Spatial distribution and determinants of newborns not receiving postnatal check-up within two days after birth in Ethiopia: a spatial and multilevel analysis of EDHS 2016

Destaye Guadie Kassie1*, Nega Tezera Assimamaw1, Tadesse Tarik Tamir1, Tewodros Getaneh Alemu1, Masresha Asmare Techane1, Chalachew Adugna Wubneh1, Getaneh Mulualem Belay1, Amare Wondim Ewunet1, Bewuketu Terefe2, Adiss Bilal Muhye1, Bethelihem Tigabu Tarekegn1, Mohammed Seid Ali1, BeletechFentie1, Almaz Tefera Gonete1, Berhan Tekeba1, Selam Fisiha Kassa1, Bogale Kassahun Desta1, Amare Demsie Ayele1, Melkamu Tilahun Dessie1 and Kendalem Asmare Atalell1

Abstract

Background: Accessibility and utilization of postnatal newborn check-ups within 2 days after delivery are critical for a child’s survival, growth, and development. However, the service delivery is not yet improved and fluctuates across the geographical locations in Ethiopia. Therefore, this study aimed to assess the spatial distribution and determinants of newborns not received postnatal check-ups within 2 days after birth in Ethiopia.

Methods: A secondary data analysis of the Ethiopia Demographic and Health Survey (EDHS) 2016 was done among live births within 2 years preceding the survey. A multilevel binary logistic regression model was fitted to identify the factors associated with the outcome variable. Adjusted Odds Ratio with 95% (Confidence Interval) was calculated and used as a measure of associations and variables with a p-value < 0.05, were declared as statistically significant.

Results: A total of 4036 live newborns in Ethiopia were included in the analysis, of whom half (51.21%) were females. The mean age of the mothers was 33 ± 1.3, and more than 60% (61.56%) of the mothers were not educated. The national prevalence of newborns not receiving postnatal check-ups within 2 days after birth was 84.29 (95% CI: 83.10–85.41) with significant spatial variations across the study area. Mothers who had no ANC visits were 58% higher than (AOR = 0.42(0.27–0.66) mothers who had > 4 ANC visits. Mothers who gave birth at home and others were 80% (AOR = 0.02(0.01–0.29)) and 25% (AOR = 0.76(0.59–0.99)), higher than mothers delivered at hospital. Rural mothers were 1.90 times higher (AOR = 1.90(1.29–2.81)) than urban mothers, and mothers live in administrative regions of Afar 66% (AOR = 0.34(0.16–0.69), Oromia 47% (AOR = 0.53(0.30–0.91), Somali 60% (AOR = 0.40 (0.22–0.74), Benishangul 50% (AOR = 0.50 (0.27–0.92), SNNPR 67% (AOR = 0.33(0.19–0.57), Gambela 70% (AOR = 0.30 (0.16–0.56), Harari 56%
were assessed at each postnatal contact [2, 7]. Jaundice, cord, eyes, hygiene, and immunization status occurred in the first 2 days [8]. The burden of maternal and newborn mortality is still increasing from 29 in 2016 to 33 in 2019 [8], with significant spatial variations. Hence, the World Health Organization (WHO) recommends that all newborns and mothers should receive high-quality postnatal care within the first 42 days. For the mother who is delivered at home, the first postpartum visit must be as early as possible within 24 hours of birth. A minimum of three postnatal health checks are suggested for both mothers and newborns on day 3 (48-72 hours), within 7-14 days, and at 6 weeks [4-6]. Infant feeding, history of convulsion, fast breathing, spontaneous movement, hypothermia, hyperthermia, jaundice, cord, eyes, hygiene, and immunization status were assessed at each postnatal contact [2, 7].

Globally, 2.4 million newborns died in the first month of life, with nearly half (47%) of the deaths having occurred in the first 2 days [8]. The burden of maternal and newborn mortality is high in Africa. Each year, nearly 125,000 women and 870,000 newborns die in the first week of life [9]. Sub-Saharan Africa is among the most affected area with an estimated 1.16 million babies dying in the first 28 days and 850,000 in the first week of life [1, 7, 10, 11].

Even though progress has been made in reducing maternal and child mortality in Ethiopia, neonatal mortality is still increasing from 29 in 2016 to 33 in 2019 [8], with significant spatial variations. Hence, understanding the spatial variations of low postnatal check-ups within 2 days after delivery is critical to come up with evidence-based geographically targeted interventions.

WHO recommends a postnatal check-up within 2 days after delivery to reduce neonatal mortality [1]. The first 2 days are the most critical time for the survival of the newborn. Unable to provide timely postnatal care at this stage will result in complications and even death. According to the 2019 Ethiopian Demography Health Survey (EDHS), only 35% of newborns had received a postnatal check within 48 hours after birth [12]. Postnatal care is the most neglected service in Ethiopia [4].

Previous studies identified different factors associated with low postnatal check-ups such as maternal age, birth order, wealth status, delivery sites, residences, ANC follow-up, and maternal education [12].

In recent decades, efforts have been made to increase postnatal care, which in turn reduces neonatal mortality through the Sustainable Development Goal (SDG4), [13-15]. The Ethiopian government has also made a significant improvement to increase postnatal care by training and recruiting community health extension workers [2]. However, the postnatal care coverage is very low with significant spatial variations, which range from 0.1% in Afar to 74% in Addis Ababa [12]. Thus, investigating the spatial variations and determinants of low postnatal check-ups has important for the prevention and early identification of infant problems and to meet the SDG4 goal, which aimed to reduce child mortality to 25/1000 live birth by 2030 [16]. A geographically linked data analysis using population and health facility data is important to map the low coverage of postnatal check-ups and identify inequalities in service access and provision [17, 18]. Therefore, this study aimed to investigate the spatial variations and determinants of low postnatal care coverage within two days after birth in Ethiopia to come up with geographically targeted interventions to increase the postnatal check-ups within 2 days.

Methods

Study area

The study was done in Ethiopia using the Ethiopian Demographic Health Survey 2016. Ethiopia is among the oldest countries worldwide, which is located in 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 country has a surface area of 1,112,000 km². It is a rugged, landlocked country split by the Great Rift Valley, with archaeological finds dating back more than 3 million years; it’s a place of ancient culture. Among the important sites in Lalibela with its rock-cut Christian
churches from the 12th–13th centuries. Aksum is the ruins of an ancient city with obelisks, tombs, Our Lady Mary of Zion church, and Gondar Fasil castles. Ethiopia is the 10th largest and the 2nd-most populous country in Africa after Nigeria. Administratively Ethiopia has ten regions (Tigray, Afar, Amhara, Benshangul, Gambela, Harari, Oromia, Somali, Southern, Nations, Nationalities, and People's Region (SNNPR), and Sidama (a recently added and two city administrations (Addis Ababa and Dire Dawa). Concerning resident, 79.2% of the Ethiopian population lives in rural, and 43.3% is under fifteen ages [19]. Ethiopia uses a three-tier healthcare system; 1) primary healthcare system consists of health posts, health centers, and primary hospitals, 2) secondary healthcare consists of zonal hospitals, and 3) tertiary healthcare consists of comprehensive specialized hospitals [20].

Study Design
Across-sectional retrospective study design was conducted to assess the geospatial variation and determinants of newborns not receiving postnatal check-ups within 2 days after birth.

Source of data
The data used in this article were obtained from the Ethiopia Demography and Health Survey (EDHS) 2016, which was accessed at the MEASURE DHS website after securing a formal request to the MEASURE DHS program. The survey was carried out by the central statistics agency of Ethiopia, and the Ethiopia Public Health institute Ethiopia with the technical assistance provided by ICF International. The authors requested the measure DHS trough briefly stating the objectives of this analysis and access was granted to use the data on the (http://dhsprogram.com) website [21].

Sampling and populations
The source population of this study was all mothers with newborns born in the last 2 years preceding the survey. Multi-stage stratified cluster sampling was used to select the study participants. In the first stage, 645 clusters or enumerations areas were selected randomly, and stratified into urban and rural. In the second stage, a fixed number of 28 households in each cluster was randomly selected [21]. Geographic coordinates of each survey cluster were also collected using Global Positioning System (GPS) [21]. Mothers aged 15–49 and children born within the 2 years preceding the survey in each selected household were subjected to our study.

The study was conducted among (3832 un-weighted and 4036 weighted frequency) newborns to assess the postnatal health checkups within 2 days after delivery (Fig. 1).

Fig. 1. Shows the number of clusters in Ethiopia EDHS data 2016 (n = 645 clusters)
Study variables

Outcome variable
The outcome variable for this study is postnatal check up within the first 2 days after birth. The under five data sets (KR) files, EDHS 2016 were used for this analysis, by computing the selected function of postnatal care for newborn within the first 2 days after birth and relating variables. The computing variables were Cord examined (m78a) + Temperature measured (m78b) + Counseling on danger signs (m78c) + Counseling on breastfeeding (m78d) + Observation of breastfeeding (m78e). It was recorded as “No(0)” for new born not receiving a postnatal check within 2 days after birth and “yes [1]” new born receiving a postnatal check within 2 days after birth.

Independent variables
The independent variables used in this study were as nested into; 1) individual level factors such as marital status, maternal age, religion, maternal occupation, maternal education, residence, sex of newborn, wealth index, number of ANC, place of delivery, size of the newborn at birth and number of living children in the family. 2) Community level factors such as region, distance to the health facility, community illiteracy level, health insurance, media exposure, access to electricity, access to safe water, and community poverty. Some of the community-level factors were aggregated from the individual-level factors.

Data management and analysis
We performed a secondary analysis of the EDHS 2016, using the Kids Records (KR) dataset. STATA version 14 and Microsoft Excel 16 were used for data cleaning and coding, and the spatial analysis, and mapping were done using ArcGIS version 10.8. Descriptive statistics such as frequency and percentage of different variables were computed and presented using texts, tables, and graphs.

After preparing the data we imported the data to ArcGIS version 10.8. Joining the outcome with the GPS data and projections of the Geographically coordinated data to the projected coordinated data were conducted before the analysis. Spatial autocorrelation analysis was done to test whether there is spatial variation across the study area. The spatial autocorrelation test signifies whether there is clustering or dispersion of postnatal check-ups within 2 days after birth. The value of the Morans Index is standardized into Z-score. Positive Morans Index value with positive Z-score (> 1.96, P-value < 0.05) indicates clustering/ hot spots areas. Negative Morans Index value with a negative Z-score (< −1.96, P-value > 0.05) was considered a cold spot area. GetisOrd Gi* statistic was applied to detect hotspot area or spatial clustering of newborns not receiving postnatal check-ups. Ordinary kriging interpolation was used to estimate/ predict the spatial distributions of not receiving a postnatal check within 2 days after delivery.

A multilevel binary logistic regression model was applied for each independent variable and p-value < 0.2 were entered into the multivariable multilevel logistic regressions model. The adjusted odds ratio was calculated and used as the measure of association between the dependant and independent variables, and variables having a p-value < 0.05, 95% CI were considered statistically significant.

In the EDHS data, the newborn is nested within a cluster, newborns within the same cluster were more similar to each other than within different clusters. Therefore, this violates the standard regression model assumptions, which are independence of observation and equal variance across the cluster assumptions. This implies they need to take into account between-cluster variables by using an advanced model. Therefore, a multilevel random intercept logistic regression model was fitted to estimate the association between individual-level and community-level factors and the likelihood of newborn not receiving postnatal care within 2 days after birth. Models were compared based on deviance (−2log likelihood) since the models were nested. Log-likelihood and intracellar correlation coefficient (ICC) was computed to measure the variation between clusters. The ICC indicates the degree of heterogeneity of newborn not receiving postnatal care within 2 days after birth. A multilevel binary logistic regression analysis was performed to examine the effects of individual and community level factors on newborns not receiving postnatal check-ups within 2 days after birth to identify individual and community level factors.

Results

Socio-demographic characteristics of the newborn
A total of 4036 weighted live birth were included in this analysis, of whom nearly half (48.79%) of the newborns were males. The mean ages of the mother were 33 ± SD 1.3 and near to one-third of the mothers (29.26%) were between the age group of 25 and 29 years. Near to 60% of mothers, (58.97%) were unemployed, and more than 60% (61.59%) were not educated. The majority (88.77%) of the study participants were residing in rural and nearly half (47.5%) of the mothers were in a poor wealth status (Table 1).

Maternal and child characteristics
More than one-third (36.04%) of mothers had noANC visits, and 63.64% of the mother were delivered at home. Among mothers, 53.85% had 1–3 live children in their families. The majority (96.51%) of the study participants have not used health insurance, 61.28% of the mother had a big problem reaching the health facilities, and near
to 50% of the community (47.39%) were illiterate. Around 40%, (38.98%) and (72.31%) of the mother have no access to media, and electricity (Table 2).

### Table 1  Socio-demographic characteristics of study population in Ethiopia, EDHS 2016

| Variables          | Categories                | Un weighted (n = 3832) | weighted (n = 4036) |
|--------------------|---------------------------|------------------------|---------------------|
|                    |                           | Frequency              | Percent             | Frequency | Percent |
| Region             | Tigray                    | 409                    | 10.67               | 290       | 7.19    |
|                    | Afar                      | 367                    | 9.58                | 41        | 1.01    |
|                    | Amhara                    | 332                    | 8.66                | 699       | 17.32   |
|                    | Oromia                    | 591                    | 15.42               | 1827      | 45.28   |
|                    | Somali                    | 517                    | 13.49               | 175       | 4.34    |
|                    | Benishangul               | 305                    | 7.96                | 43        | 1.05    |
|                    | SNNPR                     | 463                    | 12.08               | 832       | 20.61   |
|                    | Gambela                   | 253                    | 6.6                 | 10        | 0.24    |
|                    | Harari                    | 226                    | 5.9                 | 10        | 0.24    |
|                    | Addis Ababa               | 173                    | 4.51                | 92        | 2.29    |
|                    | Dire Dawa                 | 196                    | 5.11                | 17        | 0.42    |
| Marital status     | Never in union            | 3604                   | 94.05               | 3801      | 94.17   |
|                    | Married                   | 74                     | 1.93                | 80        | 1.97    |
|                    | Widowed                   | 30                     | 0.78                | 26        | 0.64    |
|                    | Divorced                  | 91                     | 2.37                | 84        | 2.09    |
|                    | Others                    | 33                     | 0.86                | 45        | 1.12    |
| Maternal Age       | 15–19                     | 259                    | 6.76                | 260       | 6.45    |
|                    | 20–24                     | 945                    | 24.66               | 918       | 22.76   |
|                    | 25–29                     | 1098                   | 28.65               | 1181      | 29.26   |
|                    | 30–34                     | 801                    | 20.9                | 868       | 21.51   |
|                    | 35–39                     | 521                    | 13.6                | 558       | 13.81   |
|                    | 40–44                     | 165                    | 4.31                | 191       | 4.73    |
|                    | 45–49                     | 43                     | 1.12                | 60        | 1.48    |
| Religion           | Orthodox                  | 1109                   | 28.94               | 1328      | 32.89   |
|                    | Muslim                    | 1946                   | 50.78               | 1708      | 42.32   |
|                    | Protestant                | 681                    | 17.77               | 845       | 20.95   |
|                    | Others                    | 96                     | 2.51                | 155       | 3.84    |
| Maternal occupation| Not working               | 2377                   | 62.03               | 2380      | 58.97   |
|                    | Sale                      | 374                    | 9.76                | 447       | 11.08   |
|                    | Agree employment          | 684                    | 17.85               | 813       | 20.13   |
|                    | Others                    | 397                    | 10.36               | 396       | 9.82    |
| Maternal Education | No education              | 2307                   | 60.2                | 2485      | 61.59   |
|                    | Primary                   | 1056                   | 27.56               | 1220      | 30.24   |
|                    | Secondary                 | 308                    | 8.04                | 230       | 5.69    |
|                    | Higher                    | 161                    | 4.2                 | 100       | 2.49    |
| Residence          | Urban                     | 744                    | 19.42               | 454       | 11.25   |
|                    | Rural                     | 3088                   | 80.58               | 3581      | 88.75   |
| Sex of new born    | Male                      | 1919                   | 50.08               | 1969      | 48.79   |
|                    | Female                    | 1913                   | 49.92               | 2067      | 51.21   |
| Wealth index       | Poor                      | 2036                   | 53.13               | 1878      | 47.52   |
|                    | Middle                    | 534                    | 13.94               | 846       | 20.96   |
|                    | Rich                      | 1262                   | 32.93               | 1312      | 32.51   |

Note: SNNPR-Southern Nations, Nationalities and Peoples Region, Occupation otters: cleric, skill & unskilled manual, service & others

The prevalence of newborns not receiving postnatal check-ups within 2 days
The overall prevalence of not receiving postnatal
check-ups within 2 days after birth in Ethiopia was 84% (Fig. 2). The postnatal check-ups within 2 days were higher in Addis Ababa and Tigray regions, whereas, low postnatal check-ups were observed in Afar, Somali and Gambela regions (Fig. 3).

**Spatial analysis result**

**Spatial autocorrelation**

The spatial autocorrelation analysis result showed that newborns not receiving a postnatal check-up within 2 days after delivery significantly varied across Ethiopia, with a Global Moran’s I value of 0.47, p-value < 0.0001, and z-score 7.13. This indicates that the newborn not receiving postnatal check-ups within the first 2 days after birth in Ethiopia has spatial dependence (Fig. 4).

**Hotspot analysis of the newborns not receiving postnatal check-ups in Ethiopia**

In the hotspot map, significant spatial clustering of not receiving postnatal check-ups within 2 days after birth was observed in Eastern (Somali), Northeastern (Afar), Southern (Oromia and SNNPR), and Western (Gembela and Benshangul) parts of Ethiopia. Whereas, spatial dispersion of newborns not receiving postnatal check-ups

| Variables                          | Categories | Un weighted (n = 3832) | weighted (n = 4036) |
|------------------------------------|------------|------------------------|---------------------|
|                                    |            | Frequency | Percent | Frequency | Percent |
| No of ANC visit                    | No visit   | 1283      | 33.48   | 1454      | 36.04   |
|                                    | 1–3 visit  | 1158      | 30.22   | 1247      | 30.92   |
|                                    | >= 4       | 1391      | 36.3    | 1333      | 33.04   |
| Place of delivery                  | Home       | 2220      | 57.93   | 2528      | 63.64   |
|                                    | Government hospital | 473  | 12.34 | 303  | 7.51 |
|                                    | Government health center | 815  | 21.27 | 902  | 22.36 |
|                                    | others     | 324       | 8.46    | 302       | 7.48    |
| Size of children at birth          | very large | 609       | 15.89   | 683       | 16.92   |
|                                    | Larger than average | 503  | 13.13 | 536  | 13.29 |
|                                    | average    | 1581      | 41.26   | 1637      | 40.57   |
|                                    | Smaller than average | 370  | 9.66  | 404  | 10.02 |
|                                    | very small | 769       | 20.07   | 775       | 19.21   |
| Number of living children in family| No children | 40       | 1.04    | 20        | 0.5     |
|                                    | 1–3        | 2161      | 56.39   | 2173      | 53.85   |
|                                    | 4–6        | 1173      | 30.61   | 1281      | 31.74   |
|                                    | 7–9        | 420       | 10.96   | 516       | 12.81   |
|                                    | 10–12      | 38        | 0.99    | 44        | 1.1     |
| Distance to health facility        | Big problem | 2102     | 54.85   | 2473      | 61.28   |
|                                    | Not a big problem | 1730 | 45.15 | 1562 | 38.72 |
| Community illiteracy level         | Lowly uneducated | 2060 | 53.76 | 2123 | 52.61 |
|                                    | Highly uneducated | 1772 | 46.24 | 1913 | 47.39 |
| Health Insurance                   | No         | 3710      | 96.82   | 3895      | 96.51   |
|                                    | yes        | 122       | 3.18    | 141       | 3.49    |
| Media exposure                     | Lowly no exposed | 1916 | 50   | 2463 | 61.02 |
|                                    | Highly no exposed | 1916 | 50   | 1573 | 38.98 |
| Access to electric city            | lowly no electricity | 1292 | 33.72 | 1118 | 27.69 |
|                                    | highly no electricity | 2540 | 66.28 | 2918 | 72.31 |
| Accesses to safe water             | lowly no access water | 3214 | 83.87 | 3486 | 86.36 |
|                                    | highly no access water | 618  | 16.13 | 550  | 13.64 |
| Community wealth index             | lowly poor | 1916 | 50  | 2463 | 61.02 |
|                                    | highly poor | 1916 | 50  | 1573 | 38.98 |
| Prevalence of newborn not receiving postnatal care | No | 3230 | 84.29 | 3427 | 84.90 |
|                                    | Yes        | 602       | 15.71   | 609       | 15.10   |

*Note: place of delivery others: government health center, others home, privet health facility, non-government health facility & other, ANC: Antenatal care*
was observed in Northern, Central, and Southern parts of the country specifically in regions of Tigray, Amhara, and Addis Abeba (Fig. 5).

Satscan analysis of newborns not receiving postnatal check-up within 2 days after birth
Purely Spatial analysis scanning for clusters with high rates was applied using the Bernoulli model. A total of 287 significant clusters of newborns not receiving postnatal check-ups were specified, of which 41 and 100 were primary (most likely clusters) and secondary clusters, respectively. The primary cluster, was found in the Eastern (Somali region) of Ethiopia at 5.589269 N, 44.175032 E geospatial locations, with a relative risk of 1.47 and log-likelihood ratio (LLR) of 48.1 at a p-value<0.0001. Those shows mothers who lived in this spatial window is 1.47 time at higher risk of not receiving postnatal check-up than those outside the window. Whereas the secondary clusters were honored in the Western parts of the country (Gambela and Benishangul) at 7.417914 N; and 35.317365 E geospatial locations, with relative risk and LLR of 1.29 and 31.2, respectively (Table 3).

Spatial scan statistical analysis of hotspot areas of newborns not receiving postnatal check-ups in Ethiopia, produced using Arc GIS version 10.8 (Fig. 6).

Interpolation of a newborn not receiving a postnatal check-up within the first 2 days
Ordinary Kriging interpolation was used to predict the prevalence of not receiving postnatal check-ups within the first 2 days among newborns in unobserved areas. The high predicted prevalence of not receiving postnatal check-ups was observed in the Eastern, Southeastern, and Southern parts of Ethiopia. Whereas low prediction of not receiving postnatal check-ups among newborns was observed in the Southern, Western, and Northern parts of Ethiopia, specifically in Amhara, Tigray, and Addis Ababa regions (Fig. 7).

Graph shows newborns not received postnatal check-up within the first two days after birth among 11 regions
Fig. 4  Global spatial autocorrelation of newborns not receiving postnatal check-ups within 2 days after birth in Ethiopia produced using ArcGIS version 10.8. Data EDHS 2016

Fig. 5  Hot spot analysis of newborns not receiving postnatal check-ups within 2 days after birth using Getis Ord Gi statistics in Ethiopia, produced using ArcGIS version 10.8
Factors associated with newborns not receiving postnatal check-ups in Ethiopia

The multilevel binary logistic regression model was the best-fitted model for our data; after LR and ICC, tests were checked. Thus, the two-level logistic regression model was fitted to obtain an unbiased result and to come up with a valid inference. Deviance was used to check the model's fitness and a model with the lowest deviance value is the best fit model. Hence, the final model was the best-fitted model in our data, which gives the lowest deviance value. The ICC value of the individual model was 0.3442 \(= 34.42\), 95% CI: (0.17–0.71), which indicates that about 34.42% of the overall variability of the newborn, not receiving postnatal check-up was presented between cluster variability and the deviance of the null model was \((-2 \times -1571922) = 3, 142.78\). An ICC value of the individual model was 0.3442 = 34.42, 95% CI: (0.17–0.71), which indicates

Table 3 SaTScan analysis results of postnatal check-ups with 2 days after birth in Ethiopia, EDHS 2016

| Cluster | Enumeration area (cluster) identified | Coordinate/Radius | Populations | Cases | RR | LLR | P-value |
|---------|---------------------------------------|-------------------|-------------|-------|----|-----|---------|
| 1       | 138, 164, 85, 358, 146, 492, 92, 490, 543, 278, 171, 198, 95, 318, 77, 187, 497, 556, 520, 629, 521, 588, 553, 458, 480, 208, 214, 251,573, 239, 269, 116, 22, 294, 378, 630, 568, 33, 277, 527, 289 | 5.59 N, 44.18 E / 443.03 km | 320 | 268 | 1.47 | 48.1 | < 0.001 |
| 2       | 554, 46, 299, 526, 243, 459, 552, 168, 371, 119, 197, 326, 437, 177,325, 477, 376, 586, 555, 448, 207, 446, 219, 270, 593, 154, 265, 489,284, 114, 231, 469, 47, 221, 291, 549, 63, 417, 558, 106, 76, 337,13, 105, 343, 567, 338, 411, 432, 470, 315, 62, 603, 446, 468,236, 447, 248, 69, 175, 260, 104, 227, 592, 507, 370, 306, 304, 536,435, 643, 309, 113, 406, 193, 349, 502, 70, 462, 141, 275, 126, 618,294, 161, 374, 266, 434, 142, 395, 565, 621, 450, 331, 577, 180, 466,280, 41 | 7.42 N, 35.32 E/ 268.40 km | 642 | 469 | 1.29 | 31.2 | < 0.001 |
| 3       | 4, 632, 75, 596, 440, 366, 178, 499, 205, 427, 334, 570, 348, 599, 544, 389, 368, 241, 55, 547, 191, 571, 344, 276, 332, 189, 254, 37, 249, 620, 488, 307, 135 | 11.85 N, 41.92 E / 237.67 km | 244 | 198 | 1.40 | 28.1 | 0.0001 |
| 4       | 71, 168, 552, 459, 243, 197, 526, 299, 46, 554, 437, 325, 326, 119,477, 376, 177, 207, 586, 154, 446, 448, 219, 270, 555, 337, 593, 489,265, 284, 417, 76, 338, 231, 114, 469, 47, 221, 291, 549, 63, 13, 106, 558, 470, 105, 343, 567, 432, 411, 486, 62, 315, 603, 447, 346, 233, 426, 69, 227, 306, 260, 104, 248, 175, 507, 392, 370, 406, 113, 536, 435, 304, 141, 309, 434, 126, 502, 466, 643, 87, 450, 618, 565, 193, 142, 180 | 7.20 N, 35.32 E/ 260.29 km | 563 | 412 | 1.3 | 27.2 | 0.0001 |
| 5       | 422, 34, 316, 398, 405, 468, 600, 232, 21, 518 | 5.84 N, 39.18 E /102.80 km | 93 | 78 | 1.4 | 13.4 | 0.0001 |
| 6       | 12, 506, 333, 476, 491, 372, 93, 122, 51, 71, 564, 245, 230, 529, 453, 441, 557, 330, 594, 25, 484, 30 | 9.09 N, 40.87 E/116.33 km | 189 | 142 | 1.3 | 10.8 | 0.010 |
| 7       | 235, 585, 127 | 13.75 N, 39.99 E/15.05 km | 25 | 24 | 1.6 | 9.3 | 0.049 |
| 8       | 120, 24, 206, 403, 456, 38, 429 | 10.99 N, 38.05 E/59.81 km | 32 | 29 | 1.5 | 7.9 | 0.132 |
| 9       | 515, 615 | 11.07 N, 36.46 E/89.4 km | 15 | 15 | 1.7 | 7.8 | 0.157 |
| 10      | 134, 263, 192 | 14.18 N, 39.98 E/27.69 km | 25 | 23 | 1.6 | 6.9 | 0.357 |
| 11      | 566 | 9.46 N, 42.46 E/0 km | 12 | 12 | 1.7 | 6.3 | 0.543 |
| 12      | 171 | 13.25 N, 40.04 E/0 km | 11 | 11 | 1.7 | 5.7 | 0.731 |
| 13      | 610 | 9.37 N, 42.10 E/0 km | 11 | 11 | 1.7 | 5.7 | 0.731 |
| 14      | 139 | 8.41 N, 38.37 E/0 km | 10 | 10 | 1.6 | 5.2 | 0.882 |
| 15      | 425, 80, 551 | 13.35 N, 38.35 E/39.54 km | 29 | 25 | 1.5 | 5.0 | 0.902 |
| 16      | 152, 312, 327 | 12.69 N, 37.89 E/17.71 km | 16 | 15 | 1.6 | 5.0 | 0.913 |
| 17      | 619, 26 | 7.47 N, 39.09 E/31.00 km | 20 | 18 | 1.5 | 4.7 | 0.936 |

RR relative risk, LLR log likelihood ratio
Fig. 6  Spatial scan statistical analysis of hotspot areas of newborns not receiving postnatal check-ups within 2 days after birth in Ethiopia produced using Arc GIS version 10.8

Fig. 7  Ordinary Kriging interpolation of newborns not receiving postnatal check-ups within 2 days after birth in Ethiopia produced using Arc GIS version 10.8
check-ups; whereas, in the model III (community level factors) regions such as Afar AOR = 0.16, 95% CI: (0.08–0.34), Oromia AOR = 0.27, 95% CI: (0.15–0.48), Somali AOR = 0.25, 95% CI: (0.14–0.46), Benishangul AOR = 0.37, 95% CI: (0.22–0.69), SNNPR AOR = 0.32, 95% CI: (0.18–0.57), Gambela AOR = 0.24, 95% CI: (0.13–0.47), Harari AOR = 0.40, 95% CI: (0.22–0.72), and Dire Dawa AOR = 0.32, 95% CI: (0.17–0.59), community wealth status AOR = 0.59, 95% CI: (0.43–0.81), community illiteracy AOR = 0.62, 95% CI: (0.46–0.83), and media exposure AOR = 0.79, 95% CI: (0.62–0.99) were significantly associated with not receiving postnatal check-up among newborns. However, in the final model (model IV) ANC visit AOR = 0.42, 95% CI: (0.27–0.66), place of delivery AOR = 0.02, 95% CI: (0.01–0.92), residence AOR = 1.90, 95% CI: (1.29–2.81) and regions such as Afar AOR = 0.34, 95% CI: (0.16–0.69), Oromia AOR = 0.53, 95% CI: (0.30–0.91), Somali AOR = 0.40, 95% CI: (0.22–0.74), Benishangul AOR = 0.50, 95% CI: (0.27–0.92), SNNPR AOR = 0.33, 95% CI: (0.19–0.57), Gambela AOR = 0.30, 95% CI: (0.16–0.56), Harari AOR = 0.44, 95% CI: (0.25–0.78), and Dire Dawa AOR = 0.30, 95% CI: (0.17–0.54) remains statistically significant.

In our study, the odds of not receiving postnatal check-ups within 2 days after birth was increased by 58% among mothers who have not attended ANC visits as compared to their counterparts. The odds of not receiving postnatal check-ups among mothers who delivered at home and others were increased by 80 and 25% higher than mothers who had delivered at the hospital (AOR = 0.02 (0.01–0.029) and (AOR = 0.76 (0.59–0.99)), respectively. The majority of Ethiopian communities who have lived in different regions were significantly associated with newborns not receiving postnatal check-ups. The odds of newborns not receiving postnatal check-ups among mothers in Afar 66% (AOR = 0.34 (0.16–0.69), Oromia 47% (AOR = 0.53 (0.30–0.91), Somali 60% (AOR = 0.40 (0.22–0.74)), Benishangul 50% (AOR = 0.50 (0.27–0.92), SNNPR 67% (AOR = 0.33 (0.19–0.57)), Gambela 70% (AOR = 0.30 (0.16–0.56), Harari 56% (AOR = 0.44 (0.25–0.78)), and Dire Dawa 70% (AOR = 0.30 (0.17–0.54) were higher than mothers in Addis Ababa, respectively. The odds of newborns not receiving postnatal check-ups among mothers who lived in rural were 1.90 times higher than in urban mothers (AOR = 1.90 (1.29–2.81)) (Table 4).

Discussion

Neonatal death is unexpectedly increased in Ethiopia in recent years, the postnatal check-up within 2 days after birth is essential to improve the survival of both the mothers and the newborns. Lack of proper care within the first 2 days leads to complications for the newborn as well as the mother. Hence, this study aimed to investigate the spatial variations and determinants of not receiving a postnatal check-up within 2 days among live births in Ethiopia [1, 22].

The overall national prevalence of newborns not receiving postnatal check-ups within 2 days after birth in Ethiopia was 84.29, 95% CI: (83.11–85.41), which is in line with the study conducted in Ethiopia 83% [23]. However, the finding of our study was slightly lower than those of the study conducted in rural Bangladesh at 90%, and in Ethiopia at 90% [5, 24]. This could be because the study conducted in Bangladesh was conducted in the rural population, which might inhibit the utilization of postnatal check-ups. The study period might be the other reason for the variations in the result. The higher non-utilization of postnatal check-ups in the previous Ethiopian study might be linked to the study period, in recent years efforts have been made to increase the maternal health service utilization through training and recruiting community health extension workers.

On the other hand, the finding of this study was higher than the study conducted in the United Kingdom 44.8%, in the Southern Ethiopia 61.6% [25], Ezha district, Ethiopia 76.1% [26], Addis Abeba, Ethiopia 63% [27], and a study conducted in low and middle-income countries such as Malawi 74%, Senegal 21%, Mali 74.82% [28], and Nepal 66% [29–31]. The discrepancy of our study with the United Kingdom could be explained by the fact that, healthcare access, infrastructure, and awareness of the population towards the utilization of postnatal check-ups in the United Kingdom [32]. The difference in studies conducted in Ethiopia might be explained by the study period and most studies conducted in Ethiopia were conducted in urban, which increases the utilization of postnatal check-ups. Furthermore, the discrepancy in the study conducted in low and middle-income countries might be explained by the low healthcare access in Ethiopia. The difference for the Nepal study might be due to the differences in socio-cultural practice, sample size and geographical differences. For instance, in the African study data were collected using house to house survey, mothers may have good health care awareness, whereas our study was conducted using a nationally representative data and 88% of the population have been lived in the rural area have little awareness of postnatal care service after birth for mothers and newborn. In Ethiopia, child birth at home is also very high, which might contribute to the low utilization of postnatal check-ups [33].

Consistent with the previous studies conducted in Ethiopia [34, 35], significant autocorrelation of not receiving postnatal check-ups were detected among newborns. Spatial clustering of early postnatal non-utilization was observed in Eastern, Southeastern, South, southeastern, and western parts of the country, which was
Table 4  Multivariable multi level logistic regression analysis results as individual-level, community-level and together individual and community factors that associated with new born not receiving postnatal check up in the first 2 days after birth in Ethiopia, EDHS 2016 (n = 3832)

| Variables                  | Categories          | Newborns receiving PCPs within 2 days AB | Models                      |
|---------------------------|---------------------|----------------------------------------|-----------------------------|-----------------------------|-----------------------------|
|                           |                     | No | yes | Null Model I AOR (95%CI) | Individual Model II AOR (95%CI) | Community Model III AOR (95% CI) | Over all variables Model IV AOR (95%CI) |
| Maternal Age              | 15–19               | 209 | 50  | 0.06(0.68–1.66)          | 1.06(0.68–1.66)               | 1.08(0.70–1.69)               |                                           |
|                           | 20–24               | 795 | 150 | 0.88(0.65–1.19)          | 0.88(0.65–1.19)               | 0.88(0.65–1.19)               |                                           |
|                           | 25–29               | 929 | 169 | 1                         | 1                         | 1                         |                                           |
|                           | 30–34               | 676 | 125 | 0.98(0.71–1.36)          | 0.94(0.68–1.30)               | 0.99(0.66–1.49)               |                                           |
|                           | 35–39               | 441 | 80  | 1.12(0.74–1.69)          | 0.99(0.66–1.49)               | 1.08(0.56–2.06)               |                                           |
|                           | 40–44               | 140 | 25  | 1.22(0.63–2.36)          | 1.08(0.56–2.06)               | 0.98(0.00–1.00)               |                                           |
|                           | 45–49               | 38  | 5   | 0.54(0.13–2.35)          | 0.48(0.11–1.99)               | 0.48(0.11–1.99)               |                                           |
| Marital status            | Marriage            | 3054| 176 | 1                         | 1                         | 1                         |                                           |
|                           | Not marriage        | 550 | 52  | 1.13(0.76–1.68)          | 1.09(0.73–1.62)               | 1.09(0.73–1.62)               |                                           |
| Sex of new born           | Male                | 1625| 294 | 1                         | 1                         | 1                         |                                           |
|                           | Female              | 1605| 308 | 1.02(0.82–1.26)          | 0.80(0.60–1.23)               | 0.80(0.60–1.23)               |                                           |
| Live children in family   | No children         | 35  | 5   | 0.76(0.24–2.39)          | 0.69(0.22–2.88)               | 0.69(0.22–2.88)               |                                           |
|                           | 1–3                 | 1754| 407 | 1                         | 1                         | 1                         |                                           |
|                           | 4–6                 | 1032| 141 | 0.96(0.69–1.34)          | 1.04(0.75–1.44)               | 1.04(0.75–1.44)               |                                           |
|                           | 7–9                 | 374 | 42  | 1.16(0.67–1.98)          | 1.28(0.76–2.17)               | 1.28(0.76–2.17)               |                                           |
|                           | 10–12               | 35  | 7   | 0.44(0.10–1.85)          | 0.59(0.14–2.38)               | 0.59(0.14–2.38)               |                                           |
| Maternal occupation       | Not working         | 2047| 330 | 1.05(0.75–1.47)          | 1.65(0.76–1.49)               | 1.65(0.76–1.49)               |                                           |
|                           | sales               | 298 | 76  | 1                         | 1                         | 1                         |                                           |
|                           | Agree employee      | 590 | 94  | 1.19(0.78–1.83)          | 0.86(0.55–1.33)               | 0.86(0.55–1.33)               |                                           |
|                           | Others              | 295 | 102 | 1.26(0.83–1.93)          | 1.21(0.80–1.84)               | 1.21(0.80–1.84)               |                                           |
| Maternal education        | No education        | 2048| 259 | 1.76(1.08–2.86)          | 1.57(0.96–2.59)               | 1.57(0.96–2.59)               |                                           |
|                           | Primary             | 844 | 212 | 1.38(0.87–2.19)          | 1.21(0.76–1.92)               | 1.21(0.76–1.92)               |                                           |
|                           | Secondary           | 228 | 80  | 1.12(0.69–1.84)          | 1.00(0.62–1.64)               | 1.00(0.62–1.64)               |                                           |
|                           | Higher              | 110 | 51  | 1                         | 1                         | 1                         |                                           |
| Wealth index              | Poor                | 1849| 187 | 0.95(0.71–1.28)          | 0.83(0.57–1.19)               | 0.83(0.57–1.19)               |                                           |
|                           | Middle              | 446 | 88  | 1.12(0.78–1.61)          | 0.93(0.63–1.36)               | 0.93(0.63–1.36)               |                                           |
|                           | Rich                | 935 | 327 | 1                         | 1                         | 1                         |                                           |
| No of ANC visits          | No visit            | 1249| 34  | 0.37(0.24–0.58)          | 0.42(0.27–0.66)**             | 0.42(0.27–0.66)**             |                                           |
|                           | 1–3                 | 961 | 197 | 0.97(0.76–1.24)          | 1.01(0.79–1.29)               | 1.01(0.79–1.29)               |                                           |
|                           | >= 4                | 1020| 371 | 1                         | 1                         | 1                         |                                           |
| Place of delivery         | Respondent Home     | 2198| 22  | 0.02(0.01–0.03)**        | 0.02(0.01–0.03)**             | 0.02(0.01–0.03)**             |                                           |
|                           | Health institution  | 296 | 177 | 1                         | 1                         | 1                         |                                           |
|                           | Others              | 736 | 403 | 0.85(0.66–1.10)          | 0.76(0.59–0.99)**             | 0.76(0.59–0.99)**             |                                           |
| Children size at birth    | very large          | 507 | 102 | 0.84(0.62–1.14)          | 0.89(0.66–1.20)               | 0.89(0.66–1.20)               |                                           |
|                           | Larger than average | 431 | 72  | 0.76(0.54–1.07)          | 0.83(0.59–1.16)               | 0.83(0.59–1.16)               |                                           |
|                           | Average             | 1310| 271 | 1                         | 1                         | 1                         |                                           |
|                           | Smaller than average| 318 | 52  | 0.98(0.65–1.48)          | 0.96(0.64–1.43)               | 0.96(0.64–1.43)               |                                           |
|                           | Very small          | 664 | 105 | 1.04(0.76–1.42)          | 1.04(0.76–1.42)               | 1.04(0.76–1.42)               |                                           |
| Health insurance          | No                  | 3158| 552 | 0.49(0.30–0.80)**        | 0.68(0.42–1.10)               | 0.68(0.42–1.10)               |                                           |
|                           | Yes                 | 72  | 50  | 1                         | 1                         | 1                         |                                           |
| Distance to health facility| Big problem        | 1882| 220 | 0.84(0.66–1.07)          | 0.91(0.71–1.17)               | 0.91(0.71–1.17)               |                                           |
|                           | Not big problem     | 1348| 382 | 1                         | 1                         | 1                         |                                           |
supported by studies conducted in Ethiopia [35–37]. This could be linked with health care access, education, and population awareness in these areas.

According to the multilevel regression analysis results, the odds of not receiving postnatal check-ups among mothers who had no ANC visits were 58% higher than mothers who had four and above ANC visits, which is supported by studies done in Ethiopia [5, 38, 39], Tanzania [40], Uganda [41], and Kenya [41, 42]. The possible reasons might be mothers who have four and above ANC visits might get counseling regarding birth preparedness, skilled delivery, and early postnatal care, which might increase the postnatal check-up utilizations.

The odds of not receiving postnatal check-ups within 2 days after birth were higher among neonates delivered at home and others by 80 and 25% respectively

Table 4 (continued)

| Variables           | Categories                        | Newborns receiving PCPs within 2 days AB | Models                                                                 |
|---------------------|-----------------------------------|------------------------------------------|----------------------------------------------------------------------|
|                     |                                   | No | yes |                      | Null Model I AOR (95%CI) | Individual Model II AOR (95%CI) | Community Model III AOR (95%CI) | Over all variables Model IV AOR (95%CI) |
| Region              | Tigray                            | 251 | 158 |                      | 1.56(0.92–2.65) | 0.94(0.58–1.51) |                                                                  |
|                     | Afar                              | 351 | 16  |                      | 0.16(0.08–0.34)* | 0.34(0.16–0.69)** |                                                                  |
|                     | Amhara                           | 265 | 67  |                      | 0.65(0.36–1.18) | 1.04(0.59–1.83) |                                                                  |
|                     | Oromia                            | 529 | 62  |                      | 0.27(0.15–0.48)* | 0.53(0.30–0.91)** |                                                                  |
|                     | Somali                            | 481 | 36  |                      | 0.25(0.14–0.46)* | 0.40(0.22–0.74)** |                                                                  |
|                     | Benishangul                       | 268 | 37  |                      | 0.37(0.20–0.69)* | 0.50(0.27–0.92)** |                                                                  |
|                     | SNNPR                             | 408 | 55  |                      | 0.32(0.18–0.57)* | 0.33(0.19–0.57)** |                                                                  |
|                     | Gambela                           | 230 | 23  |                      | 0.24(0.13–0.47)* | 0.30(0.16–0.56)** |                                                                  |
|                     | Harari                            | 181 | 45  |                      | 0.40(0.22–0.72)* | 0.44(0.25–0.78)** |                                                                  |
|                     | Addis Ababa                       | 99  | 74  |                      | 1 | 1                       |                                                                  |
|                     | Dire Dawa                         | 167 | 29  |                      | 0.32(0.17–0.59)* | 0.30(0.17–0.54)** |                                                                  |
| Residence           | Urban                             | 537 | 207 |                      | 1 | 1                       |                                                                  |
|                     | Rural                             | 2693| 395 |                      | 1.03(0.69–1.54) | 1.90(1.29–2.81)** |                                                                  |
| Community wealth level | Lowly poor                     | 1486| 430 |                      | 1 | 1                       |                                                                  |
|                     | Highly poor                       | 1744| 172 |                      | 0.59(0.43–0.81)* | 0.94(0.66–1.33) |                                                                  |
| Community illiteracy | Lowly uneducated                | 1612| 448 |                      | 1 | 1                       |                                                                  |
|                     | Highly uneducated                 | 1618| 154 |                      | 0.62(0.46–0.83)* | 0.91(0.67–1.24) |                                                                  |
| Media exposure      | No                                | 2218| 1012|                      | 0.79(0.62–0.99)* | 0.98(0.75–1.29) |                                                                  |
|                     | Yes                               | 302 | 300 |                      | 1 | 1                       |                                                                  |
| Accesses to electric city | Lowly no electricity        | 977 | 315 |                      | 1 | 1                       |                                                                  |
|                     | Highly no electricity             | 2253| 287 |                      | 0.73(0.52–1.02) | 0.93(0.67–1.31) |                                                                  |
| Access to safe water | Lowly no accesses water          | 2673| 541 |                      | 1 | 1                       |                                                                  |
|                     | Highly no accesses water          | 557 | 61  |                      | 0.90(0.64–1.25) | 1.07(0.75–1.54) |                                                                  |

Note: ICC Intra variability coefficient, null model (I) ICC = 0.1311856 = 13.12, 95% CI: (0.11–0.16), Deviance = −2 × −1571392 = 3,142.78
Individual model (II) ICC = 0.3442178 = 34.42, 95% CI: (0.17–0.71), Deviance = −2 × −1136.6712 = 2273.34
Community model (III) ICC = 0.4582245 = 45.82 95% CI: (0.27–0.79), Deviance = −2 × −1448.7476 = 2, 897.50, Multilevel model (IV) ICC = 0.0902263 = 9.02, 95% CI: (0.01–0.76), Deviance = −2 × −2 × −1101.4277 = 2,202.8
SNNPR Southern Nations Nationality Peoples’ Region, others place of delivery: others home, privet health facility, non-government health facility & others, PCP Postnatal check-ups, Occupation others: cleric, skill & unskilled manual, service & others, AB After birth

**Factors associated in individual & community level(model II & III)

***Factors associated in over all variable (modelIV)
as compared to mothers who gave birth at hospitals. Similar reports had been released in the previous studies conducted in Ethiopia [27, 43], Tanzania [40], and Uganda [41]. The possible reason might be mothers who gave birth in hospital might have a possibility of staying for 2 days or be counseled to have a follow-up 2 days after birth stayed and can get appropriate health care follow-up for the newborns and mothers. Whereas, mothers who gave birth at home; are culturally restricted to move out of their homes for a certain period, which reduces the postnatal care utilization.

Similar to the previous study conducted in Ethiopia [38, 44], Uganda [41], and Kenya [42], the odds of not receiving a postnatal check-up among rural mothers were 1.9 times higher as compared to their counterparts. The possible reasons might be due to the difficulty of getting healthcare access and infrastructure in rural. Education, health information, and antenatal follow-up were lower in rural, which contributes to the low utilization of postnatal check-ups.

In agreement with the previous studies conducted in Ethiopia [33–36], West African countries [45], and Pakistan [46], the odds of a newborn not receiving a postnatal check-up within 2 days after birth were higher by 66% in Afar, 47% in Oromia, 60% in Somali, 50% in Benishangul, 67% in SNNPR, 70% in Gambela, 56% in Harari and 70% in Dire Dawa as compared with Addis Abeba. The possible explanation for the low utilization of postnatal check-ups within 2 days after birth in regions other than Addis Ababa might be related to population awareness of the importance of postnatal check-ups. Moreover, socio-cultural practice, socio-economic variation, access to healthcare facilities, availability of skilled healthcare providers for postnatal care counseling, and access to transport, that might influence the utilization of postnatal check-ups.

This study has paramount importance in reducing neonatal mortality, especially in the first 2 days by improving the postnatal check-ups. High-risk areas for not receiving postnatal check-ups could be very important to design effective local, geographically targeted interventions to increase the postnatal check-ups utilizations.

**Strength and limitations**

The strength of our study is using large sample size and a country representative data. The other strength of this study is using advanced statistical models (geospatial and multilevel analysis), which account the cluster variabilities. However, our study has some limitations, first, since we used secondary data analysis, we fail to incorporate some clinical variables, which might effect on the outcome variable. The second limitation of this study was we couldn’t include the paternal informations, which might influence our result.

**Conclusion**

Low postnatal check-up utilization remains a big challenge in Ethiopia, with significant spatial variations across regional and local levels. Spatial clustering of not receiving postnatal check-ups within 2 days was observed in Afar, Oromia, Gambela, Benishangul, SNNPR, Harari, and Dire Dawa regions. Residence, ANC visits, place of delivery, and administrative regions were significantly associated with not receiving postnatal check-ups. Geographically targeted interventions to improve ANC follow-up and institutional delivery should be strengthened.

**Abbreviations**

ANC: Antenatal Care; ANCs: Antenatal Care Visits; CRS: Coordinate Reference System; DHS: Demographic and Health Survey; EAs: Enumeration Areas; EDHS: Ethiopia Demographic and Health Survey; GIS: Geographic Information Systems; ICC: Intra-class Correlation Coefficient; SNNPR: Southern Nations, Nationalities and Peoples Region; WHO: World Health Organization.

**Acknowledgments**

We thank the University of Gondar College of Medicine and Health Sciences for offering free access to the digital online library for searching the electronic databases. We also thank the MEASURE DHS Program for accessing the data.

**Authors’ contributions**

DGK & KAA conceptualized, designed, analyzed, developed, and drafted the manuscript. NTA and TTT participated in the design and analysis. All authors critically reviewed the manuscript for important intellectual content and contributed to the final approval of the version to be submitted.

**Funding**

Not applicable.

**Availability of data and materials**

The corresponding author will give the data for formal requesters.

**Declarations**

**Ethics approval and consent to participate**

We registered and granted a letter from the online database of DHS program and the Ethiopian Public Health Institute through: https://dhsprogram.com/methodology/survey/survey-display-478.cfm to access the data. We also thank the MEASURE DHS Program for accessing the data.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

**Author details**

1. Department of Pediatrics and Child Health Nursing, School of Nursing, College of Medicine and Health Science, University of Gondar, Gondar, Ethiopia.
2. Department of Community Nursing, School of Nursing, College of Medicine and Health Science, University of Gondar, Gondar, Ethiopia.
References

1. Organization WH. WHO recommendations on postnatal care of the mother and newborn: World Health Organization; 2014.

2. Bwalya BB, Mulenga MC, Mulenga JN. Factors associated with postnatal care for newborns in Zambia: analysis of the 2013-14 Zambia demographic and health survey. BMC Pregnancy Childbirth. 2017;17(1):1–13.

3. Organization WH. HRP annual report 2019. 2020.

4. Organization WH. Counseling for maternal and newborn health care: A handbook for building skills: World Health Organization; 2013.

5. Seid A, Ahmed M. Determinants of postnatal checkup for newborns in Ethiopia. Further analysis of 2016 Ethiopia demographic and health survey. BMC Pregnancy Childbirth. 2020;20(1):1–7.

6. Kmitowitz C. Postnatal care: WHO highlights the urgency of physical and mental support: British Medical Journal Publishing Group; 2022.

7. WHO. Newborn death and illness www.who.int › pmi › media › press_ materials › fs › newborn death and illness. 2020.

8. Sakeah E, Aborigo R, Sakeah JK, Dalaba M, Kanyomse E, Azongo D, et al. The role of community-based health services in influencing postnatal care visits in the Builsa and the West Mamprusi districts in rural Ghana. BMC Pregnancy Childbirth. 2018;18(1):1–9.

9. Mengesha HG, Sahle BW. Cause of neonatal deaths in Northern Ethiopia: a prospective cohort study. BMC Public Health. 2017;17(1):1–8.

10. Bwalya BB, Mulenga MC, Mulenga JN. Factors associated with postnatal care for a positive postnatal experience: executive summary; 2022.

11. WHO. Newborn death and illness www.who.int › pmi › media › press_ materials › fs › newborn death and illness. 2020.

12. Central Statistics Agency E. Ethiopia Mini Demographic and Health Survey 2019. Ethiopian Public Health Institute Addis Ababa Federal Ministry of Health Addis Ababa. Rockville: The DHS Program ICF; 2021.

13. Black RE, Levin C, Walker N, Chou D, Liu L, Temmerman M, et al. Reproductive, maternal, newborn, and child health: key messages from disease control priorities 3rd edition. Lancet. 2016;388(10061):2811–24.

14. Child EWE. Partnership for Maternal Newborn & Child Health. Progress in Partnership. 2017.

15. Bhatta ZA, Black RE. Global maternal, newborn, and child health—so near and yet so far. N Engl J Med. 2013;369(23):2262–35.

16. Losano R, Fulluman N, Abate D, Abay SM, Abbafati C, Abbasi N, et al. Measuring progress from 1990 to 2017 and projecting attainment to 2030 of the health-related Sustainable Development Goals for 195 countries and territories: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):2091–138.

17. Warren C, Daly P, Toure L, Mongi P. Maternal and postnatal care: Opportunities for Africa’s new Hor. Cape Town: Partnership for maternal, newborn and child health; 2006. p. 79–90.

18. Berhe A, Bayray A, Berhe Y, Teka U, Desta A, Araya T, et al. Determinants of postnatal care utilization in Tigray, Northern Ethiopia: A community based cross-sectional study. PLoS One. 2019;14(8):e0221161.

19. Marcus HG, Mehretu A, Crummeny DE. "Ethiopia". Encyclopaedia Britannica. 2021. https://www.britannica.com/place/Ethiopia. Accessed 9 Dec 2021.

20. Mariam M. The role of community health workers in improving postnatal care utilization among women in rural Africa: a cross-sectional study. Reprod Health. 2015;12(1):341.

21. Dhakal S, Chapman GN, Simkhada PP, Van Teijlingen ER, Stephens J, Raja AE. Utilization of postnatal care among rural women in Nepal. BMC Pregnancy Childbirth. 2007;7(1):1–9.

22. Keya KT, Rahman MM, Rob U, Bellows B. Distance traveled and cost of transport for use of facility-based maternity services in rural Bangladesh: a cross-sectional survey. Lancet. 2013;382:17.

23. Smith HC, Saxena S, Petersen I. Postnatal checks and primary care consultations in the year following childbirth: an observational cohort study of 309,573 women in the UK, 2006–2016. BMJ Open. 2020;10(11):e036835.

24. Walker SB, Rossi DM, Sander TM. Women’s successful transition to motherhood during the early postnatal period: A qualitative systematic review of postnatal and midwifery home care literature. Midwifery. 2019;79:103552.

25. Tenessea ZT, Trunese AH. Spatio-temporal distribution and associated factors of home delivery in Ethiopia. Further multilevel and spatial analysis of Ethiopian demographic and health surveys 2005–2016. BMC Pregnancy Childbirth. 2020;20(1):1–16.

26. Sisay MM, Gerezemew TT, Demile YW, Alem AT, Beyene DK, Melak MF, et al. Geographical variation and predictors of zero utilization for a standard maternal continuum of care among women in Ethiopia: a spatial and geographically weighted regression analysis. BMC Pregnancy Childbirth. 2022;22(1):1–18.

27. Mesfin A, Assefa N, Tegi K, Shibru S, Dargarhaw R, Bante A. Essential newborn care practice and its predictors among mother who delivered within the past six months in Chenqra District, Southern Ethiopia. 2017. PLoS One. 2018;13(12):e0208984.

28. Habte A, Gebreiremskel F, Shewangizaw M, Dessu S, Glagen M. Uptake of complete postnatal care services and its determinants among rural women in Southern Ethiopia: Community-based cross-sectional study based on the current WHO recommendation. PLoS One. 2021;16(2):e0246243.

29. Mersha A, Assefa N, Tegi K, Shibru S, Dargarhaw R, Bante A. Essential newborn care practice and its predictors among mother who delivered within the past six months in Chenqra District, Southern Ethiopia, 2017. PLoS One. 2018;13(12):e0208984.

30. Keya KT, Rahman MM, Rob U, Bellows B. Distance traveled and cost of transport for use of facility-based maternity services in rural Bangladesh: a cross-sectional survey. Lancet. 2013;382:17.

31. Smith HC, Saxena S, Petersen I. Postnatal checks and primary care consultations in the year following childbirth: an observational cohort study of 309,573 women in the UK, 2006–2016. BMJ Open. 2020;10(11):e036835.

32. Walker SB, Rossi DM, Sander TM. Women’s successful transition to motherhood during the early postnatal period: A qualitative systematic review of postnatal and midwifery home care literature. Midwifery. 2019;79:103552.

33. Dhakal S, Chapman GN, Simkhada PP, Van Teijlingen ER, Stephens J, Raja AE. Utilization of postnatal care among rural women in Nepal. BMC Pregnancy Childbirth. 2007;7(1):1–9.

34. Keya KT, Rahman MM, Rob U, Bellows B. Distance traveled and cost of transport for use of facility-based maternity services in rural Bangladesh: a cross-sectional survey. Lancet. 2013;382:17.

35. Smith HC, Saxena S, Petersen I. Postnatal checks and primary care consultations in the year following childbirth: an observational cohort study of 309,573 women in the UK, 2006–2016. BMJ Open. 2020;10(11):e036835.

36. Alemu K. Spatial Patterns and Determinants of Postnatal Care Use in Ethiopia: A finding from Demographic and Health Survey.

37. Defar A, Okwaraji YB, Tigrabu Z, Persson LÅ, Alemu K. Geographical differences in maternal and child health care utilization in four Ethiopian regions; a cross-sectional study. Int J Equity Health. 2019;18(1):1–11.

38. Ayale BG, Woldu MA, Gebrehiwot HW, Gebre-Egziabher EG, Gebretesae H, Hadgu T, et al. Magnitude and determinants for the place of postnatal care utilization among mothers who delivered at home in Ethiopia: A multilevel analysis from the 2016 Ethiopian demographic health survey. Reprod Health. 2019;16(1):1–10.

39. Abraha TH, Gebrezielgiabr BB, Aregawi BG, Belay DS, Tikue LT, Reda EB. Factors associated with compliance with the recommended frequency of postnatal care services in four rural districts of Tigray region, north Ethiopia. Kori J Fam Med. 2019;40(5):329.

40. Kanté AM, Chung CE, Larsen AM, Exavery A, Tani K, Phillips JF. Factors associated with compliance with the recommended frequency of postnatal care services in three rural districts of Tanzania. BMC Pregnancy Childbirth. 2015;15(1):341.

41. Nduugga P, Namiyonga NK, Sebuwufu D. Determinants of early postnatal care attendance: analysis of the 2016 Uganda demographic and health survey. BMC Pregnancy Childbirth. 2020;20(1):163.

42. Akunga D, Menya D, Kabue M. Determinants of postnatal care use in Kenya. Afr Popul Stud. 2014;28(3):1447–59.

43. Chaka EE, Abdurahman AA, Nedjat S, Majdzadeh R. Utilization and determinants of postnatal care services in three rural districts of Tanzania. BMC Pregnancy Childbirth. 2017;16(2):e0246243.

44. Kote G. Determinants of postnatal care check-ups in Ethiopia: A Multi-Level Analysis. Ethiop J Health Sci. 2021;31(4):1029–857.

45. UNICEF. Maternal and Newborn Health Disparities in Ethiopia. 2017. Available from: Maternal and Newborn Health Disparities in Ethiopia. https://data.unicef.org/resources/maternal-newborn-health-disparities-country-profiles.
44. Tesema GA, Mekonnen TH, Teshale AB. Individual and community-level determinants, and spatial distribution of institutional delivery in Ethiopia, 2016: Spatial and multilevel analysis. PLoS One. 2020;15(11):e0242242.
45. Solanke BI, Amoo EO, Idowu AE. Improving postnatal checkups for mothers in West Africa: A multilevel analysis. Women Health. 2018;58(2):221–45.
46. Saira A, Wilson LA, Ezeh KO, Lim D, Osuagwu UL, Agho KE. Factors associated with non-utilization of postnatal care among newborns in the first 2 days after birth in Pakistan: a nationwide cross-sectional study. Glob Health Action. 2021;14(1):1973714.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.