MEKELLE UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

DEPARTMENT OF REPRODUCTIVE HEALTH

QUALITY AND SPATIAL DISTRIBUTION OF IMMEDIATE POSTPARTUM CARE IN ETHIOPIA: A MULTILEVEL ANALYSIS USING PERFORMANCE MONITORING FOR ACTION ETHIOPIA 2023 DATA.

PRINCIPAL INVESTIGATOR: HAFTAAB ASHEBR (BSc, PH)

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Advisor Approval Sheet

This is to certify that the thesis paper entitled **"Quality and spatial distribution of immediate postpartum care in Ethiopia: a multilevel analysis using performance monitoring for action Ethiopia 2023 data"** is submitted in partial fulfillment of the requirements for the degree of MPH with specialization in "Reproductive Health" to the Graduate Program of the College of Health Science Mekelle University and has been carried out by **Haftaab Ashebr Berhe** ID No: CHS/RRH/004/13 under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence can submit the thesis paper to the Department.

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Name of Co advisor	Signature	Date

Declaration

I hereby declare that this MPH thesis paper is original work and has not been presented for a degree at any other university and all sources of material used for this proposal have been duly acknowledged.

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ASSURANCE THE OF PRINCIPAL INVESTIGATOR

The undersigned agreed to accept responsibility for the scientific ethical and technical conduct of the research project and for the provision of required progress reports as per the terms and conditions of the Research Publications Office in effect at the time of Grant is forwarded as the result of this application.

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ABBREVIATIONS

AIC: Akaike information criterion

ANC: Antenatal Care

BCG: Bacillus of Calmette and Guérin

EAs: Enumeration Areas

ICC: Interclass Correlation Coefficient

IPPC: Immediate Postpartum Care

LMICs: Low and middle-income countries

MLRA: Multilevel Regression Analysis

MMR: Maternal Mortality Rate

MOR: Median Odds Ratio

PCV: Proportional Change in Variance

PNC: Postnatal Care

PMA: Performance for Action

RE : Resident Enumerator

SSA: Sub Saharan Africa

SBA: Skilled Birth Attendant

SDP: Service delivery point

SNNPR: South Nation Nationality's People Region

VIF: Variance Inflation Factor

WHO: World Health Organization

ABSTRACT

Background: The immediate postpartum period is associated with a significantly increased risk of morbidity and mortality for both the mothers and newborns. Providing quality immediate postpartum care helps reduce negative outcomes. Most studies conducted in Ethiopia have identified factors associated with postnatal care utilization. However, no evidence links household and community data to service delivery points and their geographic distribution, which are necessary to assess the quality of immediate postpartum care.

Objectives: To assess the quality and spatial distribution of immediate postpartum care in Ethiopia, 2024.

Methods: We used a cohort of household and facility data from the National Performance Monitoring for Action Ethiopia study, which was conducted in 2023 across four major regions (Amhara, Oromia, South Ethiopia, and Addis Ababa). A total of 1,351 postpartum women and their newborns were linked to the nearest 264 health facilities. A multilevel binary logistic regression analysis was employed to assess contextual factors. The adjusted odds ratio with a 95% confidence interval (CI) was used to measure the associations between variables, with statistical significance set at $P<0.05$. The SaTScan V.10.2.5 and ArcGIS V.10.8 geostatistical software were used to explore the spatial distribution and interpolation of the quality of immediate postpartum care.

Results: The quality of immediate postpartum care among women and their newborns was 29.8% (95% CI 27%- 32%), ranging from 14.1% in Southern Ethiopia to 40.9% in Addis Ababa. In the multivariable multilevel analysis, religion (AOR=0.51; 95% CI 0.31-0.83), antenatal care visits (AOR=1.78; 95% CI 1.08-2.95), cesarean delivery (AOR=0.45; 95% CI 0.27-0.76), being attended by a nurse/midwife (AOR=1.96; 95% CI 1.26-3.03), urban residence (AOR=1.85; 95% CI 1.05-3.25), birth at private hospitals/clinics (AOR=4.12; 95% CI 2.07-8.51), and higher community media exposure (AOR=2.99; 95% CI 1.76-5.06) were significant predictors of the quality of immediate postpartum care. The spatial distribution of the quality of care varied significantly across regions, with a global Moran's I = 0.99, P=0.001. Significant hotspots of good-quality care were detected in Addis Ababa.

Conclusions: The quality of immediate postpartum care was low in Ethiopia, with significant spatial variation across the country. Therefore, public health interventions should be designed for areas where the quality is low to reduce maternal and newborn mortality by increasing antenatal care visits, increasing community media exposure, and strengthening health systems in rural areas.

Keywords: quality, immediate postpartum care, spatial distribution, PMA, Ethiopia.

1. INTRODUCTION

1.1 Background of the study

The postnatal period extends from immediate childbirth up to six weeks (42 days) and is a critical time for women, newborns, partners, parents, caregivers, and families. The immediate postpartum period covers the first 24 hours after birth, during which the risks of postpartum hemorrhage and other significant morbidities are highest (1). Providing quality immediate postpartum care to the mothers and newborns reduces the morbidity associated with childbirth (2).

According to the World Health Organization (WHO), the quality of care is defined as the extent to which healthcare services provided to individuals and populations improve desired health outcomes. This includes the degree to which maternal and newborn health services increase the likelihood of timely and appropriate care to achieve desired outcomes that are consistent with current professional knowledge and take into account the preferences and aspirations of individual women and their families (3).

After the first 24 hours, both the mother and her newborn need a minimum of three postnatal health checks from a skilled provider: on day 3 (48–72 hours), within 7–14 days, and at 6 weeks. A lack of postnatal care during this sensitive period may result in complications and deaths for both the newborn and the mother (1).

The immediate postpartum period presents a higher risk of morbidity and mortality for both mother and newborn due to hemorrhage, embolism, and birth asphyxia, respectively. Almost half of maternal deaths and 38.8% of neonatal deaths occur on the first day after delivery (4,5).

To address maternal and child health challenges, the new WHO recommendations on maternal and newborn care for a positive postnatal experience, published in 2022, and other studies emphasize the importance of high-quality postnatal care. This includes continuous care and monitoring during the first 24 hours after delivery and ensuring a positive postnatal experience for women and their newborns. Women undergo uncomplicated vaginal births in health facilities are advised to remain there for at least 24 hours after birth (1,4,6).

1.2. Statement of the problem

Postnatal care services are a fundamental component of the continuum of maternal, newborn, and child care and are key to achieving the Sustainable Development Goals (SDGs) related to reproductive, maternal, and child health, including targets to reduce maternal mortality rates and prevent newborn deaths (1). However, despite the critical importance of this period for maternal and neonatal survival, postnatal care (PNC) remains the most neglected intervention in the continuum of maternal and child care (7,8).

The most recent pooled analysis in low- and middle-income countries (LMICs) revealed that 41% and 42% of women received quality maternal and neonatal PNC, respectively (7). A study conducted in Ethiopia also revealed that 39.6% of newborns received at least two components of early newborn care (Observation of breastfeeding, Counseling on breastfeeding)in the first two days after birth, whereas only 10% received all available early newborn care (9).

Maternal survival has been one of the most important developments and global health priorities in recent decades, exemplified by its adoption as the fifth Millennium Development Goal (MDG) (10) and subsequently the third SDG (11). Despite significant improvements in the coverage of key maternal, newborn, and child health interventions, maternal and child mortality and morbidity have not progressed at the same pace (12). Achieving a global maternal mortality ratio (MMR) below 70 by 2030 will require an annual reduction of 11.6%, a rate that has rarely been achieved at the national level (2).

An estimated 287,000 maternal deaths and 2.3 million neonatal deaths occurred globally in 2020 and 2022, respectively (2,6). In Ethiopia the MMR per 100,000 live births was 412 in 2016 (13) and 267 in 2020 (14), whereas neonatal mortality was 33 per 1000 live births (15). The majority of maternal and neonatal morbidity and mortality are associated with a lack of quality care at birth or skilled care and treatment immediately after birth and on the first day of life (6,16).

The WHO Multi-Country Survey on Maternal and Newborn Health (17) , along with studies conducted in LMICs (18,19), and Ethiopia (20), revealed that an increasing number of women deliver in healthcare facilities. However, maternal mortality remains high in these settings, and contact with healthcare providers does not guarantee that appropriate interventions, including essential newborn care in settings that may result in low-quality care during labor and the immediate postpartum period (16, 21, 22).

As a result, in recent years, there has been a greater focus on the quality of maternal and newborn care, particularly in LMICs (8,22). In 2017, ten countries, including Ethiopia, formed a network to improve the quality of care for maternal, newborn, and child health (MNCH), reduce maternal and newborn deaths and stillbirths, and enhance the care experience for pregnant women, mothers, and babies in health facilities (12).

The factors associated with immediate postpartum care range from individual to community-level factors. Socioeconomic and geographical factors such as region, religion, income, place of residence, education, occupation, access to media, access to maternal and child health services, level of health facility, cadre of attending professionals, delivery load of the facility, and availability of maternal and child health guidelines at the facility are associated with the quality of immediate postpartum care (IPPC) (7,23–26).

Previous studies on postnatal care in Ethiopia revealed links between postnatal use and factors such as education, parity, age, marital status, media exposure, household wealth quintile, and place of residence (24,27–29). However, no evidence links home and community data to service delivery points (SDPs) (facility characteristics) for assessing the quality of IPPC.

As a result, analyzing linked data can help answer critical supply-demand questions, such as which facility, service, or provider factors influence IPPC quality and lead to better health outcomes. To our knowledge, no studies have assessed the relationships between immediate postpartum women's individual and SDP characteristics, whether women and their newborns receive quality IPPC in Ethiopia. Keeping these research limitations in mind, we link PMA household and SDP data. The goal is to investigate the spatial distribution of IPPC and how contextual factors, specifically individual and community-level determinants, affect a woman's likelihood of using quality IPPC.

1.3. Significance of the study

Evidence suggests that immediate postpartum care is critical for both the mother and the newborn, as it significantly impacts their health outcomes, with the majority of adverse outcomes occurring within 24 hours of delivery. Therefore, understanding the quality and spatial distribution of immediate postpartum care is crucial for evidence-based decision-making aimed at improving maternal health services (2, 4).

Although studies on postnatal care have been conducted, the majority of them use traditional regression methods or compare factors at the individual and community levels without linking them to health facility factors in Ethiopia, particularly at the national level. Multilevel and geographically linked data analysis using population and health facility data is important for mapping the low quality of IPPC and identifying inequalities in service access and provision.

To conduct this study, data from PMA Ethiopia provide a robust and nationally representative dataset. The data collected through PMA Ethiopia survey is reliable and can offer valuable information on the current status of immediate postpartum care in Ethiopia.

The study findings can inform clinicians about gaps in care provision, guide the development of clinical protocols, and advocate for better resource allocation. This will ensure that mothers receive essential postpartum care, highlight inequities in access, and empower mothers to demand and receive high-quality care. Additionally, the scientific community contributes to the growing body of evidence on effective coverage and quality of care, providing insights into the spatial distribution of IPPC. The study findings can also inform program planners, policymakers, maternal and child health experts, and other stakeholders in developing plans aimed at improving the quality of IPPC services in Ethiopia.

2. LITERATURE REVIEW

2.1. Overview of the quality of immediate postpartum care

Quality of care has been defined by various organizations, with the central idea of delivering health services that maximize desired health outcomes and align with current professional knowledge (30). To achieve this goal, healthcare must be safe, effective, timely, efficient, equitable, and people-centered (3). The quality of immediate postpartum monitoring was assessed inconsistently; various studies report on different quality metrics and frequently omit crucial components of the practice. The Tripathi Index, a standardized and validated method for assessing the quality of labor and delivery care in LMICs, is one of many notable advancements in the measurement of care quality during labor and delivery in recent years (22).

The new WHO's 2022 postnatal care guidelines state that, following childbirth, all women and their newborns should receive the following components of care during the postpartum period: skilled birth attendant provided maternal and neonatal postnatal care, maternal and newborn postnatal care in the first 24 hours after birth, counseling on early initiation of breastfeeding, counseling on immediate postpartum family planning, immediate postpartum family planning uptake, skin-to-skin care at birth, cord care, application of eye ointment, weighing the neonate at birth, and vaccinations for the baby (1,7,31)

Globally, poor-quality care accounts for 50% of maternal deaths and 61% of neonatal deaths (32). The immediate postpartum period accounts for the majority of maternal and neonatal morbidity and mortality. Studies have revealed that 40–45% of maternal and neonatal mortalities occur during the first 24 hours postpartum in South Asia and sub-Saharan Africa (33). A study conducted in Ethiopia revealed that 65.1% of maternal deaths (34) and 52.4% of neonatal deaths occurred within the first two days of birth (35). Obstetric hemorrhage, hypertensive disorders of pregnancy, and perinatal asphyxia account for more than three-quarters of maternal and neonatal deaths (38, 39).

A study conducted in Nepal revealed that among women and their newborns, 23% of them received quality postnatal care (37). Another study conducted in India reported that 30% and 35.1% of women and their newborns, respectively, received quality PNC (38). Analysis of Demographic and Health Survey in 33 countries in the SSA revealed that the percentage of women who received a predischarge check ranged from 26.6% to 71.7%, with substantial variation between countries (25). Another study conducted in health facilities of Ethiopia reported that 10.7% of mothers and newborns received quality IPPC (39).

A study conducted in Ethiopia revealed that the proportion of women whose newborns received a postnatal check within two days after birth, was 13.2% and 9% of them received quality IPPC (27). Another study conducted in northern Ethiopia revealed that 67.6% of mothers and newborns received good quality care during the immediate postpartum period, and 76.8% of women and their newborns received quality IPPC in a study conducted in Gondar (40,41).

2.2. Factors associated with the Quality of IPPC

2.2.1. Individual-level factors associated with the quality of IPPC

A study conducted among 21 SSAs revealed that maternal age greater than or equal to 35 years was positively associated with the quality of IPPC service (42). Consistent with this finding, the greater the maternal age is, the more positively associated it is with the quality of IPPC (25).Studies conducted in SSA, including Ethiopia maternal secondary education and higher education, are positively associated with the uptake of quality IPPC (7,42,43).

The pooled analysis of 23 SSAs on key factors in the quality of IPPC(7),studies conducted in Ethiopia (29), and Demographic and Health Survey reports of eighteen SSA countries revealed that attending four or more ANC was positive predictor of quality IPPC(44), institutional delivery, and delivery by skilled birth attendants were positive predictors of the quality of IPPC(7). A study conducted in Pakistan on the trends and determinants of maternal and newborn postnatal care utilization showed that parity and paternal education are predictors of PNC utilization (45).

A study conducted in Uganda revealed that having a high wealth index was positively associated with the uptake of quality IPPC (46).consistent with this study, another study conducted in Ethiopia revealed that the quality of IPPC was disproportionately concentrated among the rich (27,28).

A Study conducted among 33 SSA revealed that quality of care was good when the provider's qualification was nurse/midwifery compared to other professions (25), and women who give birth via a caesarian section were associated with a higher quality of childbirth.(43–45).

2.2.2 Community and facility-level factors associated with the quality of IPPC

A study conducted in Uganda revealed that being from an urban area was positively associated with the uptake of quality IPPC (46). In line with this study, a study conducted in Ethiopia revealed that the quality of IPPC was positively associated with urban residences with spatial variation across regions

(27,28,47).An Ethiopian demographic health survey revealed that rural mothers and mothers who live in administrative regions were more likely than Addis Ababa were to not receive postnatal checkups (23).

A cross-sectional study conducted in Uganda on immediate postpartum care (43) and another study conducted in Nepal and Ethiopia on immediate postpartum care revealed that exposure to mass media was positively associated with the quality of immediate postpartum care (23,37).

A study conducted on the quality of maternal care and its determinants from Kenya's Service Provision Assessment data (48) and across sectional study conducted on determinants of the quality of childbirth care along the continuum in limited resource settings revealed that private hospitals are associated with higher rates of immediate postpartum care (49).

An institution-based study conducted in India (50), and another study conducted in northern Ethiopia on the quality of maternity care (51) reported that the delivery load per month was negatively associated with the quality of care during delivery and immediate postpartum. Studies have also shown that the presence of maternal and neonatal clinical guidelines are a positive predictor of the quality of IPPC (7,26,48,52).

2.3. Overview of spatial analysis in public health

The term spatial analysis describes methods for studying the location, distribution, and relationships of spatial phenomena(53,54). Any data or information gathered, including geographic location, is known as spatial data and can be analyzed via spatial analysis(55). Spatial analysis is based on the idea that everything relates to each other: Everything is related to everything else, but near things are more connected than distant things (56).

A pioneer example, where the space category was intuitively incorporated to the analyses performed, took place in the 19th century and was carried out by John Snow. In 1854, one of many cholera epidemics took place in London. The outbreak was centered on the Broad Street area in Soho and was linked to a contaminated public water pump. This was one of the first examples of spatial analysis in which the spatial relationship of the data significantly contributed to advancements in the comprehension of a phenomenon(57).

In areas, where there are spatial inequalities in the utilization or delivery of health services, interventions should be aimed at addressing vulnerability by allocating scarce resources to the most affected areas. To

identify the geographical locations that are most affected, it is important to incorporate spatial analysis into public health research via the application of geographical information systems. This approach has the potential to improve the efficiency of public health interventions by identifying people at the highest risk of disease, or by analyzing the distribution of inputs, such as health facilities and resources, and the intervention of public health products or results (54,57).

In summary, spatial analysis has become an essential tool in public health, enabling researchers and policy makers to understand the geographic distribution of health phenomena, assess determinants, and make data-driven decisions to improve population health outcomes (58).

2.3.1. Spatial variation of in IPPC quality

The quality of PNC utilization varies globally, with significant room for improvement in many countries, particularly low- and middle-income nations. About 63% of mothers and 48% of newborns worldwide utilize PNC within the recommended time frame, and fewer than 25% of newborns in less developed countries receive PNC within 2 days of delivery (59).

The study conducted in Ethiopia revealed a total of three statistically significant cluster areas with low PNC usage. The most likely primary SaTScan cluster of areas with low PNC was detected in southeast Ethiopia, and a secondary cluster was detected in east Ethiopia. The third most likely SaTScan cluster was detected in the northern part of Ethiopia (60). PNC coverage in Ethiopia is limited, with significant regional variations ranging from 0.1% in Afar to 74% in Addis Ababa(15). The proportion of early newborn care among newborns in Ethiopia was 39.6%, ranging from 18% in Somalia to 90% in the Addis Ababa region (9).

Conceptual framework

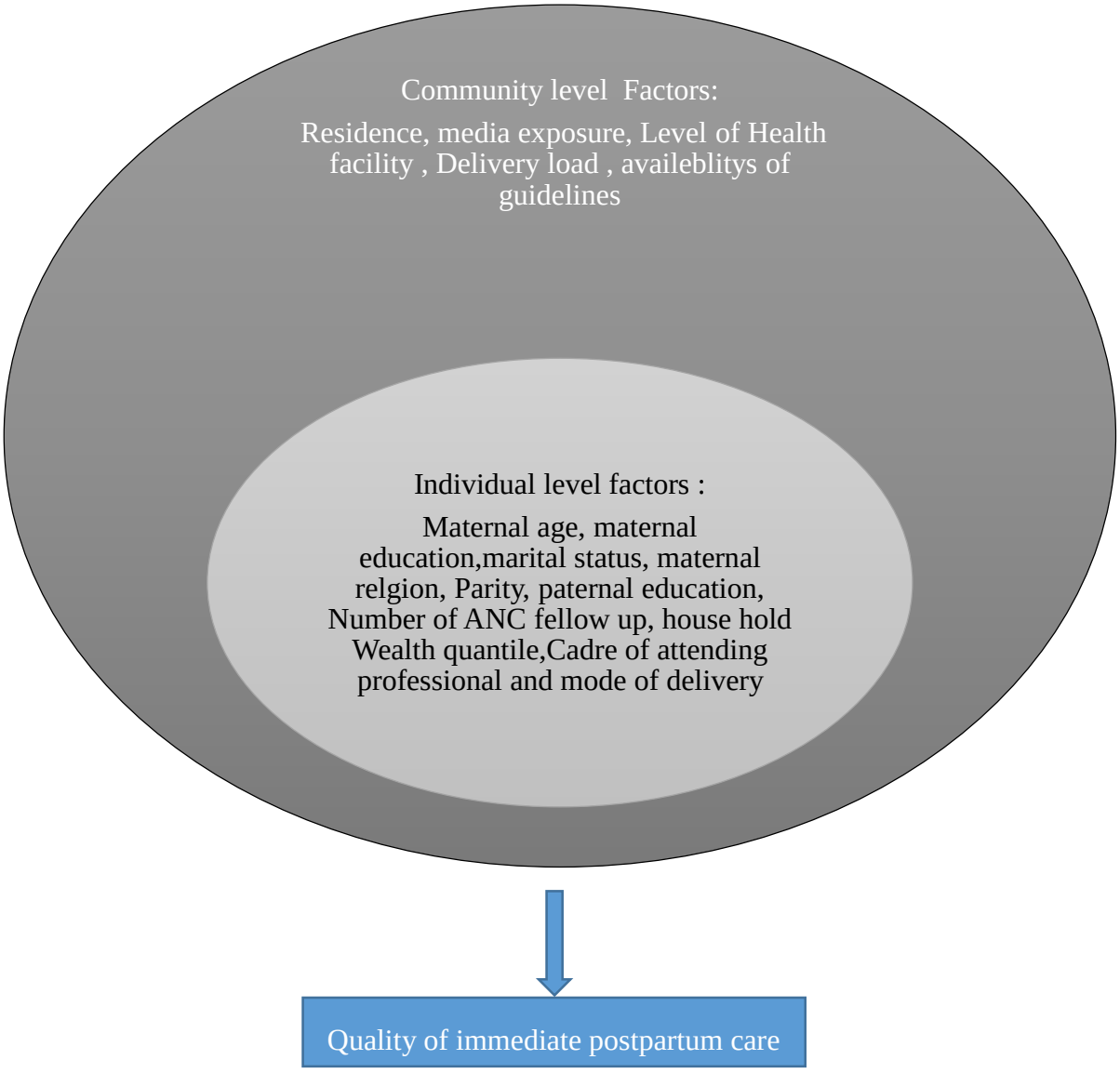


Figure 1: Conceptual framework of a study on the quality and spatial distribution of immediate postpartum care in Ethiopia: a multilevel analysis using performance monitoring for action Ethiopia data from 2021 to 2023(adapted). (27, 41, 46–48).

3. OBJECTIVES

3.1. General objective

To assess quality and spatial distribution of immediate postpartum care in Ethiopia: a multilevel analysis using Performance Monitoring for Action Ethiopia 2023 data.

3.2. Specific objective

To determine the magnitude of quality of immediate postpartum care in Ethiopia.

To identify Individual and community level factors associated with the quality of immediate postpartum care in Ethiopia.

To analyze the spatial distribution of the quality of immediate postpartum care in Ethiopia.

4. METHODS AND MATERIALS

4.1. Study area and period

This study used data from Performance Monitoring for Action Ethiopia (PMA ET) which was accessed at WWW.pmadata.org, a cohort study conducted from November 2021 to October 2023. Cohort two data were collected in three large, predominantly agrarian regions and one city. Oromia, Amhara, and the Southern Nations, Nationalities, and Peoples' Region (SNNPR) and Addis Ababa (61).Data extraction and management were conducted from September 1 to September 15,2024.

Ethiopia is located in the eastern part of Africa and is commonly known as the Horn of Africa. It is bordered by Sudan in the west, Somalia and Djibouti in the east, Eritrea in the north, and Kenya in the south. The capital of Ethiopia is Addis Ababa. The country covers 1,112,000 square kilometers (62). With a population of approximately 129,719,719 million, women of reproductive age constitute 32,599,088, and the annual population growth rate is about 2.5 percent. Approximately 80% of the population lives in rural areas (63).

Ethiopia is now home to twelve regional states (including Tigray, Afar, Somalia, Amhara, Oromia, SNNP, Central Ethiopia Regional State, BenishangulGumuz, Gambella, Sidama, South West Region, and Harari) and two administrative cities (Addis Ababa and Dire Dawa) (64).

The current Ethiopian health sector has a three-tier healthcare delivery system: level one is a woreda/district health system composed of a primary hospital, health centers, and their satellite health posts connected to each other via a referral system. Level 2 is a general hospital, and Level 3 is a specialized hospital (65).

4.2. Study design

This study was based on an analysis of the 2021–2023 PMA Ethiopia longitudinal survey, which was a community-based prospective cohort study in three regions and one city administration (61).

4.3. Population

4.3.1 Source population

All postpartum women were aged 15–49 years and resided within the region of the Panel survey.

4.3.2. Study population

All 0-9 week postpartum women aged 15–49 years living in the selected households, in the selected enumeration areas (EA) during the survey.

4.3.3. Study unit

Selected postpartum women who are between 0 and 9 weeks postpartum.

4.4. Eligibility criteria

4.4.1. Inclusion criteria

Women who were aged 15 - 49 years, and those who reported having given birth in the past 0 - 9 weeks were eligible for the survey.

4.4.2. Exclusion criteria

Women who had abortion and miscarriage during the fellow up considered noneligible.

4.4. Sample size and sampling procedure

This study used data from baseline and six week fellow-up interviews PMA-ET 2023. A total of 153 EAs, located within Panel regions were included in this study. Concurrently for each EA, all public SDPs that served the EA and up to 3 private facilities were included, and a total of 504 SDPs completed the interview and 264 SDPs that provide labor and delivery were included in this study. A total of 1926 women completed the 6 week follow up panel survey and 1351 were included in the analytical sample.

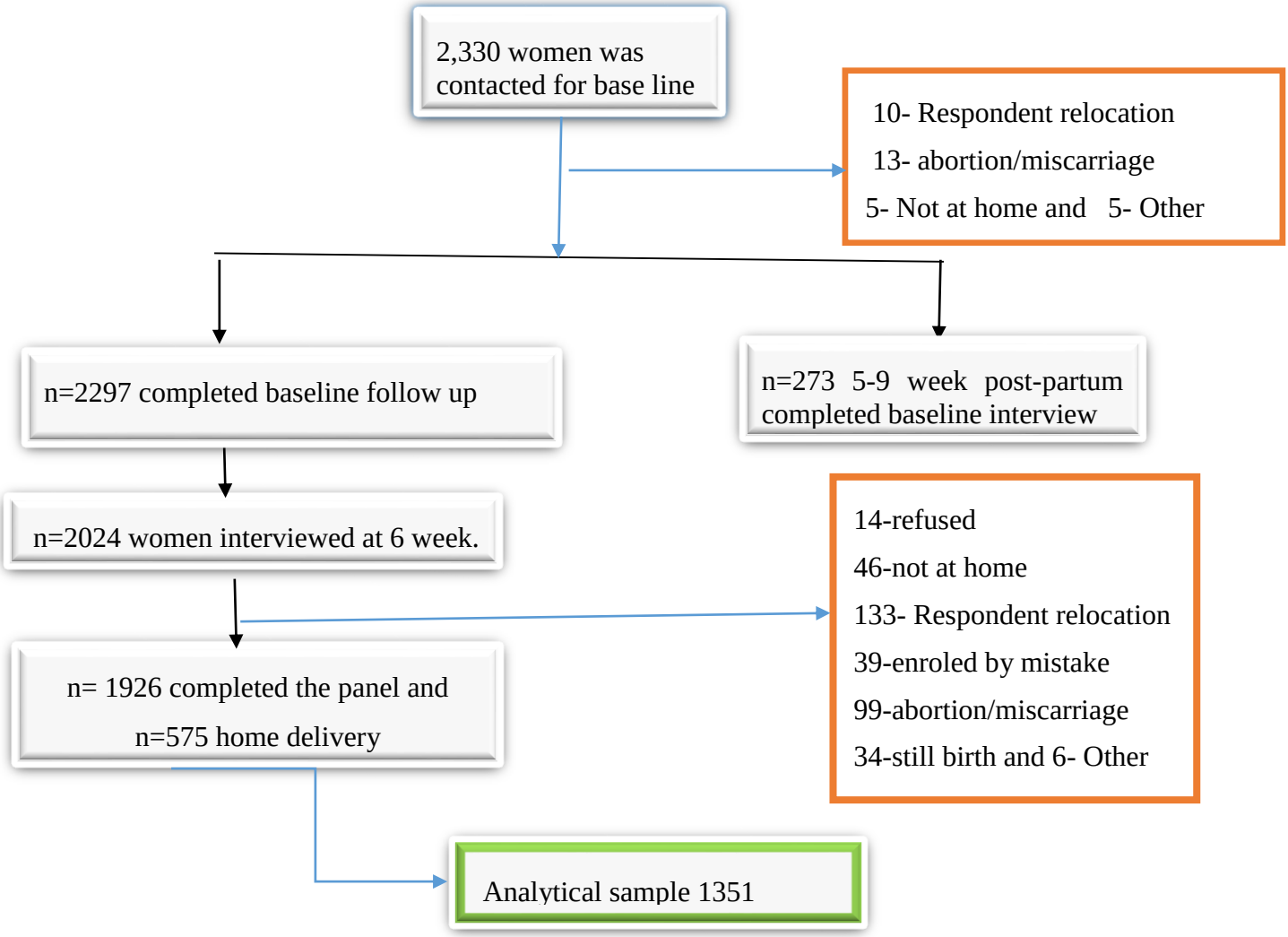


Figure 2: Schematic presentation of women in the analysis of quality and spatial distribution of the immediate postpartum care in Ethiopia, 2024.

4.5. Data source and data collection procedure (data extraction and management)

The PMA ET survey is a national representative survey that is being implemented in collaboration with Addis Ababa University, the Ethiopia Federal Ministry of Health, and the Johns Hopkins Bloomberg School of Public Health. The PMA Ethiopia generates timely cross-sectional and longitudinal data on reproductive, maternal, and newborn health indicators to inform national and regional government priorities and policies. A panel of all women who were pregnant and 0 to 9 weeks postpartum at the time of enrollment in the survey were followed up at 6 weeks, 6 months, and 1 year postpartum through separate surveys (61).

The female and household questionnaire was developed based on the 2016 PMA-MNH survey served as a base for the panel survey, with previous PMA2020, global PMA surveys, and Demographic and Health surveys. The SDP questionnaire was based on previous SDP surveys within PMA2020, the DHS Service Provision Assessment , and the WHO Service Availability and Readiness Assessment survey tools (66).

PMA used structured and pretested electronic-based questionnaires to collect data aided by an online, Open Data collection Kit (ODK) application tool by the resident enumerators. For the six-week postpartum interview, enumerators administered a survey that collected information on key MNH and delivery services, including receipt, timing and specific components of ANC, delivery-related information and receipt of immediate postpartum services for both mother and child. Information on women's socio demographic characteristics including age, education, region, parity, residence, marital status, and household wealth and birth histories was matched from the baseline interview.

The SDP survey is a combination of a census of governmental health facilities that serve the selected EA, specifically health post, health centers and primary hospitals, and a sample of up to three private health facilities within the Kebele boundary. Therefore, the SDP sample is representative of the service environment accessible to the female sample(66).

4.6. Operational definitions and measurements

4.6.1. Operational definitions

Immediate postpartum-first 24 hour after birth (1).

Community media exposure: proportion of women with at least one type of media exposure. It was categorized in to exposed (if the proportion was ≥50%)) and non-exposed (if the proportion was <50%)

Quality of care – the extent to which health care services provided to individuals and populations improve desired health outcomes (3).

Individual level factors: A variable operating at the lowest level or individual level that includes parents and household characteristics.

Community level factors: Are characteristics of the community and the facility in which the mother resides.

4.6.2. Measurements

The quality of IPPC was evaluated via 16 indicators with 2 response options (no and yes) coded as 0 and 1 respectively. Therefore, the total score of care provided to the delivering mother and newborn ranges from 0 to 16, and a higher score indicates a good quality of childbirth care. These 16 indicators include the following: 1. SBA provided maternal IPPC, 2. maternal check with in the first 24 hours, 3. administering uterotonic drug, 4. receiving immediate postpartum family planning counseling 5. Immediate postpartum family planning, 6. Respect full treatment, 7. SBA provided newborn IPPC 8. Newborn IPPC was received in the first 24 hour, 9. Drying the baby with a towel immediately after birth, 10.initiated skin-to-skin contact, 11.Baby weighing at birth 12. Application of chlorhexidine to the cord, 13. Application of eye ointment after delivery 14. Ever received a BCG vaccination and 15.ever received oral polio vaccination immediately after birth 16. Assisted the mother to initiate breastfeeding with in 1 hour.

4.7. Study variables

4.7.1. Dependent variable

The dependent variable was the quality of immediate postpartum care. Dichotomized in to good and poor, the quality of IPPC was classified, as good if the score was ≥75%, and poor if the score is less than 75% (22,51).

4.7.2. Independent variables

Individual level variable: are maternal, paternal, and household factors that affect the quality of immediate postpartum care such as: maternal age, maternal religion, marital status, maternal education, parity (the woman's number of live births), paternal education, number of ANC fellow-up, mode of delivery, cadre attending professional and household wealth quintile. The PMA 2021 to 2023 survey wealth index was calculated by weighing and attributing scores constructed from a principal components analysis of household assets and construction characteristics and then divided into five classes of wealth: lowest, lower, middle, higher and highest.)

Community level variables: those are variables that affect quality of IPPC those are: Residence, community media exposure, Level of health facility, Delivery load, and availability of guideline.

4.8. Data processing and analysis

4.8.1. Descriptive statistics

Variables from the dataset were selected, recategorized, recoded, and analyzed via STATA version 17. Descriptive statistics was presented in mean and standard deviation for numerical variables and frequency, percentages for categorical variables. Finally, the result was presented and summarized in texts, numbers, tables, and figures.

4.8.2. Multilevel modeling

When the nature of data is hierarchical the use of traditional regression methods is inappropriate because the assumption of independence of observations that underlies ordinary regression models does not hold. The reason why this assumption is violated is the influence of context (67).

To overcome the above- stated assumption faced when dealing with hierarchically structured data such as the PMA Ethiopia in which individuals are nested in households, households are nested in the community using multilevel modeling is more appropriate. This type of modeling enables us to precisely estimate the standard errors without the need to stick to the assumption of independence of observations (67). Therefore, this study employed multilevel binary logistic regression analysis that takes into account the hierarchical nature of the PMA Ethiopia data and the binary response of the quality of IPPC outcome variable.

Bi-variable multilevel logistic regression analysis (MLRA)

Multilevel binary logistic regression analyses were conducted to select potential candidate variables for multivariable analysis. At this stage, the presence of an association between the outcome variable and each explanatory variable was investigated without controlling for the effects of the other explanatory variables. Those explanatory variables with p-values ≤ 0.25 in this model was entered in to the multivariable MLRA for adjustment. Measures of association of the individual and community level factors with Quality of IPPC was reported using the crude odds ratio (COR) with their respective 95% confidence interval (47).

Multivariable multilevel logistic regression analysis (MLRA)

This model was constructed by entering all variables with a p-value ≤ 0.25 in the bi-variable MLRA. Statistical significant variables at p-value of < 0.05 with their Adjusted Odds Ratio (AOR) and a 95% confidence interval (CI) in the multivariable model were used to declare statistically significant determinants of quality of IPPC.

4.8.2.1. Model Building

In this multilevel analysis, it has set up of two level models. The level one individual variables and the second level is the community level and four models were developed to examine the relationships between the outcome variable and the predictor variables.

Model I: The Empty Logistic Regression Model: The empty Logistic Regression Model (`intercept only' model or "null model") only contains random groups and random variation within groups. This model primarily provides us the variation in the outcome variable explained by the context or cluster and a measure of the degree of fitness of the model. According to our study the overall variation explained across the clusters (ICC) is 39.8%. Thus, for the logit link function, the logarithmic odds have a normal distribution in the population of groups, which is expressed by (68).

$$\text{Logit}(Y_{ij}) = \beta_0 + u_{0j} \text{----------Equation -1}$$

Where: Y_{ij} is the outcome variable probability of quality of IPPC, β_0 is the overall regression intercept when all predictors are adjusted to zero and $u0j$ represents the residuals at the group level.

Model II: Model with individual level factors only: In this model, we include individual-level characteristics. The model containing the individual-level variables was used to determine whether the variation across communities could be explained by the characteristics of the individuals residing within that community or not. This model expressed as:

$$\text{Logit}(Y_{ij}) = \beta_0 + \beta_1 X_{1ij} \cdots + \beta_n X_{nij} + u_{0j} \text{----------equation 2}$$

Where: β_0 is the fixed intercept, β_1 is the regression coefficient (fixed slope) for the explanatory variable, X_{1ij} is the explanatory variable at population and u_0j is the residuals at the group level.

Model III: Model with community level factors: In this model, the contribution of each community-level factor to the quality of IPPC was explored. To explore the relative contribution of the Community level variables in explaining the quality of IPPC. It is modeled as.

$$\text{Logit}(Y_{ij}) = \beta_0 + \beta_1 X_{1ij} \cdots + \beta_n X_{nij} + u_{1j} Z_{ij} \text{----------Equation 3}$$

Where: β_0 is the fixed intercept, β_1 is the fixed slope (slope coefficients), Z_{ij} is the number of factors at community level and u_{1j} is the random slope error term

Model IV: the final model (full model): This model includes explanatory variables at both the individual and the community level simultaneously. And modeled as:

$$\text{Logit}(Y_{ij}) = \beta_0 + \beta_1 X_{1ij} + \ldots + \beta_n X_{nij} + u1Z_{1ij} + uoj \text{ ---------- Equation 4}$$

Where: Y_{ij} is the probability of quality of IPPC β_0 is the log odd of the intercept ,β1, are the regression coefficient estimate of the data , X1ij,...Xnij are the independent variables defined at the population level ,Z1ij,...Znj are the independent variables defined at the community level,u1j is the random slop at community level, uoj are random intercept at the individual level.

4.8.3. Parameter estimation

The maximum likelihood estimation method was used to estimate the parameters. The maximum likelihood method is a general estimation procedure, that produces estimates for the population parameters that maximize the probability (maximum likelihood) of observing the data that are actually observed. It is generally robust and produces efficient and consistent estimates in relative to other methods. the random-effects (measures of variation) was reported as ICC, median odds ratio (MOR) and proportional change in variance (PCV) to measure the variation between clusters (69).

Intraclass correlation coefficient (ICC)

The ICC were used to measure the extent to which individuals within the same group are more similar to each other than to individuals from different groups.

The ICC was calculated as the proportion of the between- community variation in the total variation:

$$\text{ICC}= \frac{\sigma^2 u0}{\sigma^2 u0+\pi^2/3}$$

Where: $\sigma^2 u0$=variance of the level-2 residuals; $\pi^2/3$= 3.29

Proportional change in variance (PCV): expresses the change in variance between the null model (Model I) and the consecutive models. To explore the relative contribution of each model in explaining the quality of IPPC, PCV was calculated in reference to the null model as $\boldsymbol{PCV = \frac{V0-Vi}{V0}}$ Moreover, in this study, about 42.5% of the variation in quality of IPPC was explained by the final model(68).

Median odds ratio (MOR) is defined as the median value of the odds ratio of the receipt quality of IPPC between the area at the highest risk and the area at the lowest risk when two clusters (EAs) are randomly selected. The MOR in this study was calculated as MOR =exp($0.954\sqrt{\delta^2 uo}$), where, $\delta^2 uo$ indicates cluster variance. In our study, the MOR between the higher and lower areas when randomly picking out two clusters of quality of IPPC among clusters was 4.03 and 2.9 in the first and final model respectively.

4.8.4. Model diagnosis

Multicollinearity

The presence of multicollinearity among independent variables was checked via the Variance Inflation Factor (VIF) and there was no multicollinearity at cut-off point of 5 (70).

Goodness of Fit Test

The Akaike information criterion (AIC) was used to compare and select the model that best fit the data. The AIC is a popular measure for comparing maximum likelihood models. AIC can be viewed as measures that combine fit and complexity. The larger the value is, the worse the fit. Given that two models fit the same data, a model with a smaller value of the information criterion is considered to be better (71). Therefore, the model with the lowest AIC (Model 4,1374) was considered the best-fit model and all interpretations and conclusions of the results were based on Model four.

Likelihood Ratio Tests (LRT): We also used the LRT a statistical test used to compare the fit of two models (simpler model Vs. a more complex model). A significant p-value of LRT in our models suggested that the more complex model provided a significantly better fit to the data than did the simpler model. Based on our finding the likelihood ratio test statistic (LR chi2 (17) = 115.24) was highly significant ($p < 0.001$), suggesting that model four provides a significantly better fit to the data. All analyses were conducted by applying sample weighting to account for probability sampling and non-response to restore representativeness.

4.8.5. Spatial analysis

The SaTScan V.10.2.5 and ArcGIS V.10.8 geostatistical software were used to explore the spatial distribution of the quality of IPPC in Ethiopia. The global spatial autocorrelation was assessed via the Global Moran's I statistic (Moran's I) to evaluate whether the pattern was clustered, dispersed, or random across the regions. Moran's I value ranges from −1 to +1, with values close to −1 indicating that the outcome is dispersed, whereas Moran's I close to +1 indicates a clustered pattern; this implies strong positive spatial autocorrelation. A statistically significant Moran's I ($p < 0.05$) leads to the rejection of the null hypothesis (the quality of IPPC is randomly distributed) (75,76).

In the presence of positive global spatial autocorrelation, we employed a purely spatial scan statistic using a Bernoulli probability model to detect local clusters with a low or high rate of quality of IPPC. The SaTScan V.10.2.5 software was used for local cluster detection analysis. It uses a circular window that moves systematically throughout the study area to identify a significant SaTScan clustering of women and

their newborns who received quality IPPC. The maximum spatial cluster size of <25% of the population was used as an upper limit, which allowed for the detection of both small and large clusters and ignored clusters that contained more than the maximum limit. For each potential cluster, a log-likelihood ratio test statistic was used to determine if the number of observed cases within the potential cluster was significantly higher than expected or not (77).

The circle with the maximum likelihood ratio test statistic was defined as the most likely (primary) cluster, then compared with the overall distribution of maximum values. The primary and secondary clusters were identified and assigned p-values and ranked on the basis of their likelihood ratio test on the basis of the 999 Monte Carlo replications.

Ordinary kriging-type spatial interpolation techniques were used to predict the quality of IPPC among postpartum women and their newborns in Ethiopia for unsampled areas based on sampled clusters. Getis-Ord Gi* statistics were computed to measure how spatial autocorrelation varies over the study location by calculating the GI* statistic for each area. Z-scores were computed to determine the statistical significance of clustering, and the p-values were computed for the significance. Positive Z-score (> 1.96, P-value < 0.05) indicates clustering/hot spots areas; a negative Z-score (<− -1.96, P-value < 0.05) was considered a cold spot area (76).

4.9. Data quality control

To maintain the quality of the data, the PMA performs different activities, such as translating the questionnaire to the local language, pretesting the draft panel and SDP questionnaires and training session was given field supervisors and regional coordinators who then served as master trainers at the resident enumerator trainings (66).

Data related to the quality of IPPC were selected and extracted from the dataset from the panel PMA 2021 to 2023 and the SDP. After extraction, all necessary information regarding the various potential individual and community-level independent variables was retrieved. Further data cleaning, labeling, coding, recoding, and checking for missing values were performed for all selected variables. Based on the nature of the variables and the review of previous similar studies, categorization for the variables was done accordingly.

4.10. Ethical clearance/consideration

Ethical approval was obtained from the Institutional Review Board of the Mekelle University College of Health Sciences with ethical number MU-IRB 2322/2024. An authorization letter for the use of the PMA dataset was obtained from the PMA Ethiopia data lab after registration and acceptance of the consent and permission to use the data. This study utilized only the accessed data.

PMA Ethiopia received ethical approval from Addis Ababa University, College of Health Sciences (AAU/CHS) (Ref: AAUMF 01-008) and the Johns Hopkins University Bloomberg School of Public Health (JHSPH) Institutional Review Board (FWA00000287). The survey follows national and international ethical procedures and protocols for the collection of human data. The objectives of the survey were explained to the participants. The anonymity and confidentiality of the results of the participants were ensured. Participation in the data collection process was voluntary, and the information that led to the identification of individuals was deleted.

4.11. Plan for dissemination of results

After the completion of the study, the final results of this study will be presented to examiners, and the comments received will be corrected accordingly and submitted to the School of Public Health, College Health Sciences, Mekelle University. The final corrected final report of the findings of the study will be disseminated to the community research of Mekelle University, the ministry of health, and other relevant stakeholders. The result will be disseminated through workshops, seminars, and published in international and high impact journals.

5. RESULTS

5.1 Sociodemographic characteristics of mothers

A total of 1351 postpartum women and their newborns who completed the baseline and six-week follow-ups were included in this study. Nearly half of the mothers, 665 (49.22%), were within the age group of 15–24 years and ranged from 15 to 47years, with a mean or standard deviation of 26.9 (±5.89) years. Among the total respondents, 511 (37.82%) were Orthodox Christian followers, 1276(94.44%) were married, 275 (20.35%) had no formal education, and 103 (7.62%) had attended higher education; 426(31.54%) were from a household in the highest quintile, and 847 (62.7%), of the mothers lived in a rural setting. Further details of the respondent's characteristics according to different socio-demographic factors are presented in (Table 1).

Table 1: Sociodemographic characteristics of postpartum mothers and newborns in Ethiopia, 2024 (n=1351).

Variables	Unweighted (n=1351)	Percent (unweighted)	Frequency Weighted (n=1351	Percent (weighted)
Age in years				
15 – 24	618	45.74	665	49.22
25 -35	614	45.45	568	42.04
36-47	119	8.81	118	8.74
Religion				
Orthodox	594	43.97	511	37.82
Protestant	373	27.61	365	27.02
Muslim	375	27.76	460	34.05
Other	9	0.67	15	1.11
Marital status				
Married	1252	92.67	1276	94.44
Living with a man	62	4.59	41	3.03
Divorced	18	1.33	17	1.26
Widow	19	1.41	17	1.26
Child Sex0				
Male	696	51.52	693	51.29
Female	655	48.48	658	48.71
Maternal educational status				
Never attended	232	17.17	275	20.35
Primary	599	44.34	636	47.10

Variables (Continued)	Unweighted (n=1351)	Percent (unweighted)	Frequency Weighted (n=1351	Percent (weighted
Secondary	290	21.47	272	20.13
Technical & vocational	81	6	65	4.80
Higher	149	11.03	103	7.62
Paternal educational status				
Never attended	215	15.91	280	20.73
Primary	477	35.31	512	37.90
Secondary	335	24.8	291	21.54
Technical & vocational	67	4.96	61	4.51
Higher	231	17.1	181	13.4
Unrecorded	26	1.92	26	1.92
Media exposure				
Non-exposed	651	48.19	601	44.00
Exposed	700	51.81	750	56.00
Household wealth quintile				
Lowest quintile	105	7.77	137	10.14
Lower quintile	140	10.36	187	13.84
Middle quintile	176	13.03	243	17.98
Higher quintile	309	22.87	358	26.50
Highest quintile	621	45.97	426	31.54
Residence				
Urban	758	56.11	504	37.30
Rural	593	43.89	847	62.70
Region				
Amhara	307	22.72	327	24.20
Oromia	433	32.05	648	47.96
SNNP	344	25.46	274	20.30
Addis Ababa	267	19.76	102	7.54
Other in religion refers to wakefeta and catholic				

5.2 Reproductive history of mothers

One thousand one hundred twenty-three 1123(83.13%) mothers had antenatal care (ANC) visits for their current pregnancy, with 595 (44.05%) having four or more ANC visits. From the total respondents, 1183(61.43%), of mothers gave birth at a health facility among those who gave birth at a health facility. 117 (8.67%) give birth via caesarian section, and more than one third, 634 (46.92%), mothers were primipara (Table 2).

Table 2: Reproductive history of mothers in Ethiopia, 2024 (N=1351).

Variables	Unweighted (n)	Percent (unweighted)	Frequency Weighted (n)	Percent (weighted)
Parity				
Primipara	674	49.89	634	46.92
Multipara	500	37.01	507	37.52
Grand multipara	125	9.25	147	10.9
Unrecorded	52	3.85	63	4.66
Antenatal attendance				
No	251	18.58	228	16.87
Yes	1100	81.42	1123	83.13
Number of ANC visits				
Never attend	251	18.58	228	16.87
1 -3	427	31.61	528	39.08
>= 4	673	49.81	595	44.05
Delivery place				
Home delivery	575	29.85	743	38.57
Institutional delivery	1351	70.15	1183	61.43
Mode of delivery				
Vaginal delivery	1,178	87.19	1234	91.33
caesarian delivery	173	12.81	117	8.67
IPPC provider(n=1351)				
Doctor	390	28.87	303	22.42
Health officer	171	12.66	198	14.7
Nurse/Midwife	769	56.92	836	61.88
Other	21	1.55	14	1.00
Other for IPPC provider refers to skilled provider but the mother cannot distinguish				

5.3. Health facility characteristics (facility-level, linked characteristics)

During the PMA-Ethiopia panel (2021-23) survey implementation, data from 548 service delivery points were collected. Among those SDPs, 504 health facilities completed the survey. Among those, 351 (69.64%) were public, and 153 (30.36%) were private facilities. Among the sampled SDPs, 375 (74.4%), 264 (52.38%), and 366 (72.62%) provided antenatal care, labor and delivery, and postnatal care services, respectively (Table 3).

Table 3: Facility (SDP) characteristics in Ethiopia, 2024 (N=504).

Variable	Frequency	Percent
Managing authority		
Government	351	69.64
Private	153	30.36
Facility type		
Hospital	110	21.83
Health center	148	29.37
Health post	98	19.44
Private hospital/ health clinic	86	17.06
Drug Shop/Rural Drug Vendor	62	12.30
Provide antenatal care		
No	67	13.29
Yes	375	74.4
Provide labor and delivery		
No	178	35.32
Yes	264	52.38
Delivery load (n=264)		
<= 548	257	97.35
>= 549	7	2.65
Provide antenatal care		
No	76	15.08
Yes	366	72.62
Availability of guidelines		
No	304	60.31
Yes	138	27.38
Region		
Amhara	143	28.37
Oromia	147	29.17
SNNPR	124	24.60
Addis Ababa	90	17.86

5.4. Quality of immediate postpartum care

This study revealed that out of 1351 mothers who gave birth in a health facility and their newborns, 403 (29.83%) received good quality of IPPC in Ethiopia (Fig 1).

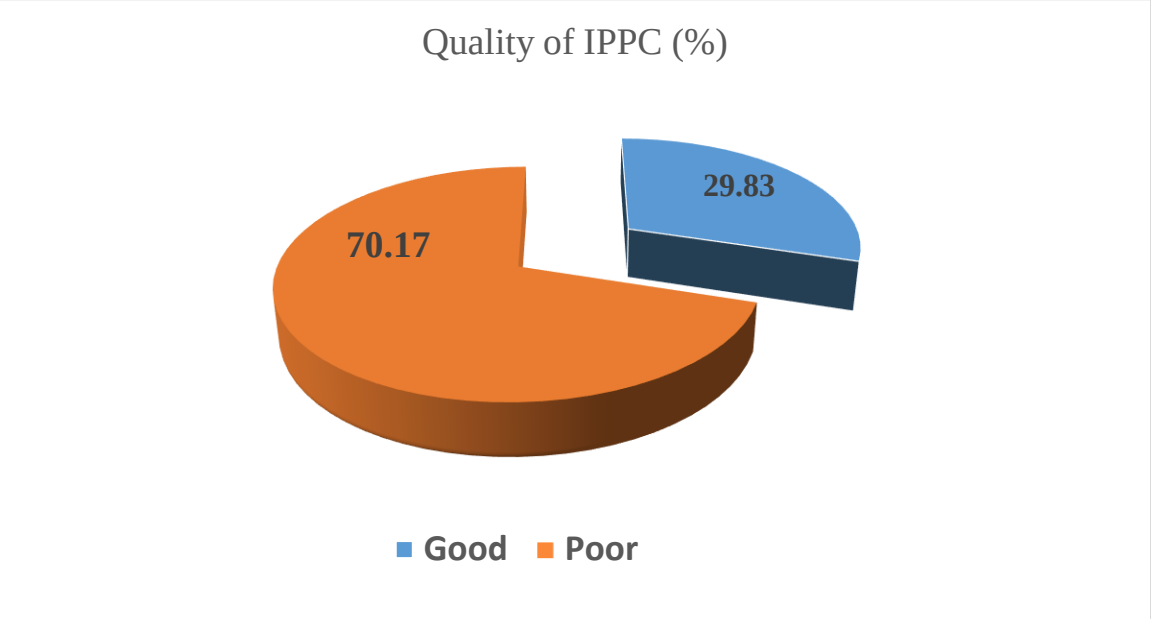


Figure 3 : Quality of immediate postpartum care among postpartum women and their newborns in Ethiopia using PMA Ethiopia, 2024.

5.5. Uptake of quality IPPC among women and their newborns in Ethiopia (n =1351)

The proportion of quality of IPPC among women who gave birth at health facilities and their newborns in Ethiopia ranged from 14.14% in SNNPR to 40.94% in the Addis Ababa region. Based on the recipient of each type of immediate postpartum care, while more than two third of mothers (70.32%) and 54.26% newborns received immediate postpartum check from skilled provider. Further, 1009 (74.69%) mothers received uterotonic drug,77 (5.7%) mothers received immediate postpartum family planning, 1087(80.46%) initiated skin to skin contact immediately after birth and 1162 (86.01%) initiated early breast feeding within one hour (Fig 4).

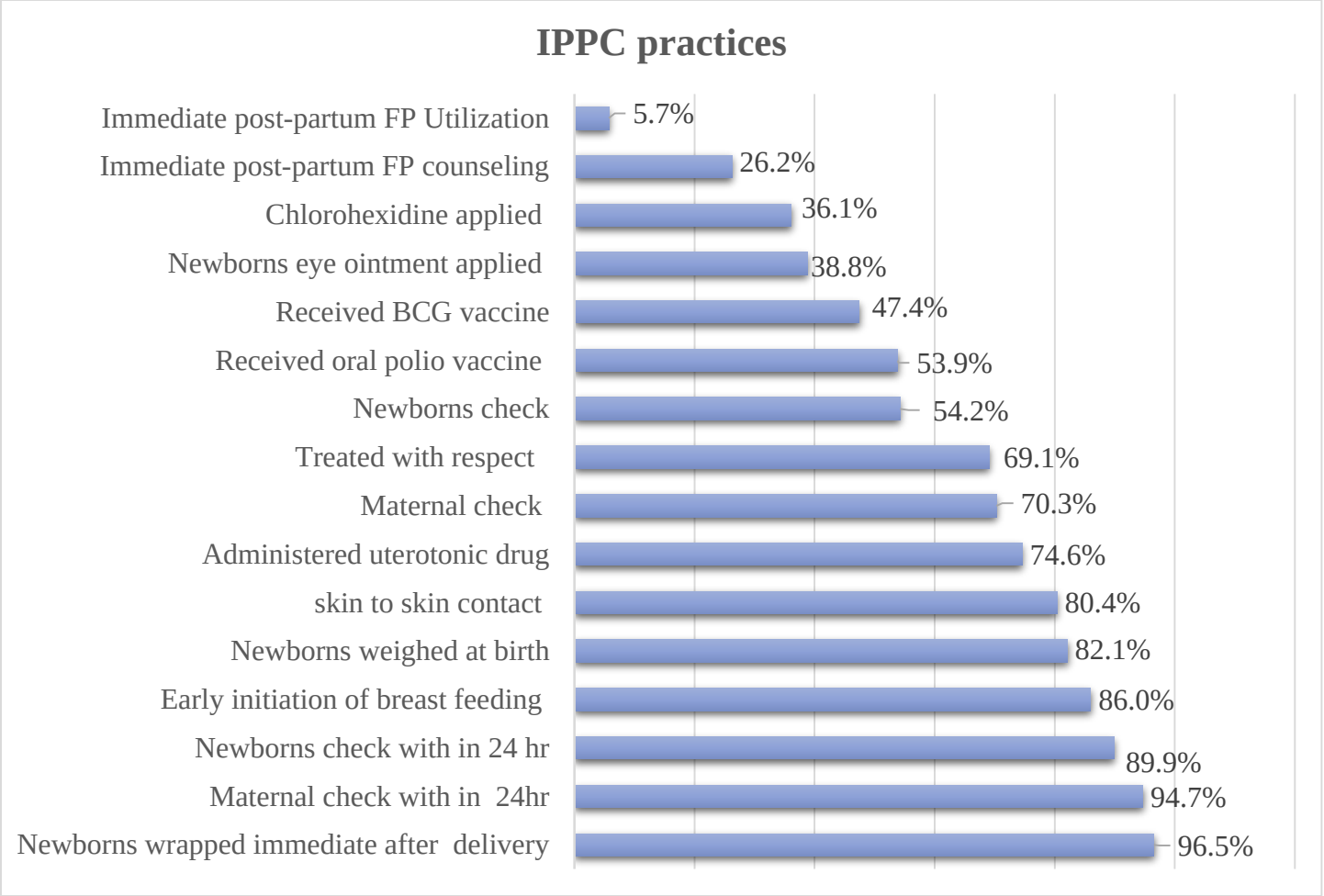


Figure 4: Coverage of quality of IPPC practices among postpartum women and their newborns, using PMA Ethiopia, 2024.

5.6. Results of Bivariable multi-level logistic regression analysis

The effect of each independent variable on the quality of IPPC uptake was examined via bi-variable multi-level logistic regression analysis. Accordingly, a woman's religion, parity, educational status, number of ANC visits, mode of delivery, IPPC provider, and household wealth quantile from the individual level and residence, facility type, and community media exposure from the community level variable became candidates for multivariable multilevel logistic regression analysis.

Table 4: Bivariable multi-level logistic regression analysis of individual and community level variables (n=1351)

Variable	Categories	OR	P-value	95%C.I. Lower-Upper
Individual level variables				
Maternal age	1.15-24(ref)			
	25-35	1.03	0.84	0.76-1.39
	36-47	1.0	0.98	0.58 -1.72
Religion	Orthodox (ref)			
	Protestant	0.83	0.39	0.54 -1.27
	Muslim	0.49	0.003	0.3 -0 .78
	Other	1.6	0.54	0.33-7.92
Marital status	Currently married(ref)			
	Living with a man	1.06	0.85	0.54 2.10
	Divorced	1.44	0.55	0.42-4.93
	Widow	0.88	0.84	0.27 -2.92
Parity	Primipara (1)	1.87	0.05	1.01 -3.51
	Multipara(2-4)	1.78	0.06	0.95 -3.34
	Grand multipara (>=5) (ref)			
Maternal education	Never attended (ref)			
	Primary	1.02	0.89	0.66-1.59
	Secondary	1.34	0.24	0.81-2.22
	Technical & vocational	1.14	0.70	0.57 -2.26
	Higher	2.29	0.005	1.28 -4.11
Paternal education	Never attended(ref)			
	Primary	1.07	0.77	0.66-1.73
	Secondary	1.25	0.39	0.74-2.11
	Technical & vocational	1.11	0.77	0.52-2.38
	Higher	1.37	0.26	0.78-2.41
Total number of ANC	Never attended (ref)			
	1-3	1.23	0.44	0.71-2.15
	>=4	1.91	0.01	1.15-3.17
Mode of delivery	vaginal delivery(ref)			
	caesarian delivery	0.51	0.003	0.32-0.79
IPPC provider	Doctor (ref)			
	Health officer	0.53	0.05	0.27-1.01
	Nurse/Midwife	1.98	0.001	1.39- 2.81
	Other	0.28	0.15	0.05 -1.57
House hold wealth quantile	Lowest quintile(ref)			
	Lower quintile	0.69	0.34	0.32 -1.49
	Middle quintile	0.51	0.09	0.24-1.11
	Higher quintile	0.85	0.67	0.41-1.76
	Highest quintile	2.0	0.04	1.0- 4.24

Variables (continued)	**Categories**	**OR**	**P-value**	**95%C.I. Lower-Upper**
Community level variables				
Residence	Rural (ref)			
	Urban	3.14	0.001	1.78-5.52
Facility type	Government health center (ref)			
	Government health hospital	0.88	0.47	0.62-1.24
	Private hospital/clinic	3.55	0.001	1.77-7.12
Delivery load	Continuous ….	0.98	0.96	0.47-2.01
Availability of guidelines	No (ref)			
	Yes	1.12	0.55	0.75-1.69
Community Media exposure	Non exposed (ref)			
	Exposed	3.67	0.001	2.14-6.28

5.7. Mixed effect multilevel logistic regression model

Random effects

Model I -This baseline model only includes the intercept, which represents the overall variation in the quality of IPPC across all the clusters (EAs). According to the results shown in Table 5, in our model the intraclass correlation coefficient (ICC) was 39.8%. This implies that 39.8% of the variation in the receipt of quality of IPPC was due to cluster (EAs) variation, whereas the remaining 60.2% of the variation was due to differences between individuals within the same cluster.

The MOR between the higher and lower areas when randomly picking out two clusters of quality of IPPC uptake among clusters was 4.03 in the first model.

Model II- this model shows the variation in the quality of IPPC uptake across clusters explained by individual level factors. The ICC decreased to 36.1%. This finding indicates that 36.1% of the variation in the quality of IPPC uptake was due to differences between clusters after accounting for individual level factors. The MOR of quality IPPC uptake among clusters decreased to 3.62 in this model. The Proportional Change in Variance (PCV) was calculated as $\boldsymbol{PCV} = \frac{\boldsymbol{V0-Vi}}{\boldsymbol{V0}}$. Moreover, in this study, about 14.6% of the variation in the quality of IPPC among women was explained by individual level factors.

Model III indicated significant variation in the quality of IPPC use after accounting for community-level factors. Accounting for 30.7% (ICC) of the total variation, the MOR and PCV were 3.13 and 32.9%, respectively.

Model IV (full model): This model shows the variation in the quality of IPPC uptake across clusters explained by individual and community-level factors. According to our final model, 27.5% (ICC) of the variation in the receipt of quality of IPPC was due to cluster variation, with the remaining 72.5% being within-cluster. The MOR between the higher and lower areas when randomly picking out two clusters of early newborn care among clusters was 2.9. Moreover, in this study, about 42.5% (PCV) of the variation in the quality of IPPC uptake was explained by the final model (model IV).

Table 5: Parameters and model fit statistics used for of quality of IPPC uptake among postpartum women and their newborn, using PMA Ethiopia, 2024

	Categories	**Model I**	**Model II**	**Model III**	**Model IV**
Parameters	Cluster level variance (σ2)	2.18	1.86	1.46	1.25
	ICC	39.8%	36.1%	30.7%	27.5%
	MOR	4.03	3.62	3.13	2.9
	PCV	Reference	14.6%	32.9%	42.5%
Model fitness	AIC	1456	1376	1419	1374
	LRT	-	70.13(p=0.001)	44 (p =0.001)	115 (p =0.001)
	Wald	Reference	61.12	44.6	103

Model 1(intercept only model), **Model 2** (individual level factors), **Model 3** (community level factors) and **Model 4** (individual and community level factors)
ICC_ Intra-Cluster Coefficient, **AIC**_ Akakie Information Criterion, **MOR**_ median odds ratio, **PCV** _proportional change in Variance **LRT**_ likelihood ratio test

5.8. Determinants of quality of IPPC uptake among postpartum women and their newborns in Ethiopia (Fixed effects).

On the basis of the chosen model (Model 4), maternal religion, total number of ANC visits, mode of delivery, IPPC provider, residence, facility type and community media exposure were significant determinants of the quality of IPPC uptake.

Among the individual factors, women who were followers of the Muslim religion had 49% less likely to receive quality of IPPC than those orthodox Christian follower women (AOR=0.51; 95% CI 0.31 -0.83). On the other side, women who had four or more ANC visits had 1.78 (AOR=1.78; 95% CI 1.08-2.95) times higher odds of utilizing the quality of IPPC. Moreover, the odds of receiving quality of IPPC among

mothers who delivered through cesarean section were 55% less than those who gave birth vaginally (AOR = 0.45; 95% CI 0.27-0.76). In addition, the odds of receiving quality of IPPC among mothers who had been attended by a nurse/midwife were 1.96 times higher than those of their counterparts who had been attended by a doctor (AOR = 1.96; 95% CI 1.26-3.03) keeping other variables constant(Table 5).

Among the community-level factors, as such, the odds of receiving quality of IPPC among women who resided in urban areas were 1.85 times more likely than who live in rural area (AOR=1.85; 95% CI 1.05-3.25). Similarly, women who gave birth at private hospitals/clinics (AOR=4.12; 2.07-8.51) were 4.12 times more likely to receive quality IPPC than at government health facilities. In addition, women who live in communities with high media exposure were 2.99 times more likely to use the quality of IPPC (AOR = 2.99; 1.76-5.06) keeping other variables constant (Table 5).

Table 6: Multilevel multivariable logistic regression analysis of predictors of quality of IPPC uptake among postpartum women and their newborn, using PMA Ethiopia, 2024

Predictors	**Categories**	**Model I**	**Model II AOR (95% CI)**	**Model III AOR (95% CI)**	**Model IV AOR (95% CI)**
Fixed effect					
Religion	Orthodox (ref)				
	Protestant	_	0.91(0.58-1.43)	_	0.92(0.6 -1.41)
	Muslim	_	0.53(0.32-0.88)*	_	0.51(0.31 - 0.83)***
	Other	_	1.08(0.2-5.6)	_	1.1(0.22-5.4)
Maternal education	Never attended (ref)				
	Primary	_	0.89(0.55-1.45)	_	0.82 (0.52-1.29)
	Secondary	_	1.18(0.67-2.06)	_	1.02(0.6-1.72)
	Technical & vocational	_	0.93(0.44-1.95)	_	0.87(0.43-1.77)
	Higher	_	2.15(1.14-4.05)*	_	1.41(0.75-2.63)
Total number of ANC	Never attended (ref)				
	1-3	_	1.21(0.68 -2.14)	_	1.37(0.79-2.38)
	>=4	_	1.74 (1.03-2.94)*	_	1.78(1.08-2.95)*
Parity	Primipara (1)	_	1.84(0.93-3.64)	_	
	Multipara(2-4)	_	1.64(0.85-3.17)	_	
	Grand multipara (>=5) (ref)				
Mode of delivery	vaginal delivery(ref)				
	caesarian delivery	_	0.48(0.29-0.80)**	_	0. 45 (0.27-0.76)**
IPPC provider	Doctor (ref)				
	Health officer	_	0.4(0.2-0.80)*	_	0.53(.26-1.11)
	Nurse/Midwife	_	1.52(1.02-2.27)*	_	1.96 (1.26-3.03)**
	Other	_	0.29(0.05-1.66)	_	0.21(0.03-1.36)

Residence	Rural (ref)				
	Urban	_	_	2.17(1.25 - 3.77)**	1.85 (1.05-3.25)*
Facility type	Government health center (ref)				
	Government hospital	_	_	0.79 (0.56-1.12)	0.98(0.64-1.48)
	Private hospital/clinic	_	_	3.6(1.82-7.12)***	4.12(2.07-8.51)***
Community Media exposure	No(ref)				
	Yes	_	_	2.77(1.61-4.74)***	2.99(1.76-5.06)***

***p value < 0.05 ** p value <0.01 *** p value < 0.001**

5.9. Spatial distribution of quality of IPPC in Ethiopia

5.9.1. Spatial autocorrelation analysis

The global spatial autocorrelation results of the quality of IPPC uptake in Ethiopia showed that there was significant positive spatial autocorrelation across regions in the country. It was found to be clustered with Global Moran's Index value: 0.99 with ($p < 0.001$) and given the z-score of 21.13, there is a less than 1% likelihood that this clustered pattern could be the result of random chance (Fig. 5).

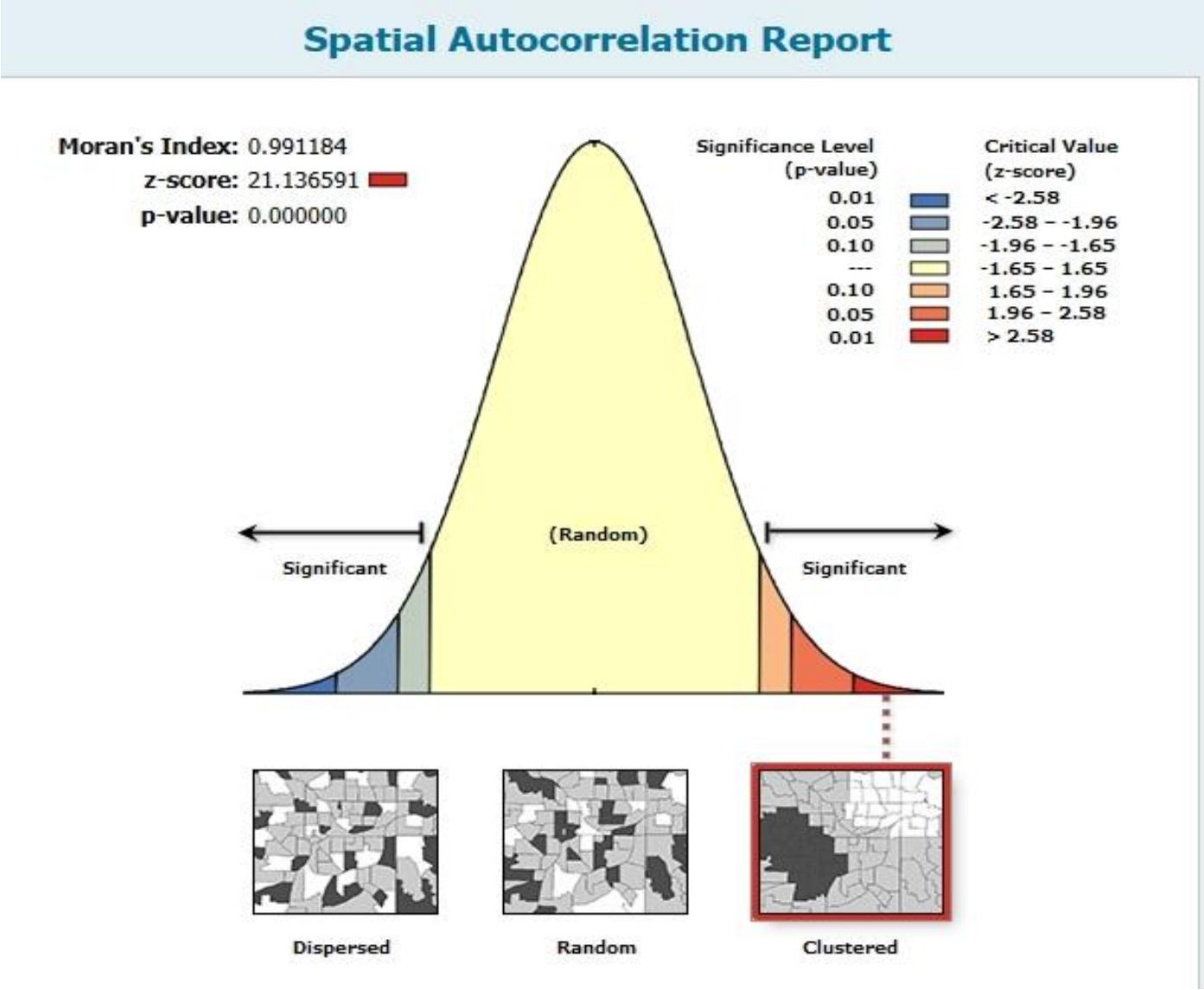


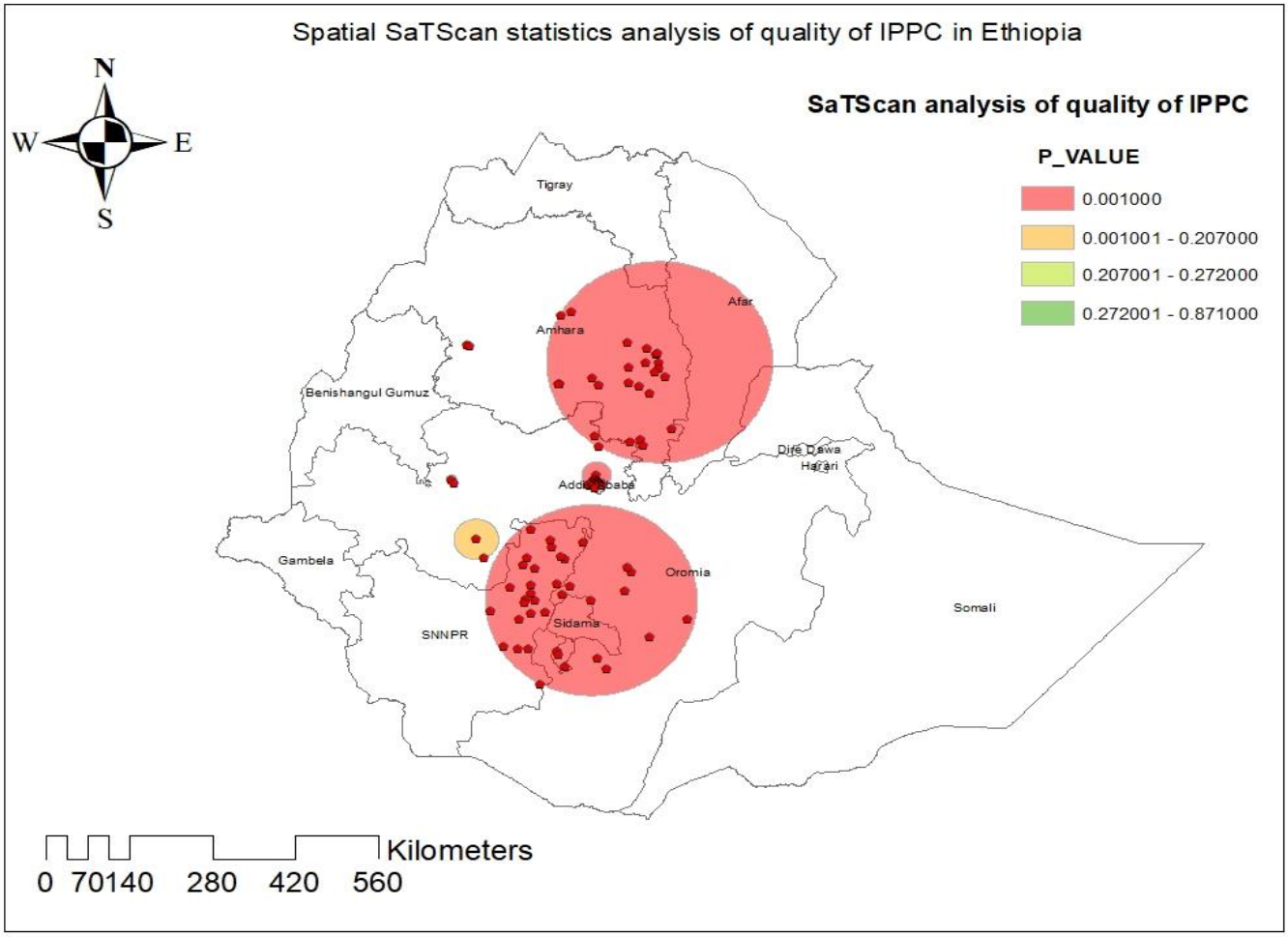
Figure 5: Spatial autocorrelation of the quality of IPPC among women and their newborns in Ethiopia using PM Ethiopia data.

5.9.2. Spatial SaTScan statistics analysis of quality of IPPC in Ethiopia

There were primary clusters of quality of IPPC among women and their newborns in Ethiopia. Of the total 153 clusters, 23 were significant primary clusters. These were in Addis Ababa and the Oromia region, centered at 9.154677 N, 38.765575 E, with a 24.49 km radius. Women and their newborns who were found in the SaTScan window were 3.00 times more likely to receive quality of IPPC than those who were found outside the cluster window region (RR = 3.00, P-value < 0.001) (Table 6 and Fig 6).

Table 7: Significant spatial clusters of quality of IPPC among women and their newborns in Ethiopia using PMA Ethiopia data.

Cluster	Enumeration area(cluster)identified	Coordinate/radius	Population	case	RR	LLR	P-value
1.(23)	456,001,007,012,002,013,010,003,009,053,024, 011,019,017,015,023,006,004,022,005,016,455, 020	9.154677 N, 38.765575 E/ 24.49 km	282	178	3.00	87.6	0.001
2.(25)	318, 360,344,314,361,315, 342, 359, 362, 363, 320,364,313,317, 316, 321, 365, 416, 323, 326, 325, 355,417,307,461	11.038898 N, 39.722195 E / 187.05 km	162	12	0.23	27.5	0.001
3(37)	444, 442, 441, 443, 745, 723, 424, 423, 749, 725, 748, 711, 726, 710, 439, 752, 703, 708, 722, 463, 720, 71047, 462, 724, 721, 701, 706, 437, 751, 709, 733, 734, 705,433, 746, 735, 744	7.058930 N, 38.683079 E / 177.31 km	330	48	0.42	26.9	0.001



Source shape file: https://fews.net/ethiopia-fews-net-admin-boundaries-2021-2023

Figure 6: Significant clusters of quality of IPPC spatial window in Ethiopia, PMA Ethiopia.

5.9.3. Getis-Ord Gi* statistics hot spot analysis of quality of IPPC

On the map, each point represents one enumeration area with the proportion of quality of IPPC in each cluster. The red color of the point on the map represents cold spots or a low proportion of good quality of IPPC in the enumeration area, whereas the blue color indicates an enumeration area with hot spots or a high proportion of poor quality of IPPC. A higher proportion of good quality of IPPC was found in Addis Ababa, Oromia (west shwa, east shewa and northern shewa), Amhara (north shewa) and SNNPR (gurage); on the other hand, SNNPR (Hadya, wolayta,silltie and kembata tembaro), Oromia (Bale, west arsi and Gujii) and Amhara (south Wollo, east Gojam and south Gondar) were characterized by a low proportion of quality of IPPC (Fig. 7).

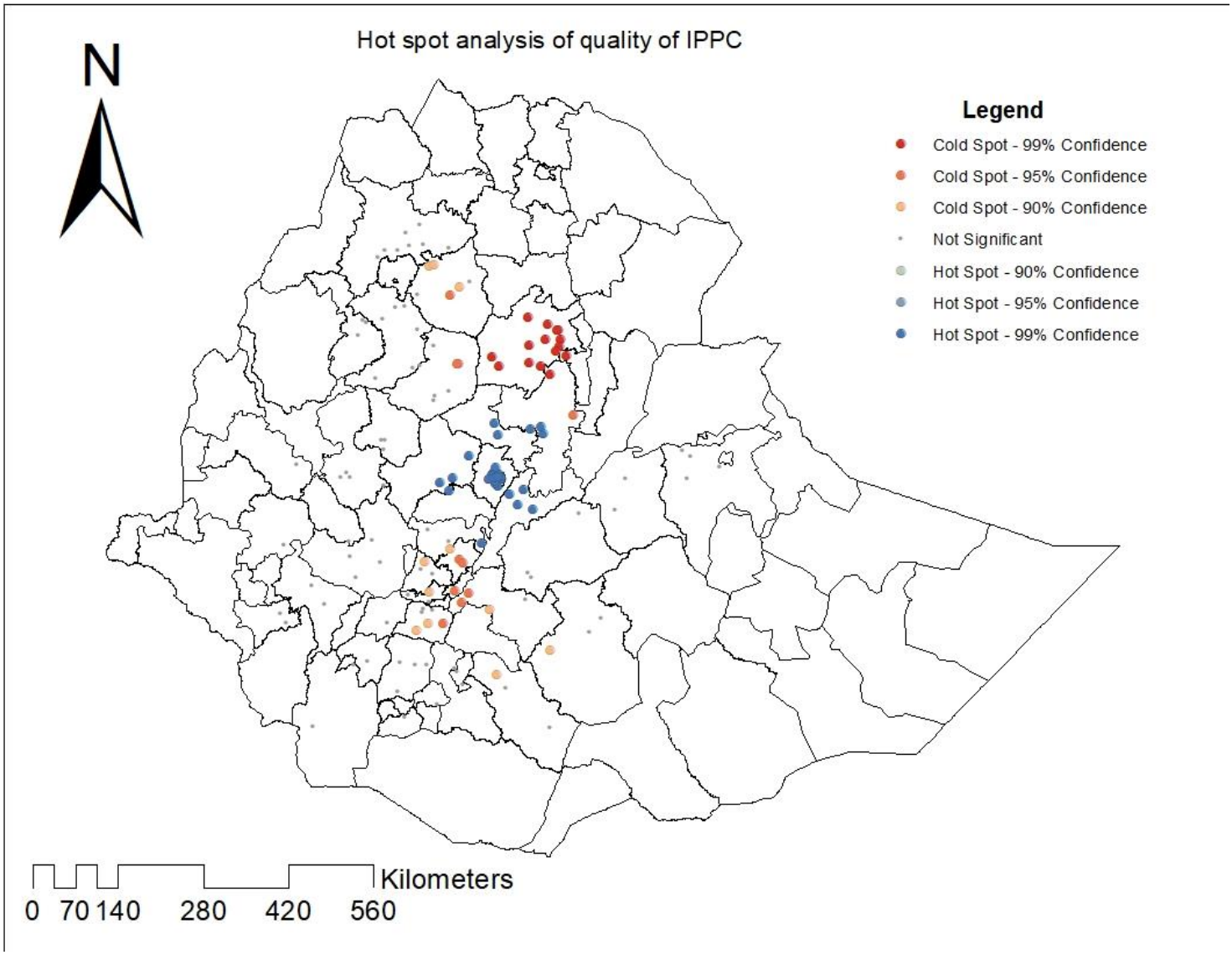


Figure 7: Hot spot analysis of the quality of IPPC spatial window in Ethiopia, PMA Ethiopia

5.9.4. Spatial interpolation or spatial prediction

In the kriging interpolation analysis, the possibility of quality of IPPC was decreasing while we moved from the lime green- to the red-colored areas. The red, orange, and yellow colors predict a high possibility of good quality of IPPC with decreasing z- score values. The green, and yellow-green colors predict low possibility areas of poor quality of IPPC. Addis Ababa and surrounding zones of Oromia, were areas of highly predicted good quality of IPPC uptake. On the other hand, the rest portion of the regions, predicted fewer possibilities for good quality of IPPC (Fig. 8).

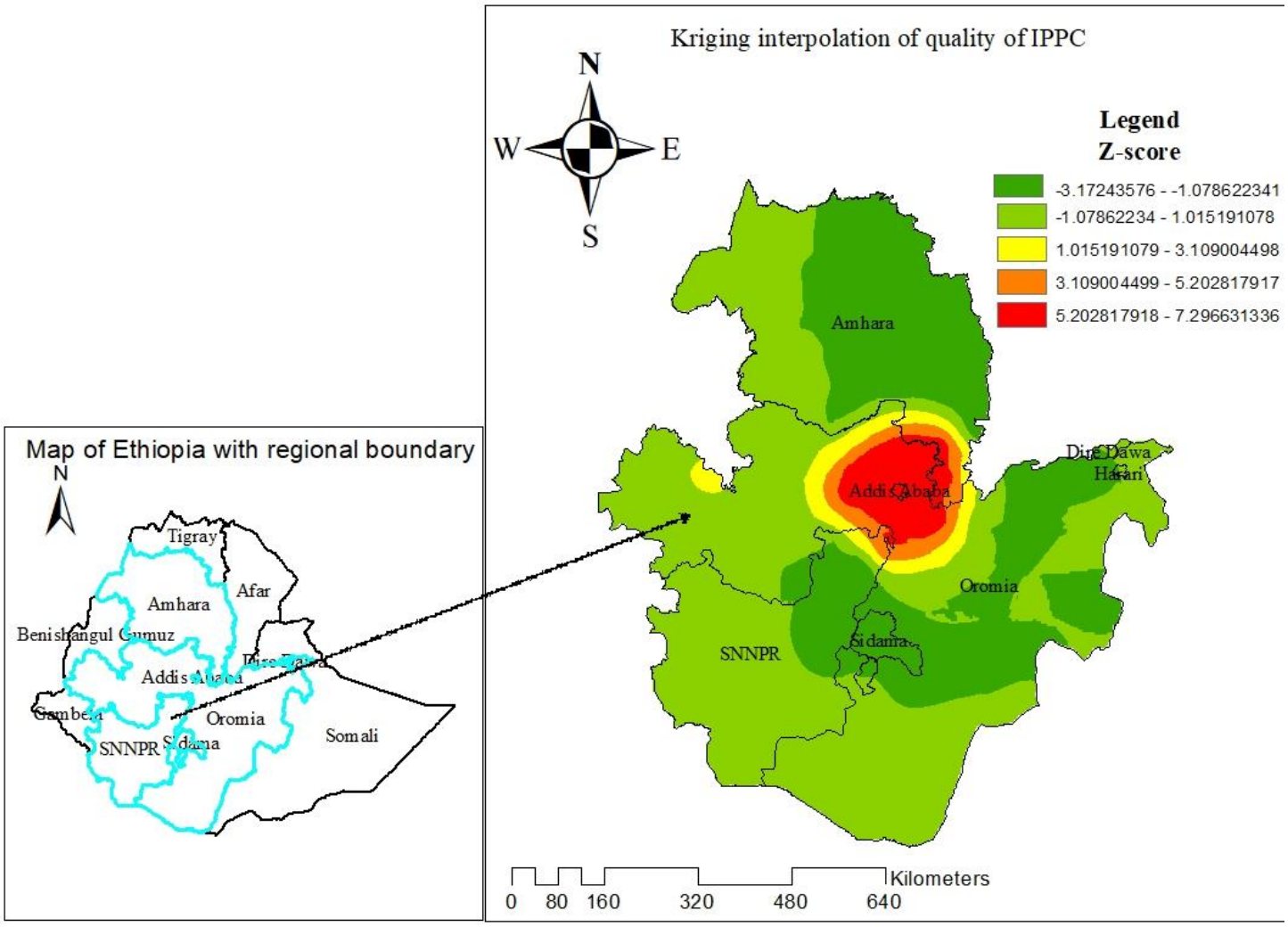


Figure 8: Kriging interpolation of quality of IPPC in Ethiopia, PMA Ethiopia

6. DISCUSSION

This study investigated the quality and spatial distribution of immediate postpartum care in Ethiopia on the basis of the most recent nationally representative PMA Ethiopia panel data. We found a substantially low uptake of maternal and newborn quality IPPC in Ethiopia, with only three out of ten 29.83% (95% CI 27% - 32%) receiving quality IPPC. This study also revealed that several individual and community-level factors were associated with the quality of IPPC. Maternal religion, total number of ANC visits, mode of delivery, IPPC provider, residence, facility type, and community media exposure were among the significant determinants of the quality of IPPC uptake.

There was significant spatial variation in the receiving quality of IPPC. In addition, the spatial scan statistics detected a total of three statistically significant SaTScan clusters of areas with high or low use of quality of IPPC.

The quality of IPPC in our study was lower than the report from India (30 to 35%), the study conducted among SSA (71.7%) and northern Ethiopia (67.6%) (25,38,40). However, this finding is slightly higher compared to a study conducted in among SSA(from 26.6% in Eswatini (Swaziland)) and (13.2%) in Ethiopia (25,27). The difference in the findings could be due to differences in measuring the quality of IPPC and the study subjects included, changes in the data collection period, variations in health system performance, sociocultural differences, or a combination of these factors. This implies that SBAs do not adhere to standard guidelines, ignoring services for mothers and babies, and/or have poor caring behaviors and skills to provide the routine quality of IPPC (40).

We observed a positive significant association between the quality of IPPC and the total number of ANC visits. Having four or more ANC visits was significantly and positively (AOR=1.78; 95% CI 1.08-2.95) associated with higher quality of IPPC uptake compared to those women who never attended. This result is supported by a study done in 23 SSA (7), study conducted in Ethiopia (29), Uganda (43)and Demographic and Health Survey report of eighteen Sub-Saharan African countries (44). This could be explained by the fact that there is an increased opportunity for mothers to become more informed about potential complications and receive greater encouragement to seek high-quality care during ANC visit(78).

In the current study, mothers and their newborns who received quality of IPPC attended by a nurse/midwife during childbirth (AOR = 1.96; 95% CI 1.26-3.03) were more likely to receive quality of IPPC compared to a doctor. The result is in line with a study conducted using Demographic and Health Survey data from 33 countries(25); this could be due to several factors, including the comprehensive and coordinated care provided by nurses/midwives and nurses and midwives are specifically trained in managing normal childbirth and providing supportive care throughout the process.

Our results also showed that mothers who delivered through cesarean section (AOR = 0.45; 95% CI 0.27-0.76) were less likely to receive quality IPPC than those who gave birth via vaginal delivery. This finding is inconsistent with studies conducted in Uganda, Pakistan, and the Demographic and Health Survey report SSA (43–45). This could be explained by the fact that, since following a cesarean delivery, there could be possible pain and sometimes late recovery. Therefore, the mother and her newborn may not get the essential IPPC, such as IPPFP counselling, IPPFP, and early initiation of breastfeeding and skin-to-skin contact.

Notably, this study found that women who are followers of the Muslim religion (AOR = 0.51; 95% CI 0.31 - 0.83) had lower odds of quality of IPPC uptake than those orthodox Christian follower women. Even though we were unable to locate any documentation to explain our findings, the possible explanation could be the differences in religious advice among followers to use the maternal health service and religious leaders' participation in health-related aspects. However, more research is needed to investigate the disparities in quality of IPPC utilization among different religious groups.

Urban residence had a positive and significant direct effect (AOR=1.85; 95% CI 1.05-3.25) on the quality of IPPC. This result is supported by studies conducted in Uganda,(46) and study conducted in Ethiopia (27,28,47). This may be due to the low socioeconomic and educational status of women from rural areas and access to health care, making them inferior compared with urban women.

In this study, women who live in communities with high media exposure (AOR=2.99; 95 CI 1.76-5.06) were more likely to use quality of IPPC than those not exposed. This is consistent with results from studies conducted in Uganda (43), Nepal (37) and in Ethiopia (23). Besides offering entertainment, mass media informs and educates, increasing women's access to knowledge and improving their ability to seek health care (46).

Other findings showed that women who gave birth at private hospitals/clinics (AOR=4.12; 2.07-8.51) were more likely to receive quality IPPC than women who gave birth at government health facilities. This finding is in line with findings from studies conducted in Kenya(48), Burkina Faso and Côte d'Ivoire (49). This could be explained by the fact that private health facilities often may have better access to resources, including trained staff, modern equipment, and essential medications. In addition, private facilities may have a stronger patient-provider relationship, with more personalized attention and communication. This can lead to improved quality of care, including quality of IPPC.

The spatial distribution of quality of IPPC is not random, and there is variation across Ethiopia. Among all regions of Ethiopia, Addis Ababa and North West of Oromia, and a very small portion of northeast SNNPR and southeast Amhara were characterized by the good quality of IPPC use. The variation might be imposed by the difference in socio-demographic status, access to health care, and the variation in the maternity continuum of care.

STRENGTH AND LIMITATION OF THE STUDY

Strength of the study

The main strength of the current study is the use of a panel household survey and health facility data collected simultaneously by PMA-Ethiopia. Most notably, our ability to geographically link nearly nationally representative data collected from women with information from nearby facilities allows us to understand the factors associated with women's receipt of quality of IPPC. In addition, the postpartum women were interviewed at a maximum of 6 weeks of their postpartum period, which may reduce significant recall bias compared with EDHS studies. Furthermore, employing spatial data analysis techniques enabled us to identify the low- and high-coverage quality of IPPC in Ethiopia, which will benefit both program designers and implementers in their design of context-specific and population-targeted interventions to increase quality of IPPC use. Moreover, the use of a multilevel model took into account the hierarchical nature of the PMA data and the variability within the community to obtain a reliable estimate.

Limitations of the study

Nevertheless, the results presented in this study should be considered in light of several limitations. One of the limitations mainly resulted from the use of secondary data, and the data were self-reported, making them highly susceptible to recall bias and social desirability bias. In addition, the knowledge, attitudes, and practices of health care providers were not assessed as they might contribute to the quality of service.

7. CONCLUSION AND RECOMMENDATIONS

7.1. Conclusions

The overall prevalence of quality of IPPC is low in this study compared to WHO recommendations. This low quality of IPPC implies that a significant proportion of mothers and their newborns are at significant risk of developing postpartum adversity. Our findings underscore the importance of addressing both individual and community-level factors to improve the quality of IPPC. Individual-level factors such as maternal religion, number of ANC visits, IPPC provider, and mode of delivery were associated with the quality of IPPC use. Similarly, community-level variables such as residence, facility type, and community media exposure were associated with the quality of IPPC utilization. Moreover, the spatial distribution of quality of IPPC was not random and was better practiced in Addis Ababa and Northwestern of Oromia, with a very small portion in the northeastern of SNNPR and southeastern of Amhara.

7.2. Recommendations

From the findings of this study, the following recommendations are therefore made:

For health facilities, to increase the quality of IPPC, health facilities should provide training regularly to update healthcare providers in accordance with current WHO guidelines. The number of ANC visits should be increased to teach women about postpartum care and its consequences. Additionally, healthcare providers should identify and address cultural and religious beliefs that may influence the quality of care.

For the government and policymakers, maternal health should be given high priority, and enough funds should be provided for maternal health interventions, including IPPC. Also, strengthen the health systems, especially in the rural and hard-to-reach areas, and ensure that there is adequate personnel with the right skills in the health sector, including doctors, health officers, nurses, and midwives. The government and other stakeholders should use the media to encourage mothers in terms of the importance of maternal health and postpartum care and the consequences of a lack of quality of care.

For researchers, future studies are needed that assess the quality of immediate postpartum care. There is a need to do a direct needs assessment of health facility and health care provider factors to identify the barriers to immediate postnatal care triangulated with qualitative research.

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9. ANNEXs

Annex Ⅰ: Data extraction form

Variables	Variable measurements	Remark
Individual level variable		
Participant ID		
Maternal age (in complete years)	1. 15, 16……	
Religion	1. Orthodox 2. Catholic 3. Protestant 4. Muslim, 96. Other	
Parity	1. 1,2……..	
Child gender	1.male 2.female	
marital status	1.Married 2.Living with a partner 3.Divorced 4.Widow	
Maternal Educational status	1.Never attended 2.Primary (grades 1-8) 3.Secondary (grades 9-10) 4.Technical & vocational 5.Higher	
Partner Educational status	1.Never attended 2.Primary 3.Secondary 4. Technical & vocational 5. Higher	
Antenatal attendance	1. 1,2…….	
Place of delivery	1) Institutional delivery, including public/ private health facility, NGO sector facilities Others 2. Home	
Household wealth quintile	1. Lowest quintile 2.Lower quintile 3. Middle quintile 4.Higher quintile 5.Highest quintile	
Community level variables		
EA_ID(enumeration area)		
Residence	1. Urban 2. rural	

Exposure mass media,	1. Yes 2. No	
Delivery load	1.1, 2…….	
Guidelines	1.yes 2.No	
Type of Health facility	1.Hospital 2.Health center 3 Health post 4.private clinic/ Health clinic 5. Drug Shop/Rural Drug Vendor	
Cadre of attending professional	1. Doctor 2. Health officer 3. Nurse/Midwife 4. Other	
mode of delivery	1.Vaginal 2.c-section	
IPPC characteristic's		
IPPC mother uptake (did someone ask you questions about your health or examine you)	1. Yes 2.No	
IPPC utilization by skilled birth attendants	1. Yes 2. no	
Timing for PNC check-up	1. Minutes 2. Hours 3. Days	
Duration??		
Before you left the facility after delivery, did a provider talk with you about using a family planning Method? (PPFP counseling)	1.Yes 2.No	
IPPFP	1. yes 2. No	
Did the doctors, nurses, or other staff at the facility treat you with respect?	1. yes 2. No	
does the health provider administer uterotonic drug	1. Yes 2. No	

Did anyone check on your baby health after delivery, while you were still in the facility other than a family member? For example did someone ask you questions about your baby's health or examine him/her?	1.Yes 2. No	
How long after delivery did the first Check take place?	1.Minutes 2.Hours 3. Days	
Enter value in		
Chlorohexidin application to cord after cutting it?	1. Yes 2. No	
Did the baby receive eye ointment following Delivery?	1. Yes 2.No	
Was the baby weighed at birth?	1. Yes 2. No	
Initiated skin-to-skin contact	1. Yes 2. No	
After delivery, was the newborn wrapped with a cloth?	1. Yes 2. No	
How long after birth did you first put the newborn to the breast?	1. Minutes 2.Hours 3. Days	
Ever received a BCG vaccination	1. Yes 2. No	
ever received oral polio vaccination immediately after birth	1. Yes 2. No	

ANNEX II multilevel multivariable logistic regression analysis of individual and community level variables (n=1351)

Predictors	Categories	p-value	AOR (95% CI)
Individual level variables			
Religion	Orthodox (ref)		
	Protestant	0.71	0.92(0.6 -1.41)
	Muslim	0.007	0.51(0.31 -0.83)***
	Other	0.9	1.1(0.22-5.4)
Maternal education	Never attended (ref)		
	Primary	0.39	0.82 (0.52-1.29)
	Secondary	0.92	1.02(0.6-1.72)
	Technical & vocational	0.71	0.87(0.43-1.77)
	Higher	0.27	1.41(0.75-2.63)
Total number of ANC	Never attended (ref)		
	1-3	0.25	1.37(0.79-2.38)
	>=4	0.02	1.78(1.08-2.95)*
Parity	Primipara (1)	0.07	1.84(0.93-3.64)
	Multipara(2-4)	0.13	1.64(0.85-3.17)
	Grand multipara (>=5) (ref)		
Mode of delivery	vaginal delivery(ref)		
	caesarian delivery	0.003	0. 45 (0.27-0.76)**
IPPC provider	Doctor (ref)		
	Health officer	0.09	0.53(.26-1.11)
	Nurse/Midwife	0.002	1.96 (1.26-3.03)**
	Other	0.1	0.21(0.03-1.36)
Residence	Rural (ref)		
	Urban	0.03	1.85 (1.05-3.25)*
Facility type	Government health center (ref)		
	Government health hospital	0.92	0.98(0.64-1.48)
	Private hospital/clinic	0.001	4.12(1.9-8.9)***
Community Media exposure	No(ref)		
	Yes	0.001	2.99(1.76-5.06)***

Annex Ⅲ：SaTScan output

```
Program run on: Wed Nov 13 23:45:24 2024

Purely Spatial analysis
scanning for clusters with high or low rates
using the Bernoulli model.
-----------------------------------------------------------------------------

SUMMARY OF DATA

Study period.....................: 2000/1/1 to 2000/12/31
Number of locations..............: 153
Total population.................: 1351
Total number of cases............: 403
Percent cases in area............: 29.8
-----------------------------------------------------------------------------

CLUSTERS DETECTED

1.Location IDs included.: 231141056, 231201001, 231201007, 231201012, 231201002, 231201013,
                          231201010, 231201003, 231201009, 231141053, 231201024, 231201011,
                          231201019, 231201017, 231201015, 231201023, 231201006, 231201004,
                          231201022, 231201005, 231201016, 231141055, 231201020
  Coordinates / radius..: (9.154677 N, 38.765575 E) / 24.49 km
  Span..................: 24.49 km
  Population............: 282
  Number of cases.......: 178
  Expected cases........: 84.12
  Observed / expected...: 2.12
  Relative risk.........: 3.00
  Percent cases in area.: 63.1
  Log likelihood ratio..: 87.581225
  Monte Carlo rank......: 1/1000
  P-value...............: 0.001
```

Annex Ⅲ: Authorization letter

Gmail haftaab ashebr <haftaabashebr401@gmail.com>

Dataset Request Notification

PMA DataLab <info@pmadata.org> Fri, Apr 5, 2024 at 6:19 PM
Reply-To: info@pmadata.org
To: haftaabashebr401@gmail.com

PMA Logo

Dear haftaab ashebr,

Your request for the following dataset(s) has been approved.

The following datasets were approved:

- Ethiopia Panel Cohort 2 HQFQ Baseline Survey
- Ethiopia Panel Cohort 2: 6-week Follow-up Survey
- Ethiopia Panel Cohort 2: 6-month Follow-up Survey
- PMA Ethiopia Panel Cohort 2 HQFQ 1-year Follow-up
- Ethiopia GPS (PMA2020) Dataset
- Ethiopia GPS (PMA-ET) Dataset
- Ethiopia 2019 Cross-sectional SQ Survey
- Ethiopia 2020 Cross-section SQ Survey
- Ethiopia 2021 Cross-section SQ Survey
- Ethiopia 2022 Cross-section SQ Survey

Please click here to log in and download a compressed folder for each dataset approved, which will contain the below files:

If you requested a Household/Female, Service Delivery Point, or Client Exit Interview datasets:

- Questionnaire(s) of the specific survey
- Dataset in 3 formats: Stata .dta, .csv and .xlsx
- User notes on the dataset
- Relevant codebooks can be downloaded on the PMA Data Codebooks page

If you requested a GPS dataset:

- PMA GPS displacement protocol
- Dataset in .csv format
- User guide README document
- Codebook as a .xlsx file
- More information about PMA GPS data is available on the PMA Data Page

If you requested any other datasets:

- Questionnaire(s) of the specific survey
- Dataset in 3 formats: Stata .dta, .csv, and .xlsx
- User notes on the dataset
- Codebook as a .xlsx file

For all types of datasets, questionnaires and user notes documents in French are also included for Francophone survey countries.

PMA releases a new version of datasets on as needed basis whenever corrections or updates are needed for the already released materials. Users who have previously been approved to download the datasets will receive an email notification whenever a newer version of the datasets become available. In which case, no new request needs to be submitted and users can obtain the new version by re-downloading the datasets from the PMA website.

Publications using PMA data should include their respective suggested citations, which can be found on the respective dataset landing pages or in user notes. We request that you do not redistribute or share the PMA datasets with other users or researchers.

Please note that PMA cannot provide in-depth support for data analysis or data related questions.

Thank you for using PMA data.

Regards,

PMA