin, immediately after delivery of the baby?	1. Yes 2. No 3. Do not know 4. No response	
318.9	After delivery, was the baby wrapped with a cloth?	1. Yes 2. No 3. Do not know 4. No response	
318.10	When was the baby given a bath for the first time?	1. Immediately after birth 2. Within 24 hours 3. Second day 4. Third day 5. Days 4-6 6. Day 7 and later 7. Not given 8. Do not know 9. No response	
318.11	How long after birth did you first put the baby to the breast?	1. Minutes 2. Hours 3. Days 4. Do not know 5. No response	
319	How long after delivery did the first check take place?	1. Yes 2. No 3. Do not know 4. No response	
320	Yesterday during the day or night, did the baby receive any of the following?	1. Breast milk	

		2. Vitamin, mineral supplements or medicine 3. Plain water 4. Sweetened, flavored water or fruit juice or tea or infusion? 5. Oral rehydration solution(ORS) 6. Infant formula 7. Tinned, powered or fresh milk 8. Herbal tonic/drinks 9. Any other liquids 10. Anything else 11. Do not know 12. No response	
321	How many days after birth did you go visit the healthcare professionals?	1. _____ 2. Do not know 3. No response	
322	Whom did you see, no including an HEW?	1. Doctor 2. Health officer 3. Professional health care provider, can distinguish 4. Traditional healer 5. Other 6. No response	
323	At your visit after delivery (either by a HEW or other professional healthcare provider) did the provider discuss:		
323.1	Exclusive breastfeeding?	1. Yes 2. No 3. Do not know 4. No response	
323.2	Immunization?	1. Yes 2. No 3. Do not know 4. No response	
323.3	Infant feeding ?	1. Yes 2. No 3. Do not know 4. No response	

323.4	Infant growth?	1. Yes 2. No 3. Do not know 4. No response	
323.5	Other infant development issues?	1. Yes 2. No 3. Do not know 4. No response	
324	Are you currently breastfeeding?	1. Yes 2. No 3. No response	
325	How long do you plan to breastfeed?	1. Months 2. Years 3. Do not know 4. No response	
	Questions about women community		
326	Do most, some, few, or no people in your community encourage women to deliver at a facility?	1. Most people 2. Some people 3. Few people 4. No people 5. Do not know 6. No response	
327	Do most, some, few, or no people in your community think it is acceptable to deliver with a traditional birth attendant?	1. Most people 2. Some people 3. Few people 4. No people 5. Do not know 6. No response	
328	Do most, some, few, or no people in your community encourage going to antenatal care?	1. Most people 2. Some people 3. Few people 4. No people 5. Do not know 6. No response	
329	Do most, some, few, or no people in your community encourage women to seek postnatal care?	1. Most people 2. Some people 3. Few people 4. No people 5. Do not know 6. No response	

Section 4: Infant (newborn) related information's

S. no	Questions	Response options	
401	Newborn sex?	1. Male 2. Female	
402	Birth weight measured?	1. Yes 2. No 3. Do not know 4. No response	
403	Newborn or Infant age?	_____months	
404	How was the baby condition at birth?	1. Baby cry immediately at birth. 2. Baby move limbs immediately after birth 3. Other specify_____.	
405	What type of care provided immediately after birth?	1. Newborn dried and wiped within 30 seconds after birth 2. Baby wrapped within one minute after delivery 3. Breast-feeding initiated immediately after birth 4. Skin-to-skin contact after birth 5. Use of cord cut instrument 6. Time of baby bath after delivery. 7. Vitamin k injection immediately after birth. 8. TTC eye ointment applied immediately after birth. 9. Other specify_____.	
406	Did you get any advice or counseling on essential newborn care?	1. Yes 2. No 3. No response	
407	At what time baby bathed after delivery? (in hours)	1. Within 24 hours 2. After 24 hours	
408	Did baby need extra care?	1. Yes 2. No	
409	If baby needed extra care, what was the major reason for that (abnormality /complication)?	1. Perinatal asphyxia 2. Suspected sepsis	

		3. Respiratory problem (respiratory distress syndrome). 4. Hypothermia 5. Hypoglycemia 6. Skin color change (jaundice- hyperbilirubinemia) 7. Other specify_____.	
410	If extra care needed, what type of care provided?	1. Supported by breathing machine 2. Supported by thermal care incubator 3. Treated by oxygen 4. Treated by glucose (hypoglycemia) 5. Treated by KMC 6. Treated by antibiotics 7. Other specify_____.	
411	Were you exclusive breast feed?	1. Yes 2. No	
412	For how long did you exclusively breastfeed?	1. Days 2. Weeks 3. Months 4. Unknown 5. No response	
413	When did you start infant complementary feeding?"	1. days 2. weeks 3. months 4. Unknown	

		5. No response	
414	What type of common food items do you usually feed your infant?	1. Grains/cereals, roots/tuber 2. Pulses, legumes (bean) 3. Nut/seeds 4. Milk, dairy 5. Meat, poultry & fish 6. Eggs 7. Dark green leafy vegetables 8. Other vegetables 9. Other fruits	

Thank you for your cooperation and participation!

11.2. Qualitative English questionnaire guide

11.2.1. In-depth interview guide

I. Background characteristics

- Participant code _____
 - Area of residence _____
 - Date of interview _____
 - Interviewer name _____
1. Age of the interviewee in complete years _____
 2. Gender _____.
 3. Family size _____.
 4. Number of under five children in the household _____.
 5. Educational status _____.
 6. Occupation _____.

II. Guiding items

1. When do you think mothers should start breastfeeding after birth? Why?
2. Is there any taboo in your locality related to colostrum giving to baby/newborn? (example, conception/believe) If yes, please explain?
3. Do you have any role in relation to when should your infant start breastfeeding after birth? (Probe: if yes, what role? if not, why?)
4. How long do you think infants exclusive breastfeed? Why?
5. Do you have any role in relation to duration of your child exclusive breastfeed? (probe: if yes, what role? If no, why? Frequency?)
6. When do you think complementary feeding should initiate to an infant/child? Why?
7. Do you have any role in relation to when your child should start complementary feeding? (Probe: if yes, what role? if not, why?)
8. Who decide kind of food to feed your infant? Why?
9. Could you please list me the common food items that your child usually feed? (**probe:** Why these food items only?)

10. What are your main sources of information about appropriate child feeding (**probe:** breastfeeding? complementary feeding? Dietary diversity?)
11. What are the barriers/challenges mothers face to practice age-appropriate infant feeding practice? (**probe:** timely start of breast feeding, exclusive breastfeeding, complementary feeding and dietary diversity)
12. Have you ever heard any child health problem or disease that is related to inappropriate infant feeding practice? If yes, would you explain me please?
13. Is there anything you want to tell me about age-appropriate infant feeding practice? (**probe:** start and duration of breastfeeding, complementary feeding....?)

Thank you for your time and valuable information.

11.3. Participant Consent Information

11.3.1. Qualitative study information sheet

Dear participant! Greetings (good morning/afternoon).

I am Shikur Mohammed Awol, a PhD student at school of public health, Addis Ababa University. I am conducting a research for partial fulfilment of PhD degree in Public Health. This study obtained ethical approval from the institutional review board of College of health sciences, Addis Ababa University. I have also received permission from the health authorities of the study site/s to conduct the study.

You are kindly requested to be included in the study, which will have importance in improving child feeding care. Knowing mother's barriers of continuum of age-appropriate infant feeding practice provides an opportunity to improve infant feeding practices and prevent associated consequences of inappropriate feeding. You are requested to give full socio-demographic, perception towards optimal infant feeding practice and barriers to practice optimal feeding. No information concerning you, as an individual will be passed to another individual or institution without your agreement. Your participation is voluntary and you have the right not to participate fully or partially. Moreover, you are allowed to ask questions and have received adequate clarification in a language you understand. If you agree to be included in the study. You are requested to confirm this with your signature below.

Procedure: we kindly invite you to participate in this research. If you are willing to participate in this research, you need to understand and sign the agreement form. Then after, you will be interviewed by the data collector. You do not need to write your name or tell your name to the data collector and all your audio recorded responses and results obtained will be kept confidentially by using system whereby no one will have access to your response.

Risk/discomfort: by participating in this project, you may feel that it has some discomfort especially on wasting time about 30-45 minutes. We hope you will participate in the study for the sake of benefit of the research result. There is no risk in participating in this research project.

Benefits: if you participate in this research project, there may not be direct benefit to you but your participation is likely help us to meet the research objective.

Incentives: you will not be provided any incentives or payment to take part in this project.

Confidentiality and privacy: the information collected from this research will be kept confidential. Information collected will be stored in a file, without your name, only code number is used. It will not be revealed to anyone except the principal investigator and supervisors, and it will be kept locked with password.

Right to refuse and withdraw: you have full right to refuse from participating in this research. you can choose not to respond to some or all question if you do not want to give your response. You have also full right to withdraw from this study at any time you wish without losing any of your right.

Person to contact: If you have any questions on the survey, please contact the principal investigator: Shikur Mohammed at 0940646066 or shikurmohamed@yahoo.com . If you have any questions on your rights as a participant, please contact IRB office at +251-115-540-392 or +251-911-408-525, 018961396 or chs.irb@aau.edu.et . If you feel you need an emergency medical attention at the time of the interview, we will arrange transportation and related cost to the nearest health facility.

May I continue to signing the consent form? Yes _____1, No____2

11.3.2. Data access request form (for quantitative study)

Dear PMA Ethiopia research team,

I am Shikur Mohammed Awol, a PhD student at school of public health, Addis Ababa University. We have planned to conduct a research entitled “ **determinants of maternal use of skilled birth attendant, and optimal newborn and infant care practices in Ethiopia**” for partial fulfilment of PhD degree in Public Health using the PMA 2020 panel datasets. This study obtained ethical approval from the institutional review board of College of health sciences, Addis Ababa University. Therefore, we kindly request your (PMA-Ethiopia) project office to access all the necessary data from the project dataset to address the following three specific objectives:

- ✓ To evaluate the influence of quality of antenatal care components on maternal use of skilled birth attendant after any ANC visit in Ethiopia.
- ✓ To determine and identify factors associated with home-based optimal newborn care practice in Ethiopia.
- ✓ To determine the level of completion of continuum of age-appropriate infant feeding practice and barriers among mothers in Ethiopia.

The data can be used for purposes that are agreed upon by the research team and approved by IRBs. The principal investigator and supervisors also agree that they will not share or transfer to anyone outside the research team, and it will be protected using password. For your reference in data sharing, we have attached herewith our study questionnaire which contains all the required outcome and independent variables.

Agreed by:

Recipient/ Researcher Name: Shikur Mohammed Awol

Signature: _____ Date: _____

Agreed by:

Provider/ Researcher Name: _____

Signature: _____ Date: _____

11.4. Consent form (for qualitative study)

I confirm that I have read/listened and understood the information sheet for the above study. I have had the opportunity to consider the information and asked questions which have been answered to my satisfaction. I also consented to my interview being audio recorded during interviews. I am willing to participate in the study with my full consent and understanding.

_____	_____	_____
Name of participant	signature	Date
_____	_____	_____
Name of researcher	Signature	Date

NB: If the participants is not literate, fingerprint should be used instead.

11.5. Amharic Interview guide

አጠቃላይ መረጃዎች እና በጥናቱ ለመሳተፍ የስምምነት ማረጋገጫ ፎርም

ጤና ይስልኝ! (እንዴት አደራችሁ/ዋላችሁ?)

ስሜ ----- ይባላል። በአዲስ አበባ ዩኒቨርሲቲ በሕብረተሰብ ጤና ት/ቤት ሶስተኛ ዲግሪዬን በመስራት ላይ እገኛለሁ። የዚህ ጥናት ፕሮፖዛል በአዲስ አበባ ዩኒቨርሲቲ የጤና ሳይንስ ኮሌጅ ከፍተኛ ባለሙያዎች ጉባዔ ወይም አይ.አር.ቢ ተገምግሞ ተቀባይነት ያገኘ ነው። ጥናቱ እዚህ እንዲሰራ ከሚመለከታቸው አካላት (ሀላፊዎች) ፍቃድ ያገኘም ነው።

በዚህ ጥናት እንዲሳተፉ በአክብሮት እንጠይቃለን። ከርሶ የሚገኘው መረጃ ወደፊት የልጆች አመጋገብና ጤና ለማሻሻል ይረዳል ተብሎ ይታመናል። ልጆችን በአግባቡ ከመመገብ ጋር ተያይዘው ያሉ ተግዳሮቶችን ለይቶ ማወቅ የልጆችን አመጋገብ ሁኔታ ለማሻሻልና እንዲሁም ተያይዘው ሊመጡ የሚችሉ ችግሮችን ለመከላከል ይጠቅማል ተብሎ ይታመናል። በዚህ ጥናት የእርስዎ ተሳትፎ በፍፁም ፈቃደኝነት ላይ የተመሰረተ ነው፤ በጥናቱ ሙሉ ለሙሉ ወይም በከፊል የመሳተፍ መብትዎ የተጠበቀ ነው፤ ምንም አይነት ተጨማሪ ጥያቄ ካለዎት መረጃ ሰብሳቢውን መጠየቅ ይችላሉ።

በጥናቱ ለመሳተፍ ፈቃደኛ ከሆኑ፤ የጥናቱ አላማ መረዳትና በስምምነት ፎርም ላይ እንዲፈርሙ በአክብሮት እንጠይቃለን። ስምዎን ያለመፃፍም ሆነ ለመረጃ ሰብሳቢው ያለመናገር መብትዎ የተጠበቀ ነው።

በዚህ ጥናት በመሳተፍ ምንም አይነት ጉዳትም ሆነ ችግር አይደርስብዎትም፤ የተወሰነ ሰዓትዎ ከመሻማት በቀር። በተመሳሳይም በዚህ ጥናት በመሳተፍ ምንም አይነት የገንዘብም ሆነ ልላቸው ተግባራዊ ጥቅም አያገኙም፤ ነገር ግን ከርሶ የሚገኘው መረጃ ወደፊት የልጆች እንክብካቤና አመጋገብ ለማሻሻል ይጠቅማል።

የጥናቱ መረጃዎች ሁሉ ሚስጥራዊነታቸው የተጠበቀ ይሆናል። የግለሰብ ስም በፍፁም አይጠቀስም፤ መረጃውም መለያ ኮድ በመስጠት በሚስጥር ይይለፍ ቃል በመጠቀም ይቀመጣል፤ ለሌላ ከጥናቱ አባላት ውጪ ላሉ አካላትም አየሰጥም።

በዚህ ጥናት የመሳተፍም ሆነ ያለመሳተፍ መብትዎ የተጠበቀ ነው፤ እንዲሁም ሁሉም ወይም የተወሰኑ ጥያቄዎችን የመመለስ ወይም ያለመመለስ መብትዎ የተጠበቀ ነው። በፈለጉ ሰዓት ከጥናቱ ማቋረጥ ይችላሉ በተለያዩ አታሚ ጆርናል ከመታተሙ በፊት ከሆነ።

ማንኛውንም ከጥናቱ ጋር በተያያዘ ጥያቄ ካሎት **አቶ ሽኩር መሃመድን** በሚከተለው አድራሻ ማግኘት ይችላሉ።

ስልክ ቁጥር: 09 40 64 60 66 ኢ-ሜይል: shikurmohamed@yahoo.com

ጥያቄ አለዎት? በዚህ ጥናት ለመሳተፍ ፈቃደኛ ከሆኑ የስምምነት ፎርምን ሊፈርሙ ይችላሉ?

አዎ 1

አይ፤አልፈርምም 2

በጥናቱ ለመሳተፍ የስምምነት ማረጋገጫ ደርሞ

በዚህ ጥናት ስሳተፍ በሙሉ ፈቃደኝነት ላይ የተመሰረተ ነው። ጥናቱን በሚመለከት ጥያቄዎችን ለመጠየቅ እድሉ ተሰጥቶኛል፤ አጥጋቢ ምላሽም አግኝቻለሁ። የጥናቱን አላማ በግልፅ ተረድቼ፤ በጥናቱ ለመሳተፍ ሙሉ ፈቃደኝነቴን ገልጼለሁ።

ፊርማ	ቀን
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የመረጃ ሰብሳቢ ስም	ፊርማ	ቀን
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N.B. የጥናቱ ተሳታፊ በእጃቸው መፈረም ማይችሉ ከሆነ የጥቅ አሻራ ይወሰዳል።

I. አጠቃላይ መረጃ

- የተጠያቂ መለያ ቁጥር _____
- የተጠያቂ መኖሪያ ስፍራ _____
- የቃለ መጠየቅ የተደረገበት ቀን _____
- የመረጃ ሰብሳቢ ስም _____

1. የተጠያቂ እድሜ በአመት _____
2. የተጠያቂ ፆታ _____
3. የተጠያቂ ቤተሰብ ብዛት _____
4. ቤት ውስጥ እድሜያቸው ከ5 አመት በታች ህፃናት ብዛት _____
5. የተጠያቂ የት/ት ደረጃ _____
6. የተጠያቂ የስራ ሁኔታ _____

II. ቃለመጠይቅ

1. እናቶች ልጅ ከወለዱ በኋላ መቼ ነው ጡት ማስጀመር ያለባቸው ብለው ያምናሉ? ለምን?
2. እዚህ እናንተ አካባቢ ለልጅ የእንገር ወተት (colostrum) ከመስጠት ጋር በተያያዘ የተለየ አስተሳሰብ ወይም እምነት አለን? አዎ ከሆነ፤ እባክዎ ያብራሩ::
3. ልጅዎ ከተወለደ በኋላ መቼ የእናት ጡት መጀመር እንዳለበት መወሰን ይችላሉ? አዎ ከሆነ፤ምን አይነት ውሳኔ መስጠት ይችላሉ? መልስዎ አይ ከሆነ፤ለምን?
4. ልጅ ከተወለደ በኋላ ለምን ያህል ጊዜ ጡት ብቻ መጥባት ወይም መመገብ አለበት ብለው ያምናሉ? ለምን?
5. ልጅዎ ጡት ብቻ ለምን ያህል ጊዜ መጥባት እንዳለበት በመወሰን ላይ የእርሶ አስተዋፅኦ አለበት ብለው ያምናሉ? አዎ ከሆነ፤ምን አይነት አስተዋፅኦ? አይ ከሆነ፤ ለምን?
6. ለልጅዎ ከጡት በተጨማሪ ምግብ መቼ መጀመር አለበት ብለው ያምናሉ? ለምን?
7. ልጅዎ መቼ ከጡት በተጨማሪ ምግብ መጀመር እንዳለበት እርሶ አስተዋፅኦ አለበት? አዎ ከሆነ፤ ምን አይነት አስተዋፅኦ? አይ ከሆነ፤ ለምን?
8. ለልጅዎ ምን አይነት ምግብ መመገብ እንዳለበት የሚወስነው ማን ነው? ለምን?
9. ልጅዎ በብዛት የሚመገባቸው የምግብ አይነቶች ሊዘረዝሩላችኋል ይችላሉ? ለምን እነዚያ ምግቦች ብቻ?

10. ለእርሶ ስለ ልጅ አመጋገብ የመረጃ ምንጭ ማን ነው? ስለጡት አመጋገብ? ስለተጨማሪ ምግብ?
ስለተመጣጠነ ምግብ?
11. እናቶች ልጆቻቸውን በአግባቡ ለመመገብ ተግዳሮት ወይም እንቅፋት ሚሆኑባቸው ነገሮች ምንድን ናቸው?
ከወሊድ በኋላ ቶሎ ጡት ለማስጀመር? ጡት ብቻ ለመመገብ? ተጨማሪ ምግብ ለመጀመር? የተመጣጠነ
ምግብ ለመመገብ?
12. ልጅን በአግባቡ ካለመመገብ ጋር ተያያዞ የሚመጡ የጤና ችግሮች ሰምተው ያውቃሉን? አዎ
ከሆነ፤ ሊዘረዝሩሊኝ ይችላሉን?
13. ልጅዎን በአግባቡ ከመመገብ ወይም ከማጥባት ጋር በተያያዘ ለነግሩኝ የሚፈልጉት ነገር አለን? ጡት
ከመጀመር ጋር? ጡት ብቻ ከመመገብ ጋር በተያያዘ? ተጨማሪ ምግብ ለልጅ ከመጀመር ወይም
የተመጣጠነ ምግብ ከመመገብ ጋር በተያያዘ?

ለሰጡን መረጃና ግዜዎ እጅግ በጣም እናመሰግናለን።

Unka waliigala waliigaltee odeeffannoo fi qorannoo irratti hirmaachuu mirkaneessu

Nagaan isiniif haa ta’u! (Akkam bultan/ooltan?)

Ani maqaan koo _____ ‘n jedhama. Yunivarsiitii Finfinneetti kutaa barnoota saayinsii hawaasaatti digirii sadaffaa koo hordofaa/hojjechaan jira. Piroopozaaliin qorannoo kanaa Yunivarsiitii Finfinneetti yaa’ii ogeessota ol’aanoo kolleejjii saayinsii fayyaatiin yookiin “IRB”tiin gamaggamamee fudhatama kan argatedha. Qorannoon kunis bakka kanatti akka hojjetamuuf qaamota dhimmi isaa ilaallatu (itti gaafatamtoota) irraa heyyamni kennameti.

Qorannoo kana irratti akka hirmaattaniif kabajaan isin gaafanna. Odeeffannoon isin irraa argamu gara fuula duraatti haala kenninsa nyaataa fi fayyaa ijoollee fooyyessuuf fayidaa qaba jedhamee amanama. Ijoollee seeraan nyaachisuu waliin walqabatee rakkoo jiru adda baasanii beekuun, haala ijoollee nyaachisuu fooyyessuu fi akkasumas rakkoo isa waliin walqabatee dhufu ittisuuf ni gargaara jedhame amanama. Qorannoo kana irratti hirmaannaan keessan fedhii keessan irratti kan hunda’e dha. Qorannoo kana irratti guutummaa guutuutti yookiin gar-tokkeen hirmaachuun mirga keessan, gaaffii dabalataa yoo qabaattan nama odeeffannoo funaanu gaafachuu dandeessan.

Qorannoo kana irratti hirmaachuuf yoo fedhii qabaattan, kaayyoo qorannoo kana gargaaruuf unka waliigaltee irratti akka mallatteesitan kabajaan isin gaafanna. Maqaa keessan barreessuus ta’e nama odeeffannoo kana funaanutti himuu dhiisuuf mirga qabdu. Qorannoo kana irratti hirmaachuu keessaniif miidhaas ta’e rakkoo kamiyyuu isin irra hin geessisu yoo yeroo murtoofte murasaa isin irraa fudhate malee. Haaluma wal fakkaatuun, qorannoo kana irratti hirmaachuu keessaniif fayidaa qarshiis ta’e faayidaa biroo kallattiidhaan argattan hin jiru. Haa ta’u malee odeeffannoon isin irraa argamu gara fuula duraatti kunuunsaa fi haala kenninsa nyaata ijoollee fooyyessuuf gargaara. Odeeffannoon qorannoo kanaa iccitiin isaa kan eegame ta’a. Maqaan nama dhuunfaa gonkuma hin himamu; odeeffannoof koodii addaa kennuun iccitii “password” fayyadamuun taa’a; miseensota qorannoo kana irratti hirmatanitti malee kan birootti hin kennamu.

Qorannoo kana irratti hirmaachuus ta’ee hirmaachuu dhiisuun mirga keessani dha; akkasumas gaaffiiwwan murtaa’e ykn hunda deebisuu ykn deebisuu dhiisuuf mirga qabdu. Yeroo barbaaddanitti qorannoo kana addaan kutuu ni dandeessu; addatti maxxansa “journal” irratti otoo hin maxxanfamiin yoo ta’e.

Qorannoo kana waliin wal qabate gaaffii kamiyyuu yoo qabaattan **obboo Shikur Mohaammad** teessoo armaan gadiin argachuu dandeessu.

Lakk. Bilbilaa: 09 40 64 60 66

E-mail: shikurmohamed@yahoo.com

Gaaffii qabduu? Qorannoo kana irratti hirmaachuuf fedhii yoo qabattan unka waligaltee irraatti mallatteessuu dandeessuu? Eeyyee_____1. Lakki; hin mallatteessu_____2

Unka waliigaltee qorannoo irratti hirmaachuu ibsu

Qorannoo kana irratti yeroon hirmaadhu fedhii koo guutuu irratti kan hundaa'e dha. Qorannoo kana kan ilaallatu gaaffiiwwan gaafachuuf carraan naaf kennamee, deebii gahaas argadheera. Kaayyoo qorannoo kanaa ifatti hubadhee irratti hirmaachuuf fedhii koo guutuun mallattoo koon nan mirkaneessa.

Mallattoo hirmaataa

Guyyaa

Maqaa namaa odeeffanoo funaanuu

Mallattoo

Guyyaa

Hubachiisa. Namni qorannoo kana irratti hirmaatu kan qalamaan barreessuu hin dandeenye yoo ta'e; ashaaraa qubaan mallatteessu ni danda'a.

I. Odeeffannoo waliigalaa

- Lakk. addaa nama gaafatamuu: _____
 - Iddoo jireenya nama gaafatamuu: _____
 - Guyyaa af-gaaffiin godhame: _____
 - Maqaa nama odeeffannoo funaanuu: _____
1. Umrii nama gaafatamuu waggaan_____
 2. Saala nama gaafatamuu _____
 3. Baay'ina maatii _____
 4. Baay'ina ijoollee manaa umriin isaanii waggaa shanii gadii _____
 5. Sadarkaa barnootaa nama gaafatamuu_____
 6. Dalagaa/hojii gaafatamaa_____

II. Af-gaaffii

1. Haadholiin erga mucaa dahanii booda, yoom mucaa harma hoosisuu jalqabu jettee amanta? maaliif?
2. As naannoo keessanitti ijoolleef aannan silgaa kennuu waliin wal qabatee ilaalchi addaa jiraa? yoo jiraate nu ibsamee
3. Mucaan keessan erga dhalatee booda harma haadha hodhuu yoom akka jalqabu murteessuu ni dandeessuu? yoo dandeessan murtoo akkamii kennuu dandeessu? Deebiin keessan lakki yoo ta'e maaliif?
4. Mucaan erga dhalatee booda yeroo hammamiif harma qofa hodhuu qaba jettanii amantu? maaliif?
5. Mucaan keessan harma qofaa yeroo hammam akka hodhuu qabu murteessuurratti gaheen qaba jettanii amantuu? Eeyyee gaheen qaba yoo jettan, qooda maalii? gahee hin qabdan yoo ta'e maaliif?
6. Mucaan keessan harma hodhuun maddiitti nyaata dabalataa yoom argachuu qaba jettanii amantu? maaliif?
7. Mucaan keessaan harma hodhuun maddiitti yoom nyaata dabalataa eegalu qaburratti gahee qabduu? yoo gahee qabaattan, gahee akkamii? gahee hin qabdan yoo ta'e, maaliif?
8. Mucaan keessan nyaata gosa akkamii akka nyaachuu qabu kan murteessu eenyu? maaliif?
9. Mucaan keessan yeroo baay'ee gosoota nyaataa fayyadamu naaf tarreessuu dandeessuu? Maaliif gosoota nyaataa kana qofaa fayyadame?

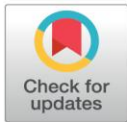
10. Isiniif waa'ee mucaa nyaata nyaachisuu madda odeeffannoo kan ta'e eenyu? waa'ee harma hoosisuu? waa'ee nyaata dabalataa? waa'ee nyaata madaalamaa?
11. Haadholiin ijoollee isaanii sirriitti nyaachisuuf wantootni rakkoo yookiin gufuu isaanitti ta'an maali? Da'umsa booda dafanii harma jalqabsiisuuf? Harma qofa hoosisuu? Nyaata dabalataa jalqabuu? Nyaata madaalamaa nyaachisuu?
12. Mucaa sirriitti nyaachisuu dhabuu waliin walqabatee rakkoowwan fayyaa fiduu dhageessanii beektuu? Eeyyee yoo ta'e, nu tarreessuu ni dandeessuu?
13. Mucaa keessan sirriitti nyaachisuu yookiin harma hoosisuu waliin wal qabatee nutti himuu waan barbaaddan ni jiraa? harma jalqabsiisuu waliin? Harma qofa hoosisuu waliin walqabatee? Nyaata dabalataa mucaa jalqabsiisu yookiin nyaata madaalamaa nyaachisuu waliin wal-qabatee?

Odeeffannoo fi yeroo keessan waan nuuf kennitaniif baay'ee isin galateeffanna!

11.6. Published original papers

11.6.1. Paper I

PLOS ONE



RESEARCH ARTICLE

Receiving quality antenatal care service increases the chance of maternal use of skilled birth attendants in Ethiopia: Using a longitudinal panel survey

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Abstract

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Data Availability Statement: Data cannot be shared publicly because of we ourselves accessed from performance monitoring for action Ethiopia project. Data are available from the PMA-Ethiopia

Background

Evidence has suggested that maternal use of skilled birth attendant is the most important factor to reduce maternal mortality because of more than three-fourths of maternal deaths occur during child delivery or within 24 hours after delivery due to hemorrhage, hypertension, ruptured uterus and sepsis. In Ethiopia, more than 42% of pregnant women with 4+ antenatal care (ANC) visit did not deliver by skilled birth attendant. The factors for women not using skilled birth attendant after any ANC visit is not well-studied yet. Therefore, the aim of this study was to assess effect of quality antenatal care service on maternal use of skilled birth attendant after any antenatal care visit.

Methods

This study was initiated using performance monitoring for action Ethiopia longitudinal panel survey datasets. A total of 1,511 postnatal women were included in the analysis. Generalized estimating equation Poisson regression model was used to assess the effect of quality ANC service on maternal use of skilled birth attendant by accounting the clustering nature of the data using Stata vers.16 software.

Results

This study showed that about 54% of women used skilled birth attendant during the current baby delivery (rate = 53.6%, 95% UI = 51–56%). Nearly, 39% of the women received quality (more than 75th percentile) ANC service (rate = 39.05%, 95% UI = 36–42%). The highest and the lowest antenatal care service the women received, respectively, were blood pressure measure (91.9%) and syphilis test (12.4%). Women who received better quality ANC service were 20% higher more likely to use skilled birth attendant compared to women who received low quality ANC service (adjusted IRR = 1.20, 95% UI = 1.11, 1.31).

website (contact via info@pmadata.org) for researchers who meet the criteria for access to confidential data.

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

Conclusion

Maternal use of skilled birth attendant can be improved by providing quality ANC service during subsequent ANC visits. Improving ANC service delivery may encourage or positively reinforce women's and partner's decision to use skilled birth attendant.

Introduction

World Health Organization (WHO) and United Nations Children Funds (UNICEF) strongly advised the global community to accelerate efforts to reach the global Sustainable Development Goals (SDG) targets of less than 70 maternal deaths per 100,000 live births by 2030 [1, 2]. However, the progress to achieve this target is slow in most developing countries including Sub-Saharan African countries, where nearly 73% of maternal deaths occurred in these countries due to direct obstetric causes. More than three-fourths of those deaths occurred during child delivery or within 24 hours after delivery due to hemorrhage, hypertension, ruptured uterus and sepsis [2–6], yet majority of those deaths could have been prevented if women had used skilled birth attendant [7].

Different factors have influenced to ensure women deliver in health facilities by a skilled birth attendant [8]. The underlying barriers of maternal use of skilled birth attendant can be categorized as predisposing factors (sociodemographic and set of beliefs towards behaviour), enabling factors (economic or transport or service access barriers), and quality of maternal healthcare services [9]. Several studies were conducted to explore factors influencing maternal use of skilled birth attendant, but the reasons for maternal not use of skilled birth attendant particularly after women had any antenatal care (ANC) visit is not well studied. Few studies have reported that the odds of maternal use of skilled birth attendant after any ANC visit was higher among women who had received main ANC services, which include blood pressure measurement, blood and urine sample examination, vaccination for tetanus, information on danger signs, and message on nutrition and iron tablets [10–13]. In addition, studies have reported that the odds of maternal use of skilled birth attendant increased by 30 to 50% if women had blood pressure measurement, and gave urine and blood samples as part of antenatal care services [11, 14].

Evidence has shown that antenatal care is the key means to identify and prevent progression of the early onset of predominant causes of maternal and perinatal morbidity and mortality in low-and middle-income countries including Ethiopia: the predominant causes of maternal mortality in these countries are postnatal hemorrhage, preeclampsia/eclampsia and infection [15]. As a result of this, WHO envisions a world where every pregnant woman and newborn receives quality care along the continuum of care due to pregnancy-related complication and mortality remain unacceptably high. ANC provides an opportunity to identify any pre-existing women's medical, obstetrical and social factors to monitor weight gain and assess nutritional status, and to identify those risk factors arising during current pregnancy and to ensure a safe transition to positive labor and birth [10, 15, 16]. However, the effect of quality ANC service on maternal use of skilled birth attendant is not well studied.

In Ethiopia maternal use of skilled birth attendant improved from 28% in 2016 to 50% in 2019; however, more than 42% of pregnant women with four or more ANC visit did not deliver by skilled birth attendant [3, 17]. The factors for women not using skilled birth attendant after any number of ANC visit is not well-studied yet [3, 4, 10]. Therefore, the objective of this study was to measure the effect of quality ANC service on maternal use of skilled birth

attendant after having at least one ANC visit to improve future maternal use of skilled birth attendant or facility delivery.

Materials and methods

Study settings and design

This study was initiated using performance monitoring for action Ethiopia (PMA-Ethiopia) longitudinal panel survey datasets. Performance monitoring for action -Ethiopia survey was conducted in six regions that collectively represent 90% of the population in Ethiopia, namely, Addis Ababa, Oromia, Amhara, Tigray, former Southern Nations Nationality People (SNNP) and Afar regions. The details of performance monitoring for action Ethiopia project settings can be accessed from the published PMA-Ethiopia project protocol [18].

In PMA-Ethiopia, longitudinal panel survey design was used to identify service delivery gaps in relation to maternal and newborn healthcare. In this panel survey, women were screened for pregnancy (self-identified as current pregnant) and enrolled, regardless of their gestational age, from 217 enumeration areas (EAs) in six regions of the country. Then, women expected date of delivery was estimated at the time of enrollment and followed after delivery at 6-weeks of postnatal period to understand the trends of health seeking behavior, utilization and quality. Therefore, this study was initiated using the PMA-Ethiopia 2019–21 datasets to assess influence of quality ANC services (process) on maternal use of skilled birth attendant.

Study population and sampling techniques

All postnatal women who were enrolled during pregnancy and received ANC service from skilled attendants from selected enumeration areas in the six regions were included. The required sample size for this study was calculated using Stata vers.16 software considering the following assumptions: a 10% outcome difference between exposed and unexposed, a 42% baseline level of use of skilled delivery in women who received quality ANC service (key indicators) chosen from studies [19], 5% level of significance, and 80% power. The required sample size was increased by design effect ($Deff = 1.5$) [20] and non-response or incompleteness rates (10%). Hence, the estimated sample becomes 1,098. The PMA- Ethiopia panel survey employed stratified two-stage cluster sampling design to select enumeration areas (clusters) and households from the six regions. In the first stage, each region was stratified into urban and rural, then enumeration areas (EAs) were selected from both strata using central statistical agency (CSA) sampling frame, which contains information about the EAs location, type of residence (urban, rural) and the estimated number of households in each EAs. Clusters were selected using probability proportional to size sampling technique. At the second stage, 35 fixed number of households were selected from each cluster and all pregnant women in a given household were enrolled and followed. In this study, to increase the power of the study, all available 1,511 women who had any number of ANC visits during their pregnancy were included in the final analysis.

Measurement, data management and analysis

In PMA-Ethiopia panel survey, a structured and standardized enrolment and follow up forms were used for interviewing women to get information about maternal, newborn and infant related healthcare. Data were collected by using Open Data Kit (ODK) system using tablet computers by trained field workers. The baseline sociodemographic and reproductive details of the women including women age, women age at first birth, women educational and employment status, women economic decision power, area of residence, household wealth quintile,

husband education and occupation, ethnicity, religion/province, family size, parity and pregnancy desire, husband and community encouragement to use maternal and child healthcare services were collected at the time of enrollment. Similarly, Pregnancy related data on receipt of ANC services (ANC components), pregnancy complications (antepartum hemorrhage, diabetes mellitus, preeclampsia), infection (malaria, HIV, syphilis, Hepatitis-B), anemia, labor and delivery related data on mode of delivery, duration of labor, type of birth attendant, place of delivery and presence of birth complication were collected during follow up interview.

Skilled delivery is defined as women receipt of skilled assistance during delivery by skilled birth attendant. Skilled birth attendant is defined as “Registered (accredited) midwife or a health worker with midwifery skills (Nurse, medical doctor and health officer) who has been educated and trained to proficiency in the skills to manage normal (uncomplicated) pregnancies, childbirth, and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns [21, 22]. To determine skilled birth assistance, women were asked a question of “did you deliver by a skilled attendant?”, and asked a follow-up question of “type of professional skilled birth attendant.”

Antenatal care service. Quality of ANC service is defined as women receipt of ANC content packages, which includes blood pressure and weight measurement, give blood, urine and stool samples during ANC visit, tetanus toxoid injection, received nutrition information during ANC visit (*eat more (quantity), eat variety/iron rich food, take iron tablets, take malaria preventive treatment, take deworming tablet, how much weight gain, exercise regularly, how to manage nausea/vomiting, reduce salt intake, do not eat raw meat*), discussed transport for delivery during ANC, discussed place of delivery during ANC visit, discussed delivery by skilled birth attendant during ANC visit, discussed place to go if experience danger signs (*headaches, blurred vision, high blood pressure, edema, convulsion/fits, bleeding*), HIV tested as part of ANC and Syphilis tested as part of ANC [10, 14, 23]. The ANC service quality was determined by giving scores to these 13 ANC services the women received during pregnancy. The reliability of these ANC services was checked and the reliability coefficient is greater than 0.7 ($\alpha = 0.756$). The score ranged from 1 to 13, and the value 11 gave a 75th percentiles. Then, women were classified as received better quality ANC service if they received more than the 75th percentiles of ANC service. The quality score was divided into above ‘75th percentile’ and below ‘75th percentile’, and reported as ‘better’ and ‘low’ quality ANC service, respectively [19, 24].

Household wealth was determined by giving scores based on number and kinds of consumer goods they own, source of drinking water, type of toilet facilities and flooring materials. Scores was derived using principal component analysis, and then households’ wealth index was divided into quintiles according to the wealth score as “lowest”, “lower”, “middle”, “higher” and “highest” [4].

Data were formally requested and downloaded from the PMA Ethiopia website [25, 26]. Data were cleaned and prepared for merging using Stata vers.16 software. The baseline and the six-week postnatal visit data were merged using the study participant identity number (participant ID). Then, the appropriate sample was restricted, and ANC service quality score was created and transformed into categorical exposure variable. Description of the study participants, unweighted and weighted frequency, by sociodemographic characteristics was done and presented using table. Sampling weight (the inverse of a sample selection probability) was applied to account the non-equal selection probability of the individuals and improve representativeness.

Different models were fitted to estimate the effect of quality ANC service on maternal use of skilled birth attendant. First, unweighted and weighted poisson regression models with robust variance were fitted to account effect of the complex sampling design used by the study.

Then, the mean square error (MSE) value of each model was computed using the formula ($MSE = Bias^2 + StdErr^2$ where, $bias = (weighted\ estimate - unweighted\ estimate)$) and compared. The MSE of the unweighted poisson regression model was smaller than the MSE of the weighted poisson regression model. Therefore, not accounting the use of complex sampling design in the model fitting will not affect the estimates.

Then, as we have a two-level cluster data (correlated data), generalized estimating equation (GEE) Poisson regression model was fitted to account the correlation of observations within an enumeration area (cluster). The full GEE poisson regression model was fitted by adjusting the effect of a potential confounder variables including area of residence, partner encourage for facility delivery, child desire before pregnancy and number of ANC visits a women had. These variables were selected as a potential confounding variable based on a p-value cutoff of less than or equal to 0.05 during bi-variable analysis. Incidence rate ratio (IRR) with 95% confidence interval (CI) was computed to measure the effect of the exposure variable on maternal use of skilled birth attendant and interpreted.

The study was initiated after getting the ethical clearance permission from Addis Ababa University College of Health Sciences. The PMA-Ethiopia project got its ethical clearance and all the necessary approvals and permission from Addis Ababa and John Hopkin universities research ethics committee, and other concerned stakeholders (regional health bureau's). Therefore, the authors formally requested access to the necessary PMA datasets with the appropriate data dictionary. All data were fully anonymized before we accessed them. The researchers have respected and obeyed the PMA-Ethiopia data use and share policy by not sharing to third person who is outside the current research team. Data received from PMA Ethiopia were password protected.

Results

Sociodemographic characteristics of antenatal care attendant women

In this study a total of 1, 511 women who had at least one number of ANC visit during their pregnancy were included from six regions of Ethiopia. About 42% of the women were from Oromia region, followed by Amhara (25.3%) and SNNP (19.6%) regions. Nearly three-fourth (73.7%) of the study participant women were from the rural part of the regions.

Higher proportions (33.1%) of women were in age categories between 25–29 years and followed by about 23% were in age categories between 20–24 years old. Nearly forty-two percent of the study participant women were Orthodox Christian by religion and followed by Muslim (34.7%). Nearly 17% of the women had no desire for children before they became pregnant. More than 53% of women in the study settings had first time ANC visit at more than 4 months of their pregnancy. (See [Table 1](#)).

Variables for Antenatal care quality index

Women were classified as received better quality ANC service if they received more than the 75th percentiles of ANC service. Therefore, based on this classification only 39% of women received better quality ANC service. (See [Table 2](#))

Effect of quality ANC service on maternal use of skilled birth attendant after any ANC visit

This study showed that about 54% of the women used skilled birth attendant during their current baby delivery. The rate of maternal use of skilled birth attendant was 20% higher among

Table 1. Sociodemographic characteristics of antenatal care attendant women in six regions of Ethiopia (n = 1,511), 2019–21.

Sociodemographic characteristics	Weighted percent	Weighted N	Unweighted N
Region			
Tigray	8.4	127	321
Afar	0.4	6	27
Amhara	25.3	382	322
Oromia	42.3	639	377
SNNP	19.6	296	307
Addis Ababa	4.0	61	157
Marital status			
Married/in union	97.7	1,477	1,467
Single	2.3	34	44
Women Age (in years)			
15–49	9.9	150	122
20–24	23.1	349	364
25–29	33.1	500	521
30–34	18.4	278	276
> = 35	15.5	234	228
Religion			
Orthodox	41.9	633	806
Islam	34.7	525	390
Protestant	21.3	322	295
Other*	2.1	31	20
Area of residence			
Urban	26.3	397	688
Rural	73.7	1,114	823
Household wealth index			
Lowest quintile	17.1	258	207
Lower quintile	16.5	250	178
Middle quintile	20.6	312	245
Higher quintile	21.6	326	283
Highest quintile	24.2	365	618
Desire for children before became pregnant			
Wanted to have a baby	73.8	1,115	1,175
Had mixed feelings about to have a baby	9.0	136	133
Did not want to have a baby	17.2	260	203
Time of first ANC initiation			
< = 4 months	47.0	710	825
>4 months	53.0	801	686
Number of times women received ANC from health care provider			
Less than 4 ANC visits	56.4	853	699
> = 4 ANC visits	43.6	658	812

*Catholic, Wakefta, traditional

<https://doi.org/10.1371/journal.pone.0279495.t001>

women with better quality ANC service compared to women who received low quality ANC service (adjusted IRR = 1.20, 95% CI = 1.11, 1.31).

In the analysis the effect of some potential confounding variables was adjusted including partner discussion where to deliver, area of residence, desire for pregnancy and number of

Table 2. Variables for antenatal care quality index among women in Ethiopia, 2019–21.

Type of service received	Frequency (%) (n = 1, 511)
Blood pressure measured as part of ANC	1, 390 (91.9)
Weight measured as part of ANC	1, 343 (88.9)
Blood sample taken as part of ANC	1, 314 (86.9)
Urine sample taken as part of ANC	1, 017 (67.6)
stool sample taken as part of ANC	532 (35.2)
Given tetanus injection during this pregnancy	1, 023 (67.9)
Received nutrition information during ANC visit	712 (47.1)
Discussed transport for delivery during ANC	985 (65.3)
Discussed place of delivery during ANC visit	1, 098 (72.7)
Discussed during ANC visit: delivery by skilled birth attendant	1, 069 (70.8)
Discussed during ANC visit: place to go if experience danger signs	727 (48.2)
HIV tested as part of ANC	1, 161 (78.2)
Syphilis tested as part of ANC	187 (12.4)
Scale reliability coefficient (alpha = 0.756)	
Received better quality ANC service	590 (39.05)

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ANC visits. The rate of maternal use of skilled birth attendant was 32% higher among women who had discussion with their partner about place of delivery compared to women who did not have discussion with their partner about their place of delivery (adjusted IRR = 1.32, 95% CI = 1.13, 1.54). Similarly, the rate of maternal use of skilled birth attendant was higher among urban resident women and women who had four or more ANC visits during pregnancy compared to their counter parts, respectively. (See [Table 3](#)).

Table 3. Effect of quality ANC service on maternal use of skilled birth attendant after any ANC visit in Ethiopia, 2019–21.

Variables	Use of skilled birth attendant (n = 1, 511)		Crude IRR (95% CI)	Adjusted IRR(95% CI)
	Yes (%)	No (%)		
Quality of antennal care				
Better	398 (67.46)	192 (32.54)	1.25(1.13,1.38)	1.20(1.11, 1.31)*
Low	412 (44.73)	509 (55.27)	1.00	1.00
Discussed with partner where to deliver				
Yes	736 (59.64)	498 (40.36)	1.39(1.20,1.59)	1.32(1.13, 1.54)*
No	74(26.71)	203 (73.29)	1.00	1.00
Area of residence				
Urban	527(76.60)	161(23.40)	2.19(1.81,2.67)	1.89(1.57, 2.29)*
Rural	283 (34.39)	540 (65.61)	1.00	1.00
Desire for children before became pregnant				
Wanted to have a baby	662 (56.34)	513 (43.66)	1.15(1.01,1.32)	1.08(0.93, 1.25)
Mixed feelings about having a baby	74 (55.64)	59 (44.36)	1.24(1.04,1.47)	1.16(0.97, 1.39)
Did not want to have a baby	74 (36.45)	129 (63.55)	1.00	1.00
Number of ANC visits				
> = 4 ANC visits	554(68.23)	258(31.77)	1.24(1.11,1.37)	1.15(1.04, 1.28)*
< 4 ANC visits	256(31.60)	443(63.38)	1.00	1.00

*statistical significance confidence interval.

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Discussion

In this study, we primarily assessed the effect of quality ANC service on maternal use of skilled birth attendant after a women had any number of ANC visit. This study revealed that women who received more than the 75th percentiles of ANC services (better quality ANC service) were more likely to use skilled birth attendant. Similarly, women living in urban setting, had 4 + ANC visit and had partner support about place of delivery were more likely to use skilled birth attendant.

Evidence has shown that the poor quality of antenatal or delivery care received by women in low-and middle income countries is contributing to the high levels of maternal mortality [27]. Similarly, evidence has suggested that maternal use of skilled birth attendant is the most important factor to reduce maternal mortality [28] because of more than three-fourths of maternal deaths occurred during child delivery or within 24 hours after delivery due to hemorrhage, hypertension, ruptured uterus and sepsis [2, 3].

The current study revealed that the rate of maternal use of skilled birth attendant was higher among women who received better quality ANC service compared to women who received low quality ANC service. This finding was consistent with previous works that revealed women who received better or adequate antenatal care services were more likely to use skilled birth attendant compared to women who received less than the 75th percentiles of antenatal care services [19, 24, 29]. This suggests that provision of quality or adequate ANC service during pregnancy had a great role in promoting skilled birth attendant or institutional delivery. Improving the quality of ANC service delivery may increase women and partner's perceived quality of care and this may lead to better utilization of facility delivery. Furthermore, provision of care may be judged of high quality against recognized standards of care but unacceptable to the women, her family and the community [27]. Therefore, attention to quality ANC service will be important to encourage or positively enforce women's and partner's decision or plan to use skilled birth attendant.

As a longitudinal panel survey, our study has many strengths. The unequal selection probability of the women and the clustering nature of the data by enumeration area were accounted in the analysis, so the findings can be reliable and used to make inference or generalization. The study also is less susceptible to recall bias as women were inquired to respond services received before few weeks. However, this study may be at risk of Hawthorne effect bias as the study women might change in using the ANC and delivery services, simply as a result of knowing being studied, but this may not be a problem in this study as the misclassification is more likely to be non-deferential in the enumeration areas. In the current study, we have assessed quality from using service process (provision) quality dimension from the women's perspective who had already at least 1st ANC visit. This is very important area, but most of the time overlooked by researchers. We haven't measure quality comprehensively from both demand and supply side. This is one of the limitations of the study.

Conclusions

Maternal use of skilled birth attendant can be improved by providing quality ANC service during subsequent ANC visits. Attention to quality ANC service will be important to encourage or positively enforce women's and partner's decision or desire to use skilled birth attendant. Health planners and providers should assure women receipt of appropriate and respectful ANC service and educate and promote husband support in maternal use of ANC service and facility delivery by explaining the benefit of subsequent ANC service and use of skilled birth attendant for the health of women and newborn through different communications means. It is also important to further qualitatively explore barriers of quality ANC service provision and

other barriers of maternal not use of SBA especially after having skilled ANC visits to promote women health and improve use of skilled birth attendant or facility delivery.

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BMJ Open Home-based optimal newborn care practice and associated factors among mothers in Ethiopia: a community-based longitudinal panel survey

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ABSTRACT

Objectives The objective of this study was to determine the level of home-based optimal newborn care practice and associated factors among mothers in Ethiopia.

Design A community-based longitudinal panel survey design.

Setting, participants and outcomes We used data from the Performance Monitoring for Action Ethiopia panel survey (2019–2021). A total of 860 mothers of neonates were included in the analysis. A generalised estimating equation logistic regression model was used to identify factors associated with home-based optimal newborn care practice and to account for the clustering nature of the data by enumeration area. An OR with 95% CI was used to measure the association between exposure and outcome variables.

Results The level of home-based optimal newborn care practice was 8.7% with 95% uncertainty interval ranging from 6% to 11%. After adjusting the effect of potential confounding factors, area of residence remained statistically significantly associated with mothers' optimal newborn care practice. The chance of home-based optimal newborn care practice was 69% times lower among mothers from rural areas compared with those in urban areas (adjusted OR=0.31, 95% CI=0.15, 0.61).

Conclusion The findings of this study showed that the level of home-based optimal newborn care practice was very low in Ethiopia. Also, home-based optimal newborn care practice was lower among mothers from rural areas in the nation. Therefore, health planners and healthcare providers, including health extension workers, should give priority attention to mothers from rural areas to improve their optimal newborn care practice by considering their context-specific factors or barriers.

INTRODUCTION

The WHO and UNICEF strongly advised the global community to accelerate efforts to reach the global Sustainable Development Goal targets of less than 25 under-5 deaths per 1000 live births and less than 12 neonatal deaths per 1000 live births, by 2030.^{1 2} Nevertheless, the 2019 UNICEF report indicated that globally, 52 million under-5 children will die from 2019 to 2030. From those under-5

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The generalised estimating equation model was applied to account the clustering nature of the data by enumeration area.
- ⇒ The study is less susceptible to recall bias because of short recall data collection weeks considered.
- ⇒ Being a longitudinal panel survey study, the issue of reverse causality will not be a problem in this study.
- ⇒ The study might be at risk of Hawthorne effect bias because of the study being a longitudinal panel survey study.
- ⇒ In the Performance Monitoring for Action project, there were no data on some important exposure variables, which might have confounded the true relationship between the exposure and outcome variables.

deaths, half of them will be newborns if the basic maternal and child healthcare service utilisation and quality continue to be unimproved.^{3 4} In Ethiopia, the decline in neonatal mortality is not as significant as the change in infant and child mortality in the last several years. Infant and under-5 mortalities per 1000 live births decreased from 59 and 88 in 2011 to 43 and 55 in 2019, respectively. On the other hand, neonatal mortality per 1000 live births slightly decreased from 37 in 2011 to 33 in 2019.^{5 6}

Practice of optimal essential newborn care interventions is low in developing countries including Ethiopia because reaching mothers and newborns to encourage and support these practices is more challenging in settings, like Ethiopia, where many births occur at home.^{7–11} As a result of this, Ethiopia has brought an alternative option to avail the necessary clean and essential newborn care services that could be provided by health extension workers at health posts or a household level.^{10 11}

A field trial study conducted in rural India reported that home-based neonatal care is

acceptable, feasible, and reduced neonatal and infant mortality by nearly 50% among malnourished, illiterate and rural population.⁹ Similarly, the Lancet neonatal health series suggests that 15%–32% of neonatal deaths can be prevented through the promotion of some essential practices, including clean home delivery, hygienic cord care, thermal care, early and exclusive breast feeding and care seeking for illness.¹² However, studies conducted in developing countries reported low prevalence of mothers' optimal essential newborn care practice, which ranged between 10% and 50%.^{13–18} In Ethiopia, nearly three-quarters of mothers bathed their newborns during the first 24 hours of life (74.7%), approximately 20% applied butter and other substances on the infant's cord (19.9%) and over 40% did not give colostrum milk (44.5%).⁸

Previous studies reported that the likelihood of implementing optimal essential newborn care practice was higher in women who were urban residents, educated, with higher income, had antenatal and postnatal care follow-ups, had better knowledge of newborn danger signs and had information on essential newborn care practice.^{13–16, 18} However, the prevalence of optimal newborn care practice and associated factors was not well studied in Ethiopia. Therefore, understanding factors associated with optimal newborn care practice is very important to design or adapt behavioural change interventions on newborn care at home and health-seeking behaviour.¹⁹ Panel data can give more information on temporal relationship between exposure and outcome of interest and improve precision of estimates by minimising recall bias. The objective of this study was to determine the level of home-based optimal newborn care practice and associated factors among mothers who gave birth at home in Ethiopia.

METHODS

Study design

In the Performance Monitoring for Action (PMA) Study, a longitudinal panel survey design was used to generate data in relation to maternal healthcare service utilisation and newborn care practices in the settings. Therefore, until now, we have produced two manuscripts using PMA-Ethiopia datasets including the current one. The first manuscript was entitled 'Receiving quality antenatal care service increases the chance of maternal use of skilled birth attendants in Ethiopia', and it was published in *PLOS ONE* journal in December 2022.²⁰ In both manuscripts, the data generation process was almost the same.

Study setting

The PMA-Ethiopia panel survey was conducted in six regions in Ethiopia, namely, Addis Ababa, Oromia, Amhara, Tigray, former Southern Nations, Nationalities and People's Region and Afar in 2019–2021. Women were recruited and enrolled during pregnancy, and followed at 6 weeks of postnatal period including their newborns.

The details of the PMA-Ethiopia project design and settings can be accessed from the published PMA-Ethiopia project.²⁰

Study population

The study population were all mothers of neonates who were enrolled during pregnancy, gave birth at home and interviewed between 6 and 8 weeks of postnatal period.

Patient and public involvement

It was not appropriate to involve members of the public in the design, or conduct, or reporting, or dissemination plans of our research because our study was initiated using the already collected datasets by PMA-Ethiopia survey.

Sample size estimation and sampling technique

The required sample size for this study was calculated using Stata V.16 software considering the following assumptions: a 10% outcome difference between exposed and unexposed, a 27% baseline level of received antenatal care service (key indicators) during pregnancy chosen from studies,¹⁴ 5% level of significance and 80% power. The required sample size was increased by design effect (1.5). Hence, the estimated sample becomes 807.

The PMA-Ethiopia panel survey employed stratified two-stage cluster sampling design to select enumeration areas (EAs) (clusters) and households from the six regions. In the first stage, each region was stratified into urban and rural, then EAs were selected from both strata using Central Statistical Agency sampling frame, which contains information about the EAs' location, type of residence (urban, rural) and the estimated number of households in each EA. Clusters were selected using probability proportional to size sampling technique. At the second stage, 35 fixed numbers of households were selected from each cluster, and all pregnant women in a given household were enrolled and followed.

To increase the power of the study, all available 860 mothers of neonates who gave birth at home were included in the final analysis.

Data collection method

In the PMA panel survey, structured and standardised enrolment and follow-up forms were used for interviewing mothers to get information about maternal and newborn-related healthcare. Data were collected by using Open Data Kit system using tablet computers by trained field-workers. Baseline data on household location, housing and sanitation practices, economics and asset ownership, sociodemographic status and reproductive health details were collected at the time of enrolment by trained field-workers. Data on maternal and newborn healthcare practice were collected at 6–8 weeks of postpartum periods by trained female community health extension workers. The data collection was supervised by trained Masters of Public Health (MPH) professionals.

Measurements

Essential newborn care

This is defined as care provided to every newborn by mothers, which includes cord care, thermal care and feeding care.

Optimal newborn care practice

To measure optimal newborn care practice, a composite score of the three components (safe cord care, optimal thermal care and optimal feeding) was used and categorised into binary outcome. Mothers who optimally practised all the three components were categorised as 'practised optimal newborn care', otherwise categorised as 'practised suboptimal newborn care'.^{8 16–18 21}

Safe cord care

This is defined as cord tie and cut with a new or boiled blade plus no substance applied to the cord stump except medically indicated medications, like chlorhexidine.^{18 21} Then, a safe cord care practice was given a score of 1 if the mother practised both as per the recommendation, or else 0.

Optimal thermal care

This is defined as baby wrapped after birth plus baby bath after 24 hours of birth.^{18 21} Optimal thermal care practice was given a score of 1 if the mother did the practice optimally as per the recommendation.

Optimal feeding practice

This is defined as the mother initiating breast feeding within an hour after delivery plus no additional feeding (no pre-lacteal) given other than breast milk.^{18 21} Optimal feeding practice was given a score of 1 if the mother practised it as per the recommendation.

Household wealth

Household wealth was determined by giving scores based on the number and kinds of consumer goods they own, source of drinking water, and type of toilet facilities and flooring materials. Scores were derived using principal component analysis, and then households' wealth index was divided into quintiles according to the wealth score as 'lowest quintile', 'lower quintile', 'middle quintile', 'higher quintile' and 'highest quintile'.⁶

Data management and analysis

Data were formally requested and downloaded from the PMA-Ethiopia website.^{22 23} Then, data were cleaned and prepared for merging using Stata V.16 software. The baseline and the 6-week follow-up visit data were merged using the study participant identity number (participant ID). Description of the study participants, unweighted and weighted frequency, by sociodemographic characteristics, was done and presented using tables. Sampling weight was applied to account the non-equal selection probability of the individuals and improve representativeness.

Generalised estimating equation logistic regression model was fitted to identify factors associated with the

outcome variable, and to account the clustered nature of observations within an EA. OR with 95% CI was computed to measure the association between exposure and outcome variables, and interpreted.

Potential confounding variables were identified and selected based on a p value cut-off less than 0.2. Variables including mothers' area of residence (urban, rural), household income (lowest, lower, middle, higher, highest), mothers' age category (5 years' interval category), parity (<5, ≥5 live births) and number of antenatal care visits (≥4, <4 visits) were included in the final model to assess any confounding effect between them.

RESULTS

Sociodemographic characteristics of study participants

In this study, a total of 860 mothers who gave birth at home were included from six regions of Ethiopia. About 47% of the mothers were from Oromia, followed by Southern Nations, Nationalities and People's Region (27.1%) and Amhara (17.4%). Nearly 97% of the study participants were from the rural part of the regions. More than 55% of the mothers never attended formal education, followed by about 39% who attended primary school. Over half (51.2%) of the mothers were assisted by their family members during delivery and followed by 32.9% of mothers who were assisted by traditional birth attendants. Fifty-two per cent of the newborns were male by gender (see table 1).

Level of home-based optimal newborn care practices

In this study, the level of home-based optimal newborn care practice was 8.7% with 95% uncertainty interval ranging from 6% to 11%. Separately, nearly 38%, 37% and 43% of mothers practised safe cord care, optimal thermal care and feeding care, respectively (see table 2).

Factors associated with home-based optimal newborn care practice

In this study, first, the association between potential exposure and outcome variables was assessed. During binary analysis, mothers' area of residence, household income, mothers' age category, parity and number of antenatal care visits were statistically significantly associated with mothers' optimal newborn care practice at a p value less than 0.2. Mothers' area of residence remained statistically significant after adjusting the effect of potential confounding variables using a p value less than 0.05.

Compared with mothers from urban areas, the chance of home-based optimal newborn care practice was 69% times lower among mothers from rural areas (adjusted OR=0.31, 95% CI=0.15, 0.61) (see table 3).

DISCUSSION

In this study, we assessed the level of home-based optimal newborn care practice and associated factors among mothers who gave birth at home. This study revealed

Table 1 Sociodemographic characteristics of mothers who gave birth at home in six regions of Ethiopia (n=860), 2019–2021

Sociodemographic characteristics	Weighted per cent	Weighted N	Unweighted N
Region			
Tigray	4.4	38	67
Afar	3.6	31	159
Amhara	17.4	150	135
Oromia	47.4	406	234
Southern Nations, Nationalities and People's Region	27.1	233	261
Addis Ababa	0.1	2	4
Marital status			
Married/in union	97.1	832	835
Single	2.9	28	25
Women's age (in years)			
15–19	9.1	79	79
20–24	20.1	172	185
25–29	29.4	253	249
30–34	21.0	181	186
≥35	20.4	175	161
Religion			
Orthodox	28.9	249	237
Muslim	39.1	335	342
Protestant	29.9	256	262
Other*	2.1	20	11
Area of residence			
Urban	3.4	30	49
Rural	96.6	830	811
Household wealth index			
Lowest quintile	32.8	282	299
Lower quintile	26.1	224	202
Middle quintile	22.3	191	184
Higher quintile	16.7	144	151
Highest quintile	2.1	19	24
Education level			
Never attended	55.2	473	525
Primary	39.2	338	293
Secondary	5.6	49	42
Delivery assistant			
No one assisted	9.8	85	76
Family member	51.2	439	386
Traditional attendant	32.9	283	344
Health extension worker	6.1	53	54

Continued

Table 1 Continued

Sociodemographic characteristics	Weighted per cent	Weighted N	Unweighted N
Baby's gender			
Male	51.5	443	424
Female	48.5	417	436
Parity			
<5 live births	31.7	273	263
≥5 live births	68.3	587	597
Number of ANC visits			
≥4	87.7	754	760
<4	13.3	106	100
*Catholic, Wakefta or traditional. ANC, antenatal care.			

that the prevalence of home-based optimal newborn care practice was less than 10%. This study also showed that mothers from rural areas were less likely to practise home-based optimal newborn care.

Evidence has shown that 15%–50% of neonatal deaths can be averted by exercising optimal newborn care practices: cord cutting with a sterile blade and hygienic cord care, bathing the baby after 24 hours and giving appropriate thermal care, early and exclusive breast feeding and care seeking for illness.^{9,12} The current study revealed that only nearly 9% of mothers practised optimal newborn care; however, previous works conducted in similar settings reported higher prevalence of optimal newborn care practice, which ranged from 10% to 50%.^{13–16,18} The possible explanation for the higher prevalence could be due to majority of study participants had given birth at a health facility in the previous studies. As a result of this, the mothers might have the chance to receive advice on optimal newborn care practice. Evidence has shown that mothers who received counselling about essential newborn care during delivery were more likely to practise optimal newborn care.²¹

Table 2 The level of home-based newborn care practices among mothers who gave birth at home in Ethiopia (n=860), 2019–2021

Variables	Response category	Frequency	Percentage
Home-based optimal newborn care	Yes	75	8.72
	No	785	91.28
Safe cord care	Yes	325	37.79
	No	535	62.21
Optimal thermal care	Yes	314	36.51
	No	546	63.49
Optimal feeding practice	Yes	373	43.37
	No	487	56.63

Table 3 Assessment of factors associated with home-based optimal newborn care practice among mothers who gave birth at home in Ethiopia, 2019–2021

	Optimal newborn care practice (n=860)			
Variables	Yes (%)	No (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Area of residence				
Rural	60 (7.40)	751 (92.6)	0.26 (0.14, 0.47)	0.31 (0.15, 0.61)*
Urban	15 (30.61)	34 (69.39)	1.00	1.00
Household wealth index				
Lowest	22 (7.4)	277 (92.6)	0.39 (0.16, 0.96)	0.77 (0.28, 2.13)
Lower	14 (6.9)	188 (93.1)	0.34 (0.13, 0.87)	0.71 (0.25, 1.95)
Middle	15 (8.2)	169 (91.8)	0.40 (0.16, 1.01)	0.74 (0.27, 1.98)
Higher	18 (11.9)	133 (88.1)	0.60 (0.25, 1.45)	1.02 (0.42, 2.47)
Highest	6 (25.0)	18 (75.0)	1.00	1.00
Educational level				
Never attended	44 (8.4)	481 (91.6)	0.81 (0.35, 1.88)	—
Primary	25 (8.5)	268 (91.5)	0.66 (0.27, 1.61)	—
Secondary	6 (14.3)	36 (85.7)	1.00	
Parity				
<5 live births	31 (11.5)	232 (88.5)	0.71 (0.46, 1.07)	0.94 (0.56, 1.58)
≥5 live births	46 (7.6)	551 (92.4)	1.00	1.00
Women's age category				
15–19	4 (5.1)	75 (94.9)	0.46 (0.17, 1.22)	0.53 (0.18, 1.54)
20–24	11 (5.9)	174 (94.1)	0.51 (0.25, 1.02)	0.49 (0.22, 1.10)
25–29	21 (8.4)	228 (89.6)	0.72 (0.41, 1.28)	0.73 (0.38, 1.38)
30–34	19 (10.2)	167 (89.8)	0.94 (0.53, 1.66)	0.87 (0.48, 1.55)
≥35	20 (12.4)	141 (87.6)	1.00	1.00
Number of ANC visits				
≥4	65 (8.6)	695 (91.4)	0.99 (0.51, 1.94)	0.84 (0.43, 1.64)
<4	10 (10.0)	90 (90.0)	1.00	1.00
Visited/seen HEW during pregnancy				
Yes	26 (9.8)	240 (90.2)	1.03 (0.64, 1.66)	—
No	49 (8.2)	545 (91.8)	1.00	—
*Statistically significant CI. ANC, antenatal care; HEW, health extension worker.				

*Statistically significant CI.
ANC, antenatal care; HEW, health extension worker.

Previous studies reported that the chance of optimal newborn care practice was higher among mothers with the highest income, had good knowledge of newborn care, had formal education and had more than four antenatal care visits;^{13–15 18} however, none of these factors were either not statistically significantly associated with optimal newborn care practice nor measured in the current study. The possible explanation could be that the association between the exposure and outcome variables might be confounded or surrogated by mothers' area of residence. Therefore, due attention should be given to mothers from rural areas to further improve their optimal newborn care practices.

The current study revealed that the chance of home-based optimal newborn care practice was 69% times

lower among mothers from rural areas compared with mothers from urban areas. This finding was consistent with previous work that revealed mothers from rural areas practised suboptimal newborn care, such as inappropriate thermal care (baby not covered with clothe immediately after cord cutting and frequent bathing with cold water), inappropriate cord care (applying butter or ointment on the cord), inappropriate feeding practice (discarding colostrum and delayed initiation of breast feeding) and poor handwashing practice prior to contact with the newborn.^{13–15 24} The possible explanation could be that mothers from rural areas might not have adequate knowledge of the health benefits of optimal newborn care and consequences of suboptimal newborn care. Evidence has shown that optimal essential newborn care practice

was lower among mothers who did not get any advice on essential newborn care or with poor knowledge of essential newborn care and with poor knowledge of newborn danger signs.^{13 14 25–27}

As a longitudinal panel survey study, our study has many strengths. The unequal selection probability of mothers of neonates and the clustering nature of the data by EA were accounted in the analysis, so the findings can be reliable and used to make generalisation. The study was also less susceptible to recall bias, as mothers were inquired about the newborn care they provided to their baby before 6–8 weeks. As a limitation, this study might be at risk of Hawthorne effect bias, as the mothers who participated in the study might change their practice of newborn care because they knew their baby including themselves were being studied. This limitation might not be a problem in this study, as the misclassification was more likely to be non-differential in the EAs. In addition, in this analysis, the effect of mothers' knowledge and perception towards essential newborn care and knowledge of newborn danger signs on the outcome were not assessed due to data limitation in the PMA survey.

CONCLUSION

From the current findings, we can conclude that the level of home-based optimal newborn care practice was very low in Ethiopia. Home-based optimal newborn care practice was lower among mothers from rural areas in the nation. Therefore, health planners at different levels and healthcare providers, including health extension workers, should give priority attention to mothers from rural areas to improve their optimal newborn care practice by considering the context-specific factors or barriers.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval This study involves human participants and the study proposal was reviewed and approved by the Institutional Review Board of the College of Health Sciences, Addis Ababa University (reference number: 027/22/SPH). This is a secondary data-based study and participants were not contacted directly.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The data that support the findings of this study are available upon reasonable request from the Performance Monitoring for Action (PMA) website via <https://datalab.pmadata.org/datasets>. Additionally, the datasets used in this study can be provided by the lead author on reasonable request after approval of the PMA project owners.

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RESEARCH

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Level of completion of a continuum of age-appropriate infant feeding practices and barriers among breastfeeding mothers in Ethiopia: a mixed methods study

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Abstract

Background Ethiopia has committed to ending undernutrition by implementing nutrition intervention strategies, including promoting optimal feeding and care practices. To monitor and evaluate optimal infant feeding practices, it is crucial to have reliable and quality data on infant feeding indicators. Therefore, this study aimed to evaluate the extent to which breastfeeding mothers in Ethiopia have completed the continuum of age-appropriate infant feeding practices and the barriers they face.

Methods In this study, a sequential explanatory mixed method design was used. First, using datasets from performance monitoring for action (PMA) in Ethiopia, we estimated the level of the outcome and associated factors. In the quantitative (QUAN) analysis, 1755 mothers of infants were included to generate estimates. A generalized estimating equations logistic regression model was used to identify factors associated with the outcome by accounting for the clustering nature of the data by enumeration area. Then, a qualitative (QUAL) study was conducted with 14 mothers to explore their infant feeding practices using an in-depth interview guide and analyzed using a thematic approach. Results from both quantitative and qualitative data were integrated, described under the identified thematic areas, and interpreted concurrently.

Results This study showed that 13.96% (95% CI: 12.4 to 15.6%) of mothers practiced a complete continuum of age-appropriate infant feeding. Over 8% of mothers did not practice any optimal feeding. Nearly 47% of mothers practiced optimal breastfeeding, and one-fifth of mothers practiced optimal complementary feeding. Results from both quantitative and qualitative data showed that mothers' complete continuum of age-appropriate infant feeding practice was affected by their level of income, knowledge, and attitude towards optimal infant feeding, as well as by important others, including husbands, grandmothers, and health workers.

Conclusion The level of a complete continuum of age-appropriate infant feeding practice is low among breastfeeding mothers in Ethiopia. Mothers' optimal feeding practices in Ethiopia are affected by their level of knowledge and attitude towards infant feeding, income or access to food, and health workers or family members.

Therefore, collaborative efforts are needed to strengthen mothers' education on the health benefits of optimal infant feeding and design and promote strategies to improve household income or access to diverse food.

Keywords Age-appropriate infant feeding, Exclusive breastfeeding, Complementary feeding, Ethiopia

Background

Over one-third of infants worldwide have not been exclusively breastfed during the first four months of life [1, 2]. The rate of continued breastfeeding globally decreased from 74% in the first year of life to 46% in the second year of life. The recommended diverse diet was not given to over two-thirds of children aged 6 to 23 months. Feeding behaviors are suboptimal even in the richest households due to several reasons, including cultural factors and poor knowledge about optimal child feeding [2]. Only 59% and 14% of children in Ethiopia were exclusively breastfed and received adequate dietary diversity in 2019, respectively. In 2019, the proportion of infants exclusively breastfeeding decreased with age, from 73% in 0–1 months to 40% in 4–5 months [3–5].

Infant feeding practices that are inappropriate can be characterized by introducing complementary foods too early or too late, infrequent feeding, poor hygiene and feeding methods, and poor childcare practices [1]. Evidence has shown that the early introduction of complementary foods is associated with harmful effects, such as food allergies, the possibility of choking, a decrease in breast milk intake, childhood illness, and stunting [6–8]. The delayed introduction of complementary foods can cause anemia, food acceptance problems, and difficulty learning to eat [6–12]. According to experts, the potential health benefits of introducing complementary foods at six months of age outweigh any potential risk [6, 8, 12].

Evidence has shown that inappropriate infant feeding has significantly contributed to infant undernutrition, impaired development, and deaths in Sub-Saharan African countries, including Ethiopia [1, 13]. As a result of this, Ethiopia has committed to ending undernutrition by introducing and implementing nutrition intervention strategies, such as promoting optimal feeding in line with international recommendations [3, 14].

Optimal feeding practices are crucial to promoting healthy growth in infants and preventing childhood illnesses and undernutrition. Human breast milk can meet the nutrition needs of full-term and normal-birth-weight infants during the first six months of life. However, complementary foods should be introduced at six months of infant age because of the nutritional requirements of infants increase with age [1, 6, 9]. Timely and adequate complementary feeding in terms of amount, frequency, and diversity is recommended for children aged 6–23 months [6, 15, 16].

Previous research has demonstrated that mothers who gave birth at a health facility, had no economic problems

and received breastfeeding counseling during pregnancy had a higher rate of exclusive breastfeeding. Moreover, mothers with higher educational levels and postnatal checkups were more likely to initiate complementary food properly [17–21]. However, the complete continuum of age-appropriate infant feeding practices and associated factors in Ethiopia is not well documented. Therefore, this study aimed to evaluate the extent to which breastfeeding mothers in Ethiopia have completed the continuum of age-appropriate infant feeding practices and the barriers they face.

Methods

Study settings

The quantitative study was conducted using the performance monitoring for action Ethiopia (PMA-Ethiopia) longitudinal panel survey datasets. PMA-Ethiopia survey was conducted in six regions that collectively represent 90% of the population in Ethiopia, namely, Addis Ababa, Oromia, Amhara, Tigray, the former Southern Nation Nationality People (SNNP) and Afar regions. The details of PMA-Ethiopia project design and settings can be accessed from the published PMA-Ethiopia project protocol [22].

The qualitative study was conducted in selected kebeles (the smallest administration unit in Ethiopia) in the health and demographic site (HDS) of Addis Ababa University and the rural community attachment site in two regions (SNNP and Oromia regions). The study participants were mothers who had under one year of infant during the data collection period.

Study design

In the PMA study, a longitudinal panel survey design was used to generate data about maternal healthcare and infant care practices. Using the PMA-Ethiopia datasets, we have produced three manuscripts including the current one. The first manuscript entitled 'Receiving quality antenatal care service increases the chance of maternal use of skilled birth attendants in Ethiopia', and published in PLOSE ONE journal in December 2022 [23]. The second manuscript entitled 'home-based optimal newborn care practice and associated factors among Mothers in Ethiopia: a community-based longitudinal panel survey', and published in BMJ Open Journal in June 2023 [24]. In all manuscripts, the quantitative data generation process was almost the same.

Study population

The source population was all mothers who had under-one year infants in the six regions during the PMA project period, from 2019 to 21. Whereas, the study population was all breastfeeding mothers who had under-one year infant and enrolled during pregnancy and interviewed at 6 weeks, 6 months and 1 year about infant feeding practice from selected enumeration areas in the six regions during the PMA project period, from 2019 to 21.

Sample size and sampling procedure

The required sample size for the quantitative study was calculated using Stata vers.16 software considering the following assumptions: a 10% outcome difference between exposed and unexposed, a 16% baseline level of not received counseling on breastfeeding (key indicator) during pregnancy chosen from studies [17], a 5% level of significance, and 80% power. The required sample size was increased by design effect ($Deff=1.5$) and incompleteness rate (10%). Hence, the estimated sample becomes 860.

The PMA Ethiopia panel survey employed a stratified two-stage cluster sampling design to select enumeration areas (clusters) and households from both urban and rural areas of the six regions. In the first stage, enumeration areas (EAs) were selected using probability proportional to size sampling technique from the national Central Statistical Agency (CSA) sampling frame, which contains information about the EA's location, type of residence (urban, rural) and the estimated number of households in each EAs. In the second stage, 35 households per cluster were selected and all pregnant women aged 15–49 in the selected households were enrolled during pregnancy and interviewed after delivery. In this study, to increase the power of the study, all available 1,755 mothers of infants were included in the final analysis.

To address the qualitative objective, 14 participants were selected from urban and rural kebeles of an institution HDS or community attachment sites in two regions (SNNP and Oromia) using criterion purposive sampling technique. The final sample size in this study was determined based on information saturation among each group of the study participants (occupation). The eligible participants in each kebele were selected in collaboration with health workers in the areas.

Quantitative data collection and measurement

In the PMA-Ethiopia panel survey, structured and standardized forms were used to enroll mothers during pregnancy and to interview them after delivery. Data were collected by using the Open Data Kit (ODK) system using tablet computers by trained field workers. Data on household location, housing and sanitation practices,

economics and asset ownership, socio-demographic status and reproductive health details were collected during baseline census by trained field workers. Mothers and infants were followed and interviewed at 6 weeks, 6 months and 1 year of postnatal periods by trained community health extension workers. During follow-up visits data on maternal healthcare service utilization, and infant feeding and healthcare practices were collected by using a structured interviewer-administered questionnaire. The data collection was supervised by trained master's degree graduates in the field of public health.

According to WHO Infant and young Child Feeding (IYCF) definitions: early initiation of breastfeeding is defined as the proportion of children born in the last 12 months who were put to breast within one hour of birth. Exclusive breastfeeding is defined as the proportion of infants 4–5 months of age who are fed exclusively with breast milk, and continued breastfeeding at 1 year is defined as the proportion of children 12–15 months of age who are fed breast milk. The introduction of complementary foods is defined as the proportion of infants 6–8 months of age who received solid, semi-solid or soft foods [14, 25].

In this study, completion of the continuum of age-appropriate infant feeding was generated and constructed from mothers' responses on the time of initiation of breastfeeding after birth, exclusive breastfeeding until 6-months of age, and timely initiation of complementary feeding at six months of age, and dietary diversity (baby received food made from animal source and plant source foods). To determine and measure if a mother had initiated breastfeeding within an hour: mothers were asked the question of "How long after birth did you first put your infant to the breast?" To determine and measure if a mother had exclusively breastfed until 6 months: mothers were asked the question "For how long did you exclusively breastfeed?" To determine the start of complementary feeding: mothers were asked "When did you start infant complementary feeding?" Similarly, dietary diversity was measured by asking mothers whether their baby received food made from an animal sources (milk, meat, egg, and fish), and plant sources (grains/cereals, legumes (bean), veggies (root, dark green) and ripe fruits) in the previous day. Therefore, in this study infants are considered to receive diversified food if the infant had received food made from both animal and plant-based sources, as mentioned above. Finally, completion of the continuum of age-appropriate infant feeding was treated as a binary outcome and defined as "complete" if a mother practiced the four services, or "incomplete" if none or not practiced either of the four services.

The household wealth quintile was determined by giving scores based on the number and kinds of consumer goods they own, source of drinking water, type of toilet

facilities and flooring materials. The score was derived using principal component analysis, and then households' wealth index was divided into quintiles according to the wealth score as "lowest", "lower", "middle", "higher" and "highest" [4].

Qualitative data collection

First, an in-depth interview guide was prepared in English to explore mothers' early initiation of breastfeeding after childbirth, exclusive breastfeeding in the first six months of age, the introduction of complementary foods such as solid, semi-solid or soft foods at six months of age and dietary diversity [14, 26]. Then, the interview guide was translated into Amharic and Afan Oromo language by fluent speakers of both languages. Then, back translated to English by another fluent speaker of the languages to check consistency. The data were collected using the interview guide by the principal investigator (Ph.D. student) and trained MPH holder as an assistant (Afan Oromo speaker). Each in-depth interviews were convened at the participant's home or compound where there was unlikely to be interruption or excessive noise interference and convenient for participants. Interviews were commenced with introductions and clarifications about the purpose and procedures of the interview. Interviews were conducted in Amharic or Afan Oromo (as required) for 15 to 25 min. The interviewer introduced and guided the interview discussion (kept the interview focused and managed interview time). Audio recording of the in-depth interviews was done and field note taking and expansion were done on the same day after each interview.

In this study, credibility was maintained by diversifying the study participants in terms of area of residence, age and occupation. To maintain transferability efforts were made to obtain detailed responses using appropriate probes, and to ensure conformability care was taken by the researcher not to introduce the researcher's prior experience in all data processes. To ensure dependability pre-tested interview guide was used and efforts were made to build trust among participants and other means.

Quantitative data analysis

The quantitative data were formally requested and downloaded from the PMA Ethiopia website [27–30]. Then, data were cleaned and prepared for merging using Stata ver.16 software. The baseline and the follow-up visits datasets were merged using the study participant identity number (participant ID). The appropriate sample was restricted based on the design and inclusion criteria to address the study objective. Description of the study participants, unweighted and weighted (sampling weight) frequency, by sociodemographic characteristics was computed and presented using tables.

As we have binary outcome and clustered data, the generalized estimating equation (GEE) logistic regression model was fitted to account for the correlation of observations within an enumeration area (EA), considering EA as a clustering variable and controlling the effect of potential confounders. The association between each potential exposure and outcome variables was assessed. The odds ratio (OR) with the corresponding 95% confidence interval (CI) was computed to measure the association between exposure and outcome variables. Then, exposure variables that were statistically significant at $p < 0.20$ during the GEE binary logistic regression model were selected as a potential confounder variable for GEE multiple logistic regression. The GEE multiple logistic regression model was fitted to control the confounding effect of the variables. Area of residence (urban, rural), women's place of delivery (home, health facility), number of ANC visits (≥ 4 , < 4 visits), educational level (never attended, primary, secondary, vocational and higher), and wealth quintile (lowest, Lower, middle, higher, highest) were included in the final model. A $p < 0.05$ was used for the final interpretation of the statistically significant association between the exposure and outcome variables.

Qualitative data analysis

Verbatim transcription of audio records was done within a few days by the principal investigator. The interview data (transcripts) were cleaned for errors through repeated reading. A content-driven theme approach (thematic approach) was used. Codes were created from the interview data itself, following an inductive coding approach. Then, codes are applied to the text. Characteristics are coded and reduced into core categories (themes) using Atlas.ti7 software and themes (context formulated) were described.

Results

In this study, the quantitative and qualitative data were analyzed concurrently, and the findings are integrated in this section.

Socio-demographic characteristics of quantitative study participants

In the quantitative study a total of 1,755 mothers of infants were included from six regions of Ethiopia. The majority of the study participants were from Oromia (44%), SNNP (22.5%), and Amhara (22.0%) regions. Over two-thirds of the study participant mothers (78.2%) were from the rural parts of the regions. Nearly 96% of the study participant mothers were married, and nearly 42% of them had never attended formal education, followed by 39.1% attending primary school (Table 1).

Table 1 Socio-demographic characteristics of mothers of infants in six regions of Ethiopia ($n = 1,755$), 2019-21

Socio-demographic characteristics	Weighted percent	Weighted N	Unweighted N
Region			
Oromia	44.2	776	443
SNNP	22.5	395	414
Amhara	22.0	388	324
Tigray	6.1	106	282
Addis Ababa	3.7	64	171
Afar	1.5	26	121
Area of residence			
Rural	78.2	1,373	1,066
Urban	21.8	382	689
Household wealth index			
Lowest quintile	20.9	366	291
Lower quintile	19.3	340	259
Middle quintile	20.3	356	277
Higher quintile	19.7	345	329
Highest quintile	19.8	348	599
Women Age (in years)			
15–19	9.0	158	133
20–24	23.7	416	424
25–29	31.2	547	580
30–34	19.5	343	350
≥35	16.6	291	268
Marital status			
Married/in union	95.8	1,682	1,657
Single	4.2	73	98
Religion			
Orthodox	37.7	659	806
Islam	34.9	610	511
Protestant	26.0	456	421
Other*	1.4	30	17
Education level			
Never attended	42.6	747	663
Primary	39.1	686	633
Secondary	11.2	197	260
Vocational & higher	7.1	125	199
Baby gender			
Male	51.5	904	895
Female	48.5	851	860

*Catholic, Wake-feta, Traditional

Level of completion of the continuum of age-appropriate infant feeding practice

This study showed that 13.96% (95% CI: 12.4 to 15.6%) of mothers practiced a complete continuum of age-appropriate infant feeding. Over 8% of mothers did not practice any optimal feeding. Approximately 47% of mothers practiced optimal breastfeeding. Similarly, nearly one-fifth of mothers practiced optimal complementary feeding. (Table 2)

Barriers to the continuum of age-appropriate infant feeding practice

During the binary analysis of the quantitative data, mothers' area of residence, educational level, household income level, and place of delivery were found to be statistically significantly associated with mothers' completion of the continuum of age-appropriate infant feeding practice at a $p < 0.20$. However, after adjustment for the potential confounders, none of the selected variables were statistically significantly associated with mothers' completion of the continuum of age-appropriate infant feeding practice at a $p < 0.05$ (Table 3).

The qualitative findings showed that mothers optimal infant feeding practices were influenced by their low or limited source of income, their limited knowledge and attitude towards optimal feeding benefit and consequence, mother themselves and/or infant ill health status, important others (grandmother, husband, and health professional), price inflation, less access to food, and their workload or busy work conditions (Fig. 1).

The theory of planned behavior (TPB) was utilized as a framework to identify themes through the combination of quantitative and qualitative data. The results were then combined and explained in terms of the selected theme areas, which include perceived consequences, perceived social pressure, perceived behavioral control, and background factors (socio-demographic and knowledge factors).

Background factors

The chance of completion of the continuum of age-appropriate infant feeding practice was 18% times lower among mothers of rural infants compared to mothers of urban infants (crude OR=0.82, 95%CI=0.59, 1.14). Similarly, the chance of completion of age-appropriate infant feeding practice was 31% times lower among mothers not attended formal education compared to mothers with vocational & higher education.

In the PMA survey, mothers' knowledge of age-appropriate infant feeding practices was not measured, but this variable was measured in the qualitative interview. Many of the participant mothers correctly described the content and benefits of age-appropriate infant feeding practices.

"... the initial breast milk (colostrum) is important for the infants and protects them from disease. It has benefits for the mother too: prevent breast distension (pain), helps to have normal weight, and it also increases mother-child psychological attachment." (mother, age 27 years).

"Breast milk is adequate until six months. It contains all the important things (nutrients) for the infant. After six month infants should get additional

Table 2 level of completion of the continuum of age-appropriate infant feeding practices among breastfeeding mothers in Ethiopia, 2019-21

Variables	Frequency (N = 1755)	Percentage (%)
Practiced a complete continuum of age-appropriate infant feeding (yes)	245	13.96
Initiated breastfeeding within an hour after delivery (yes)	1135	64.67
Practiced exclusive breastfeeding (EBF) up to 6 months (yes)	1240	70.65
Introduced complementary food at 6 months of infant age (yes)	1,089	62.05
Practiced dietary diversity (yes)	549	31.28
Practiced optimal breastfeeding (yes)	820	46.72
Practiced optimal complementary feeding (yes)	355	20.23
Did not practice any of optimal feeding (yes)	147	8.37

Table 3 GEE multivariable logistic regression analysis for continuum of age-appropriate infant feeding practice with independent variables, 2019-21

Variables	Age-appropriate infant feeding practice(n = 1,755)		Crude OR (95% CI)	Adjusted OR(95% CI)
	Yes (%)	No (%)		
Area of residence				
Rural	136(12.8)	930(87.2)	0.82(0.59,1.14)*	0.95(0.56,1.59)
Urban	109(15.8%)	580(84.2%)	1.00	1.00
Educational level				
Never attended	67(10.1)	596(89.9)	0.69(0.45,1.05)*	0.75(0.46,1.19)
Primary	107(16.9)	526(83.1)	1.01(0.69,1.48)	1.05(0.70,1.58)
Secondary	40(15.4)	220(84.6)	0.97(0.63,1.49)	0.99(0.64,1.51)
Vocational & Higher	31 (15.6)	168(84.4)	1.00	1.00
HH Wealth index				
Lowest quintile	28(9.6)	263(90.4)	0.63(0.40,1.02)*	0.78(0.41,1.51)
Lower quintile	35(13.5)	224(86.5)	0.91(0.61,1.36)	1.08(0.60,1.92)
Middle quintile	41(14.8)	236(85.2)	0.88(0.59,1.30)	1.03(0.58,1.82)
Higher quintile	46(13.9)	283(86.0)	0.83(0.57,1.20)	0.95(0.59,1.51)
Highest quintile	95(15.9)	504(84.1)	1.00	1.00
Women age (in years)				
15–19	18(13.5)	115(86.5)	1.04(0.62,1.73)	--
20–24	65(15.3)	359(84.7)	1.17(0.80,1.70)	--
25–29	78(13.4)	502(86.6)	0.98(0.68,1.42)	--
30–34	47(13.4)	303(86.6)	1.04(0.70,1.54)	--
>=35	37(13.8)	231(86.2)	1.00	--
Place of delivery				
Health facility	165(15.2)	917(84.8)	1.26(0.94,1.68)*	1.14(0.82,1.57)
Home	80(11.9)	593(88.1)	1.00	1.00
Parity				
<5 live births	197(13.7)	1244(86.3)	0.91(0.67,1.21)	--
>=5 livebirths	48(15.2)	267(84.8)	1.00	--
Number of ANC visits				
>=4 ANC visits	94(14.6)	550(85.4)	1.01(0.76,1.32)	0.89(0.67,1.20)
< 4 ANC visits	151(13.6)	960(86.4)	1.00	1.00
Visited/seen HEW during pregnancy				
Yes	69(13.7)	435(86.3)	0.86(0.63,1.16)	--
No	176(14.1)	1,075(85.9)	1.00	--
Planned to feed other than breast milk in the first 6 months				
No	154(14.3)	926(85.7)	1.08(0.80,1.46)	--
Yes	91(13.5)	584(86.5)	1.00	--

*Statistical significance at p -value < 0.20

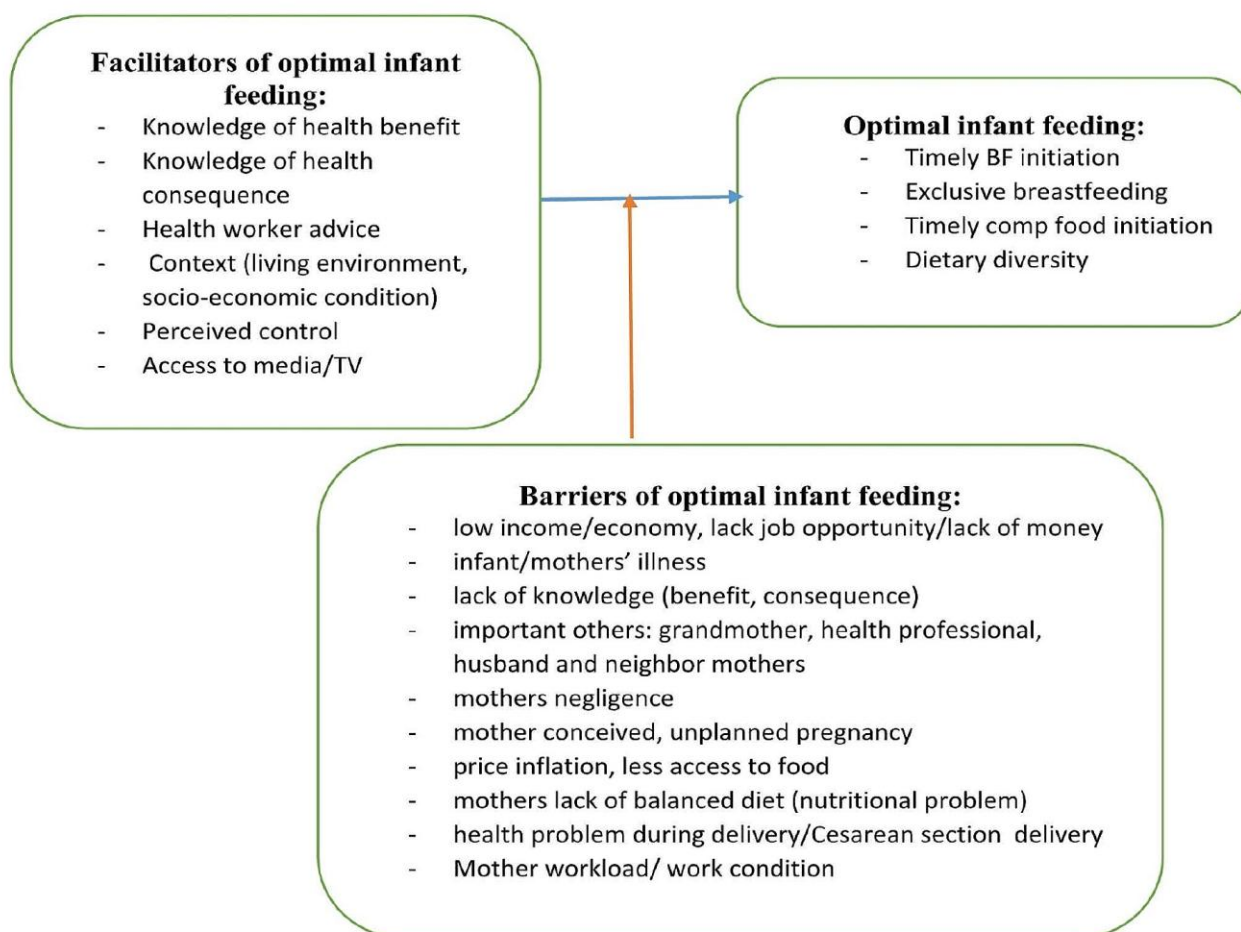


Fig. 1 Facilitator and barriers of continuum of age-appropriate infant feeding practice

foods for their proper growth. Now I am feeding breast milk only. After six months, I have the plan to feed an additional variety of foods, like cerifam, carrot, potato, porridge and milk." (Mother, 30 years).

In the qualitative interview, some mothers described that additional food mainly cow milk can be given to the infant at an earlier age, as breast milk is not enough or no problem with giving additional food (milk) before six months.

"I don't think breast milk is enough up to six months. I gave cow milk after diluting it with water at the age of three months because my breast did not produce enough milk, and the child might get hungry. The child should exercise bottle feeding at the age of three months. So far my child has not gotten any health problems, as a result of early additional food introduction." (Mother, 20 years age).

"Up to six months infants should be fed breast milk only, but if you are an employee you can start additional food starting from 5 months to fulfill the energy requirements of the infant. I have got this advice from doctors (health professionals). Up to now, I am at home so that did not start any additional food, but after this month I will return to work, so I have to start additional food mainly cow milk as per the advice." (Mother, 25 years old).

Perceived consequences

Similarly, in the PMA survey, the mother's attitudes towards age-appropriate feeding practices not measured, but this variable was measured in the qualitative interview. Many of the participant mothers correctly described the negative consequences of inappropriate infant feeding practices.

“up to six months a child should only feed breast milk. If a child is given additional food before six months, many problems will occur. The child becomes at risk of infection (disease). For example, I started bottle feeding at the age of two months because of the two fasting month. This led my child to diarrheal disease. She had diarrhea five times a day. She was seriously affected. Then, I stopped bottle feeding and breastfeeding up to six month. Early bottle feeding affects their health, especially if there is a hygiene problem. The bottle may be contaminated by flies, but mother breast milk is clean and safe.” (Mother, 27 years age).

“If a child is not appropriately fed, the child’s growth and mental development will be compromised, and the child will not have a bright mind. The child also lacks strength. The other thing, is the child will be easily susceptible to disease and cannot resist disease.” (Mother, 30 years age).

“If an infant is not properly fed, their growth will be delayed, lack strength and be unable to walk. If they do not get a balanced diet, like, eggs, fish, vegetables, milk and others, their growth will be compromised. They become malnourished (wasted) and will not have bright minds. ... They may develop anemia and become at risk of disease.” (Mother, 24 years age).

Perceived social pressure

Compared to mothers who delivered at home, the chance of the completion of continuum of age-appropriate infant feeding practice was 26% times higher among mothers who delivered at a health facility (Crude OR=1.26, 95%CI=0.94,1.68).

In the qualitative interview, some mothers described that important others including health professionals, husbands and grandmothers can positively or negatively influence child-feeding practices.

“We practice optimal feeding as per the health professional advice during pregnancy visits and after delivery. They tell us how to care for and feed our children. They tell us to expose the baby to morning sunlight for 10 minutes after delivery, and for how long the infant breastfeeds. Based on what we have heard we practice at home.” (Mother, 27 years age).

“ A neighbor nurse professional (female) told me that it is possible (no associated problem) to give cow milk after diluting with water from the age of three months. The nurse herself is giving cow milk after diluting it with water. She has been given cow milk because she works at a health office (Woreda health office) so that not convenient for her to breastfeed; however, her breast not produce enough milk, like

mine. To fulfill the child’s energy need, I should feed cow milk because we do not want our child to get hungry. ... In addition to breastfeeding, I start other foods feeding after six months of infant age. Up to one year, I feed the infant mainly rice and Endomi (processed fast food). Then, after one year I feed him what we family members eat.” (Mother, 20 years age).

“Mothers (Grandmothers) have a great role in child feeding practice. They tell you to give water and herbal medicine to prevent abdominal cramps especially if the baby is crying. For example, my mother gave water to my baby at an earlier age and she developed diarrhea. Then, I took her to a health facility and doctors (health professionals) identified Giardia and treated her.” (Mother, 27 years age).

Perceived behavioral control

The chance of completion of age-appropriate infant feeding practice was 37% times lower among mothers with the lowest household income compared to mothers with the highest household income.

The finding from the qualitative study showed that mothers may not practice optimal infant feeding due to inconvenient work conditions and low income (lack of job opportunity/lack of money), price inflation and less access to food.

“optimal complementary feeding depends on what you have. If you have access, it is good to feed them different varieties, like, eggs, meat, vegetables..., but if you don’t have access, you can do nothing what you can do is give what you have already.” (Mother, 24 years age).

“If you are expecting expense from a husband you may not feed properly as he may give a small amount of expense (money). Our (mothers) being busy with activities may influence not to feeding properly. She may leave home early in the morning and return at night from work (employed or unemployed), so the child will not get breast milk or not be properly fed.” (Mother, 20 years age).

Discussion

The quantitative finding showed that only approximately 14% of mothers started and continued age-appropriate infant feeding practices in Ethiopia. Based on both quantitative and qualitative data, factors that influenced a mother’s continuum of age-appropriate infant feeding practice were identified, integrated, and described under the identified thematic areas. The thematic areas are background factors, perceived consequences, perceived social pressure, and perceived behavioral control.

However, none of the background (socio-demographic) factors were statistically significantly associated with the outcome variable.

The World Health Organization recommended that mothers initiate breastfeeding within an hour after birth, exclusively breastfeed up to 6 months, continue breastfeeding for 1 and more years, introduce semi-solid or soft foods at 6 months, prepare minimum dietary diversity (≥ 4 food groups), and give minimum meal frequency (≥ 3 meals in a day) to promote infant and child healthy growth [31].

The current study showed that less than 14% of mothers started and continued optimal age-appropriate infant feeding practices in Ethiopia. This shows that nearly nine in 10 mothers did not start and continue age-appropriate infant feeding practices as per the recommendations. Similarly, some in-depth interview mothers described that only breast milk feeding until six months is not enough to fulfill the energy requirements of the baby, and optimal complementary feeding practice mainly depends on the availability and access to diverse foods items. Therefore, the health offices and concerned local stakeholders should collaborate to increase the continuum of age-appropriate infant feeding practice in Ethiopia by strengthening families' education on the health benefits of optimal infant feeding activities and designing and promoting strategies to improve household income or household access to diverse food.

Although no previous study estimated the level of the complete continuum of age-appropriate infant feeding practices by mothers, some studies reported the level of exclusive breast feeding and timely initiation of complementary feeding practices by mothers separately, which ranged from 10 to 88% and 34 to 83%, respectively [15–17, 19, 29–42]. Similarly, studies conducted in Ethiopia and in urban slums in India reported that proportions of mothers who initiated breastfeeding within an hour after delivery ranged from 23 to 63% [33, 36, 37]. Also, a study conducted in Ethiopia reported that about 24% of children had good dietary diversity, and about 33% of children were fed with an appropriate meal frequency [43].

The current study showed that none of the assessed background (socio-demographic) factors were statistically significantly associated with mothers' complete continuum of age-appropriate infant feeding practice; however, over three-quarters of mothers practiced sub-optimal infant feeding in different categories of socio-demographic variables, including area of residence, household income, educational status, and place of delivery. The possible explanation could be that the current study may be underpowered to identify potential factors since only 245 mothers had a continuum of feeding practices. When we stratify these 245 into the different categories of the various variables included in the final

model, we may not get a significant result. The other possible explanation could be use of secondary data, which may miss data on some potential confounder variables, including knowledge and attitude towards optimal infant feeding practice.

In this study, the effect of mothers' knowledge and attitude on the completion of a continuum of age-appropriate infant feeding practice was not assessed due to the data limitations of the PMA survey. However, some in-depth interview mothers described that optimal infant feeding has several benefits, like helping children to have proper growth and mental development (a bright mind), getting strength and resisting diseases. Similarly, studies conducted in Ethiopia and Kenya reported that optimal exclusive breastfeeding and complementary feeding practices were higher among mothers who were knowledgeable about the timing and benefits of optimal child feeding [19, 21, 33, 44]. Also, a study conducted in rural Kenya reported that the chance of a mother's early cessation of exclusive breastfeeding was lower among mothers who had knowledge of breastfeeding and had positive beliefs about the impact of exclusive breastfeeding on children and their perception of impact of exclusive breastfeeding on mother [44].

The current study also showed that higher proportions of mothers who gave birth at health facilities started and continued age-appropriate infant feeding practices compared to mothers who gave birth at home. The possible explanation could be that mothers who gave birth at a health facility might receive counseling on optimal child feeding practices during pregnancy visits and delivery by health professionals. In some in-depth interviews, mothers described that important others, including health professionals, grandmothers, and husbands, have great influence on practicing age-appropriate infant feeding. Studies conducted in rural Kenya and India reported that the chance of exclusive breastfeeding was higher among mothers who had a positive perception of the acceptability of exclusive breastfeeding by important others and had a supportive norm [44, 45].

The current study showed that nearly only 15% of mothers in all income categories practiced optimal age-appropriate infant feeding. This shows that mothers with no economic problems still practiced suboptimal feeding. The possible explanation could be mothers with higher income may have limited knowledge and attitude towards optimal infant feeding practices; however, economic problems may be a significant major barrier for mothers with lower household income. Some of the in-depth interview participants described that low income and less access to food can significantly influence mothers' age-appropriate infant feeding practices. This finding was in line with studies conducted in Ethiopia and India, which reported that low socioeconomic status was

a major barrier to practicing age-appropriate infant feeding [17, 18, 45, 46].

Using a sequential explanatory mixed method study has many strengths. The unequal selection probability of mothers of infants and the clustering nature of the data by enumeration area were accounted for in the quantitative analysis, so the findings can be reliable and used to make generalizations. As a limitation, this study might be at risk of Hawthorne effect bias, as the study mothers might change in their practice of infant feeding because they knew their baby, including themselves, was being studied. This limitation might not be a problem in this study, as the misclassifications were more likely to be non-deferential in the enumeration areas. In addition, in this analysis, the effect of mothers' knowledge and attitude towards infant feeding benefits and consequences on the outcome was not assessed due to data limitations in the PMA survey, but the effect of these variables on the outcome was explored qualitatively. Therefore, the qualitative study results would make the quantitative study results interpretation complete and reliable. Even though there was time lag between the quantitative and qualitative studies, there might not be a total change in barriers to optimal feeding practices after the quantitative study.

Conclusion

From the findings of the current study, we can conclude that the level of complete continuum of age-appropriate infant feeding practice is low among breastfeeding mothers in Ethiopia. Mothers' complete continuum of age-appropriate infant feeding practice is affected by their knowledge and attitude towards optimal child feeding, economic status, and health professionals, and family members. Therefore, public health planners and health professionals in the system, including health extension workers, should instruct and encourage mothers to practice age-appropriate feeding by explaining the benefits of optimal feeding and the consequences of suboptimal feeding. Health extension workers, together with concerned local stakeholders, should advise and encourage husbands and grandmothers to support mothers in practicing age-appropriate infant feeding. Decision makers and concerned stakeholders should also give priority attention to mothers of infants with low household income to improve their source of income.

Abbreviations

PMA	Performance Monitoring for Action
SNNP	Southern Nations Nationality People
QUAN	Quantitative
QUAL	Qualitative
HDS	Health and Demographic sites
EAs	Enumeration Areas
CSA	Central Statistical Agency
ODK	Open Data Kit system
WHO	World Health Organization
IYCF	Infant and Young Child Feeding

MPH	Masters of Public Health
OR	Odds Ratio
GEE	Generalized Estimating Equation
ANC	Antenatal Care
TPB	Theory of Planned Behavior
CI	Confidence Interval
HEWs	Health Extension Workers
CS	Caesarian Section delivery

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Author contributions

S.M. conceived the study, reviewed literature, developed the proposal and the methods, did the analysis, and wrote the draft of the manuscript. E.G. and A.W. supervised, critically reviewed and edited the study proposal and the final report. All authors read and approved the final manuscript.

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The quantitative study was conducted using PMA secondary data, but the qualitative interview was conducted with the financial support of the College of Health Sciences, Addis Ababa University. The funding institution has no role in the conceptualization, design, data collection, analysis, decision to publish or preparation of the manuscript.

Data availability

The quantitative datasets used and analyzed in the current study are available upon reasonable request from the Performance Monitoring for Action website via <https://datalab.pmadata.org/datasets>. Whereas, the in-depth interview data are available from corresponding author on reasonable request.

Declarations

Ethical approval and consent to participate

The current study was conducted after getting ethical approval from the College of Health Sciences, Addis Ababa University (reference number: 027/22/SPH). Then, PMA-Ethiopia project data owners were requested to share the quantitative data. The qualitative data were collected after getting permission from concerned offices in SNNP and Oromia regions. As study participants were infants who were incapable of giving informed consent, written informed consent was sought from their mother/guardian after the study aims and benefits were explained. Similarly, written informed consent was obtained from the same mothers of infants for their participation too. Mothers were approached in a language they were comfortable with (Amharic or Afan Oromo). Mothers were guaranteed confidentiality by not showing their identity to anyone other than members of the research team. Mothers were informed that their participation was based on their willingness, and they could withdraw or stop their data from the study at any time without affecting their relationship with the research team.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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12. Declaration

Letter for declaration (Dissertation work)

I, the undersigned, declared that this is my original work, has never been presented in this or any other University, and that all the resources and materials used for the dissertation, have been fully acknowledged.

Name: Shikur Mohammed Awol

Signature: _____

Date: April 11, 2024

Place: Addis Ababa University

Date of submission: April 17, 2024

This dissertation has been submitted for examination with my approval as University Supervisor.

Name: Dr. Eshetu Girma

Signature: _____

Date: April 15, 2024

Name: Professor Alemayehu Worku

Signature: _____

Date: April 15, 2024