

# Geographic Distribution and Determinants of Postnatal Care Utilization In Ethiopia: Spatial and A Multilevel Analysis of the Recent Demographic and Health Survey

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## ABSTRACT

**Introduction:** Maternal and child health problems are very diverse and arises from maternal services like postnatal care. However, the low postnatal care being reported in middle and low-income countries are from the multiple factors, which change over geographic space and time and need timely assessments. Therefore, the current study was aimed to assess the prevalence, spatial variations and its associated factors from country representative data.

**Methods:** A secondary data analysis was conducted on the data from EMDHS 2019 on the 2,158 mothers with birth record in last 2 years. Global Moran's I statistics and Getis Ord Gi\* statistics tools were used to visualize the spatial pattern and identify hotspot/cold spot areas, respectively. Kulldorff SaTScan was used to detect purely significant spatial clusters. A multilevel binary logistic regression applied to examine the relationship between postnatal care and its determinants. Variables included into the model at p-value of <0.25. Descriptive statistics was presented using mean, numbers, standard deviation and proportion while, inferential statistics presented using AOR with 95% CI where association was declared at p-value of <0.05.

**Results:** From the analysis, the postnatal coverage from EMDHS 2019 was 11.91% (95% CI: 10.54%, 13.28%). There was significant geographical variation within the country; high regional prevalence of postnatal care utilization was detected in Tigray, Central Amhara and Oromia and Northern part of SNNP regions. Whereas, low prevalence was observed in Somali and Afar regions. Mothers who had ANC service for 1-3 times [AOR=4.08; 95% CI: 2.25, 7.43], ANC 4 or more times [AOR=4.87; 95% CI: 2.62, 9.05] and gave birth through caesarean section [AOR=1.72; 95% CI: 1.08, 2.73] are factors which had positive association with postnatal care. Whereas, delivery attended by other non-professional individuals [AOR=0.29; 95% CI: 0.12, 0.77], mothers who live in Afar 73% [AOR=0.27; 95% CI: 0.12, 0.64], Somali [AOR=0.33; 95% CI: 0.12, 0.86] and Benishangul Gumuz regions [AOR=0.42; 95% CI: 0.19, 0.91] were negatively associated factors with postnatal care service utilization.

**Conclusion and recommendation:** According to this analysis, postnatal care in the country was below the expected level recommended by the WHO. Although high proportion of uneducated mothers, low antenatal coverage, low institutional delivery and birth attendance need the major operation, the association beyond these with number of antenatal cares, delivery attendance and the pastoralist regions require government and international community commitments. Regional specific interventions should be launched by the government and other stakeholders, which is confirmed and supported by local academic research in regions with low prevalence, to tackle those determinant factors.

**Keywords:** Geographic distribution, postnatal care, determinants, maternal health services, Ethiopia

## 1. Introduction

The United Nations (UN) Sustainable Development Goals (SDG) planned to reduce maternal mortality rate to 70 per 100,000 live births in 2030. Yet, maternal mortality rate was 152 per 100,000 live births worldwide and it was 533 per 100,000 live births in sub-Saharan Africa (SSA) in 2020. In Ethiopia, the rate was 412 per 100,000 live births in 2020<sup>1-3</sup>.

Similarly, infant and child mortality rates are among the basic indicators used to measure a country's socioeconomic situation and quality of life. Globally, above one million newborns die every year during the first 24 hours after delivery and almost all of these deaths occur in the developing countries. The neonatal mortality rates were 28 deaths per 1,000 live births in SSA. Similarly, the 2019 Ethiopia Mini Demographic and Health Survey (EMDHS) report revealed that neonatal mortality rate was 30 deaths per 1,000 live births. The majority of causes for maternal mortality (75%) were related to preeclampsia, eclampsia, postpartum infections, prolonged labor and unsafe abortions<sup>4-6</sup>.

Utilizing maternal health services during pregnancy, labor and delivery and the postpartum period highly prevent the maternal and newborn morbidity and mortality. Postnatal care (PNC) service is one of a fundamental element of the continuum of essential maternal health services given at the time from an hour after delivery of a newborn to 6 consecutive weeks. World Health Organization (WHO) defines PNC as a care given to the mother and her newborn child right after delivery up to 42 days of postpartum periods. Accordingly, WHO recommends a mother and her newborn baby to receive PNC within 24 hours of delivery, on day two to three, in the second to third week and 6 weeks after birth<sup>7,8</sup>.

The 2019 report of UNICEF showed that PNC service utilization among mothers and newborns within the first 42 days of birth were 63% and 48% respectively<sup>9</sup>. In fact, the service is the most neglected, least utilized and with high rate of discontinuity among maternal and child survival interventions in the developing countries including Ethiopia. The study conducted in 36 SSA countries by using the most recent DHS data reported that 52.48% of mothers had utilized PNC service<sup>10</sup>. In Ethiopia, the PNC service coverage was very poor (6.9%), which is illustrated by the findings from secondary data analysis of the 2016 Ethiopian Demographic and Health Survey (EDHS)<sup>11</sup>.

Previous studies conducted in Ethiopia and other developing countries has identified the predictors of PNC service utilization. The studies revealed maternal age, maternal education, paternal education, wealth quintile, religion, occupation, media exposure, distance to health facility, number of ANC visits, place of delivery, mode of delivery, parity, region and type of place of residence as determinants of PNC service utilization<sup>10,12-18</sup>.

It is known that the determinants of PNC service utilization vary between populations with different socio-economic and demographic conditions, having different structures of health system, with diverse cultures and various geographical locations. Studies conducted at national level have prominent contributions in designing appropriate policies that help to intervene the gap shown in utilizing PNC service. Using multilevel mixed-effects logistic regression model help to consider variations observed due to clustering effect and to identify both the individual

and community level variables, which cannot be handled by traditional logistic regression. Identifying factors that influence PNC service utilization in countries like Ethiopia is much important to overcome the problems and as a result, to reduce morbidity and mortality attributed to poor utilization of maternal health services in general and PNC service in particular.

## 2. Methods

### 2.1. Study settings and data source

This analysis used the 2019 Ethiopian Mini Demographic and Health Survey (EMDHS) data. Demographic and Health Survey (DHS) collects a countrywide representative data on basic health indicators in the five years' time interval. It was used a two-stage stratified sampling technique to select respondents of the survey. The survey included all the 9 regions and the 2 city administrations of Ethiopia. The current study employed Individual Recode (IR) or Kids Recode (KR) file that covers all the collected data in the woman's questionnaire. All Ethiopian women with a live birth 2 years prior the survey was the source population of the study.

### 2.2. Measurements of variables

**2.2.1. Dependent variable:** The response variable for this study was PNC service utilization. It was defined as having at least one visit that was provided by a health professional within 42 days of birth. Thus, the outcome variable was coded as "1" if mother visited at least once after delivery and "0" otherwise.

### 2.2.2. Independent variables:

**2.2.2.1. Individual-level variables:** This includes maternal education, maternal age, religion, marital status, wealth index, timing of 1st ANC check, number of ANC visits, place of delivery, mode of delivery, age of mother at 1st birth, birth order number, type of birth, delivery attendants, family size, parity and mentioned at least 3 pregnancy danger signs. Community-level variables were geographic regions where the mothers live and type of place of residence.

### 2.3. Data processing and statistical analysis

STATA version 14 was used for data processing and analysis. Sampling weight was applied to manage the representativeness of the survey and to account for sampling design when calculating standard errors. We computed summary statistics for each individual and community-level variables and described the results by using texts, tables and figures. Since DHS data had a hierarchical structure, we used multilevel mixed-effects logistic regression model to analyze the data. This model handles the violation of independent observations and equal variance assumption of the traditional logistic regression model. In this model, we fitted four models to estimate both fixed and random effect of the individual and community-level variables. We used the null model, a model without any independent variable, to check the presence of between-cluster variability. Secondly, we included all individual-level factors in the model (Model I). Additionally, Model II was fitted with only community-level variables. Finally, the combined model (Model III) was done with both the individual and community-level variables to identify factors associated with PNC service utilization (net fixed and random effects). Intra-class correlation coefficient (ICC), Proportional Change in Variance (PCV), Median Odds Ratio (MOR) and deviance were used to compare models and identify best-fitted model. We used Variance Inflation Factor (VIF) to test the existence of multicollinearity between covariates.

In this analysis, the mean VIF was 2.49 and this indicates absence of multicollinearity. Variables with p-value <0.25 in the bivariable analysis were considered as candidates for multilevel multivariable analysis. Finally, Adjusted Odds Ratio (AOR) with 95% confidence interval was used to report statistically significant variables with the PNC service utilization.

## 2.4. Spatial analysis

The spatial analysis was carried out using ArcGIS 10.7.1 and SaTScan 9.6. The weighted frequency of outcome variable was cross tabulated with cluster number using STATA software and exported to excel to calculate proportion of PNC service utilization across each cluster. Then the excel file was imported into Arc-GIS 10.7.1 and joined with geographic coordinates of each cluster using each EA's unique identification code for spatial analysis. The units of spatial analysis were DHS clusters (Since geographic coordinates of EDHS were collected at cluster level).

The Global Moran's-I statistics was used to assess the presence of spatial autocorrelation to evaluate whether the pattern of outcome variable is clustered, dispersed or random across the study area. Moran's I is spatial statistics produce a single output value which ranges from -1 to +1. Moran's, I value close to -1 indicates the pattern is dispersed, whereas Moran's I close to +1 indicates clustered and distributed randomly if it is zero. A statistically significant Moran's I with p-value < 0.05, leads to rejection of the null hypothesis (PNC service utilization is randomly distributed across the clusters) and indicates the presence of spatial autocorrelation which needs further local analysis.

The Getis-Ord Gi\* statistic was used to identify local clusters of high values (hotspots) and cluster of low values (cold spots). Getis-Ord Gi\* statistics calculates Gi\* statistic, Z-score and p-value, with Z-score and p-value determines the significance of spatial clustering. If z-score is higher, the intensity of the clustering is stronger whereas Z-score near zero indicates no apparent clustering. A positive z-score indicates clustering of high values and a negative z-score indicates clustering of low values. Spatial interpolation analysis was done using Ordinary Kriging interpolation technique to estimate PNC service utilization in un-sampled areas based on sampled values.

Spatial scan statistical analysis of Bernoulli based model was employed to test for the presence of statistically significant purely spatial clusters of PNC service utilization using Kuldorff's SaTScan version 9.6. It uses a circular scanning window that moves across the study area. Mothers who had used PNC service were taken as cases and those who had not as controls to fit the Bernoulli model. The numbers of cases in each location had Bernoulli distribution and the model required data for cases, controls, population and geographic coordinates. For each potential cluster, a log likelihood ratio test statistic and p-value were computed to determine whether the number of observed cases within the potential cluster was significantly higher than expected or not. The scanning window with maximum log likelihood was the most likely performing cluster and p-value was assigned to each cluster using Monte Carlo hypothesis testing.

## 3. Ethical Considerations

The study used a publicly available secondary data of demographic and health survey data. Initially, we requested the

MEASURE DHS team to access the datasets by completing the online request form on their website ([www.dhsprogram.com](http://www.dhsprogram.com)). Consequently, permission to access the data and the letter of authorization was granted from ICF international. Therefore, for this study consent to participate is not applicable.

## 4. Result

### 4.1. Sociodemographic characteristics of mothers

The present study included 2,158 mothers with a live birth in the 2 years preceding the 2019 EMDHS. Out of these mothers, almost half (49.07%) had no education, one-third were in the age range of 15-24 and half (49.54) were Muslims. Majority of the respondents (94.53) were married and nearly half (48.29%) were from low-income households. Only a quarter (24.51%) of the total women included in the survey live in urban areas of the country and 120 (5.56%) mothers were from Addis Ababa city administration (**Table 1**).

**Table 1:** Sociodemographic characteristics of mothers with a live birth in the 2 years preceding the EMDHS, 2019.

Variables	Frequency (n)	Percentage (%)
<b>Maternal education level</b>		
No education	1,059	49.07
Primary	755	34.99
Secondary and above	344	15.94
<b>Maternal age</b>		
15-24	705	32.67
25-34	1,108	51.34
35-49	345	15.99
<b>Religion</b>		
Orthodox	651	30.17
Protestant	396	18.35
Muslim	1,069	49.54
Others	42	1.95
<b>Married/living with partner</b>		
No	118	5.47
Yes	2,040	94.53
<b>Wealth index</b>		
Poor	1,042	48.29
Middle	302	13.99
Rich	814	37.72
<b>Region</b>		
Tigray	185	8.57
Afar	237	10.98
Amhara	208	9.64
Oromia	266	12.33
Somali	210	9.73
Benshangul Gumuz	191	8.85
SNNPR	239	11.08
Gambella	172	7.97
Harari	164	7.6
Addis Ababa	120	5.56
Dire Dawa	166	7.69
<b>Place of residence</b>		

Urban	529	24.51
Rural	1,629	75.49

**NB:** SNNPR: South Nations Nationalities and Peoples Region

## 4.2. Reproductive and obstetric characteristics of mothers

Less than one-third of the mothers (30.95%) received their first ANC service in the first trimester of the current pregnancy. On the contrary, more than a quarter of the total participants (26.51%) did not get ANC service at all. In this study, mothers who gave birth at health institution were a bit higher than a half (54.26%) and out of these women, less than one-tenth (7.09%) delivered through caesarean section. More than one-third women (38.88%) gave their first birth before the age of 18. Majority of the mothers (98.7%) gave single birth and delivery attendants for nearly one-third mothers (30.46%) were traditional birth attendants. Furthermore, four in ten mothers (41.61%) were grand multiparous (**Table 2**).

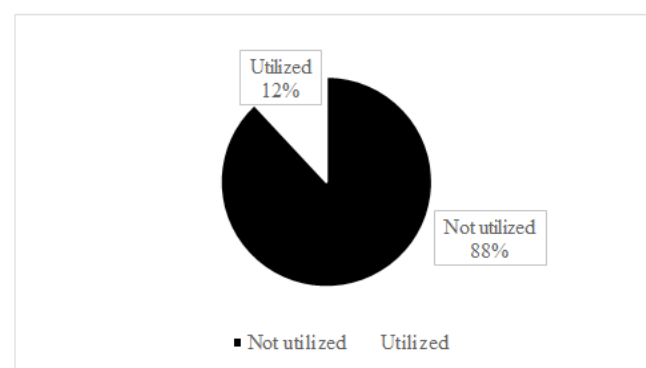
**Table 2:** Distribution of reproductive and obstetric characteristics of mothers of children less than 24 months old in Ethiopia, 2019.

Variables	Frequency (n)	Percentage (%)
<b>Time for first ANC visit</b>		
1st trimester	668	30.95
2nd trimester	810	37.53
3rd trimester	680	31.51
<b>Number of ANC visit</b>		
None	572	26.51
3-Jan	696	32.25
4 and above	890	41.24
<b>Place of delivery</b>		
Home	987	45.74
Health institution	1,171	54.26
<b>Mode of delivery</b>		
Spontaneous vaginal delivery	2,005	92.91
Caesarean section	153	7.09
<b>Age of mother at first birth</b>		
< 18	839	38.88
18-24	1,133	52.5
>24	186	8.62
<b>Birth order number</b>		
1st born	498	23.08
2nd – 4th	1,013	46.94
5th and above	647	29.98
<b>Type of birth</b>		
Single	2,130	98.7
Multiple	28	1.3
<b>Delivery attendants</b>		
Health professionals	1,204	55.82
Traditional birth attendants	657	30.46
Others	296	13.72
<b>Number of household members</b>		
4-Jan	699	32.39
7-May	987	45.74
8 and above	472	21.87

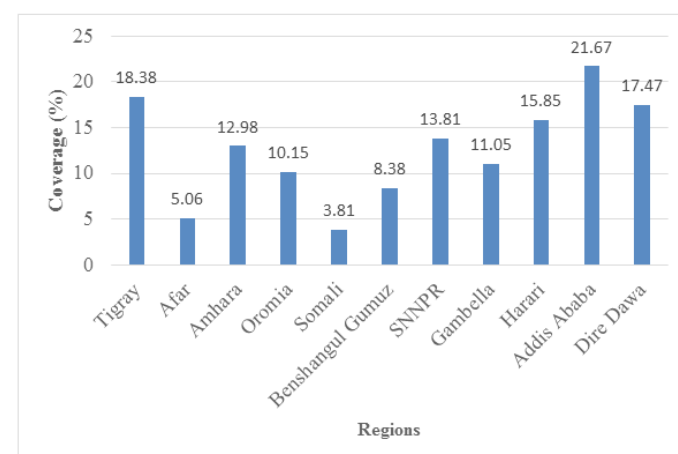
Parity		
Primiparous	498	23.08
Multiparous	762	35.31
Grand multiparous	898	41.61
<b>Mentioned at least 3 pregnancy danger signs</b>		
No	486	22.52
Yes	1,672	77.48

## 4.3. Coverage of postnatal care service utilization in Ethiopian

The coverage of postnatal care service utilization in Ethiopia was 11.91% (95% CI: 10.54%, 13.28%) (**Figure 1**). The coverage was better in the urban areas (15.88%) than the rural areas of the country (10.62%). There was also great discrepancy among the regions; it was 21.67% in the Addis Ababa city administration and 3.81% in the Somali region of Ethiopia (**Figure 2**).



**Figure 1:** Coverage of postnatal care service utilization among Ethiopian mothers who gave birth in the last 24 months preceding the 2019 EMDHS.



**Figure 2:** Coverage of postnatal care service utilization among the different regions of Ethiopia, 2019

## 4.4. Geographic distribution of PNC service utilization

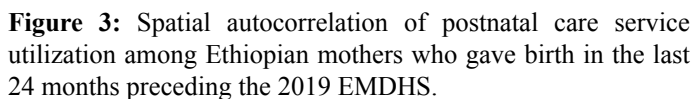
**4.4.1. Spatial autocorrelation (Global Moran's I) analysis result:** The spatial distribution of PNC service utilization found to be non-random with a global Moran's I statistic value of ( $I=0.55$ ,  $P\text{-value} < 0.01$ ) (**Figure 3**). Given the z-score of 4.37, there is less than 1% likelihood that the clustered pattern could be the result of random chance. Therefore, the null hypothesis was rejected, which was stated that PNC utilization is distributed randomly. It, told us the presence of local cluster of PNC service utilization, which needs to be further explained using local statistics. The incremental autocorrelation was determined using



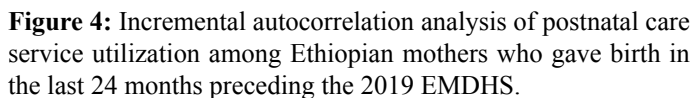
**Moran's Index:** 0.054748  
**z-score:** 4.374016  
**p-value:** 0.000012

**Significance Level (p-value)**

0.01	< -2.58
0.05	-2.58 ~ -1.96
0.10	-1.96 ~ -1.65
...	-1.65 ~ 1.65
0.10	1.65 ~ 1.96
0.05	1.96 ~ 2.58
0.01	> 2.58

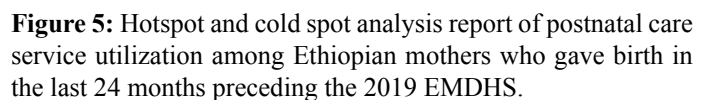


**Figure 3:** Spatial autocorrelation of postnatal care service utilization among Ethiopian mothers who gave birth in the last 24 months preceding the 2019 EMDHS.

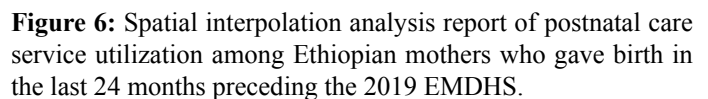


The Getis-Ord Gi\* statistical analysis result indicated that the geographic distribution of PNC service utilization was clustered in some parts of the country. Significant hotspot (high prevalence) of PNC was detected in Tigray, Amhara, Central Oromia and Northern part of SNNP regions. Whereas, statistically significant cold spots (low prevalence) were found in Dire Dawa, Harari, South Afar and Northern part of Somali regions of Ethiopia with 90%-99% confidence levels (**Figure 5**).

Geo-statistical Ordinary Kriging analysis predicted that the highest frequency of PNC service utilization in Central Oromia, North and Central Amhara regions. In contrast, area with relatively lowest frequency was detected in most part of Benshangul Gumuz, Somali, Afar and Gambella regions (**Figure 6**).



**Figure 5:** Hotspot and cold spot analysis report of postnatal care service utilization among Ethiopian mothers who gave birth in the last 24 months preceding the 2019 EMDHS.



**Figure 6:** Spatial interpolation analysis report of postnatal care service utilization among Ethiopian mothers who gave birth in the last 24 months preceding the 2019 EMDHS.

Purely spatial analysis was conducted with Cudldorff spatial saTScan analysis to detect primary spatial clusters of PNC utilization. Primary and secondary clusters of PNC utilization were identified. A total of 5 significant clusters were identified, of which, 1 was most likely (primary) cluster and 4 were secondary clusters. The primary clusters spatial window was detected in Somali region and around Oromia-Somali borders, located at 5.479641 N, 42.196835 E of geographic location with 414.10 km radius and with maximum Log-Likelihood ratio (LLR) of 15.49 (**Table 3**). It stated that women within this spatial window had 0.21 times more likely to use PNC service than those outside this area of the spatial window (**Figure 7**).

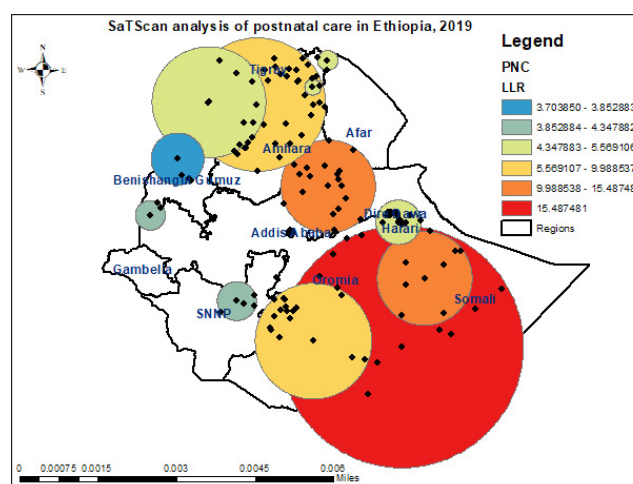
In the multilevel multivariable mixed-effects logistic regression analysis, number of ANC visits, mode of delivery, delivery attendants and geographic regions were identified as statistically significant variables with PNC service utilization among mothers who gave birth in the last 2 years prior the 2019 mini survey. Accordingly, mothers who had received ANC service for 1-3 times and 4 and more times were 4 [AOR=4.08; 95% CI: 2.25, 7.43] and 4.9 [AOR=4.87; 95% CI: 2.62, 9.05] times more likely to utilize PNC service than mothers who had no

ANC visit. Likewise, mothers who gave birth through caesarean section were 1.7 [AOR=1.72; 95% CI: 1.08, 2.73] times more likely to utilize PNC service as compared to those mothers who gave birth through spontaneous vaginal delivery. Additionally, mother whose delivery attendant was other unskilled individual were 71% [AOR=0.29; 95% CI: 0.12, 0.77] less likely to utilize PNC service than mother whose delivery attendant was health professional. Moreover, from the community-level factors,

region where the mother resides was found to be a significant predictor of PNC service utilization. The odds of PNC service utilization among mothers who live in Afar, Somali and Benshangul Gumuz regions respectively were 73% [AOR=0.27; 95% CI: 0.12, 0.64], 67% [AOR=0.33; 95% CI: 0.12, 0.86] and 58% [AOR=0.42; 95% CI: 0.19, 0.91] lower than mothers who live in the Tigray region of Ethiopia (**Table 4**).

**Table 3:** SaTScan report on significant clusters of postnatal care service utilization among Ethiopian mothers who gave birth in the last 24 months preceding the 2019 EMDHS.

Type of clusters	No. of locations	Coordinate/radius	Population	case	RR	LLR	P-value
Primary	29	(5.479641 N, 42.196835 E) / 414.10 km	254	7	0.21	15.487481	0.00015
Secondary	14	(8.995815 N, 38.793907 E) / 8.02 km	63	23	3.27	13.223402	0.0011
Secondary	20	(10.419190 N, 39.928658 E) / 159.16 km	146	2	0.11	12.498837	0.0022
Secondary	9	(7.595318 N, 42.898767 E) / 160.96 km	86	0	0	11.143412	0.011
Secondary	1	(7.596968 N, 38.357304 E) / 0 km	12	8	5.75	9.988537	0.020



**Figure 7:** Spatial SaTScan analysis of postnatal care service utilization among Ethiopian mothers who gave birth in the last 24 months preceding the 2019 EMDHS.

**Table 4:** Multilevel multivariable logistic regression analysis result of postnatal care service utilization in Ethiopia, 2019.

Variables	Null model	Model I AOR (95% CI)	Model II AOR (95% CI)	Model III AOR (95% CI)
<b>Maternal education level</b>	-		-	
No education	-	1	-	1
Primary	-	1.31 (0.93, 1.83)	-	1.23 (0.87, 1.73)
Secondary and above	-	1.33 (0.86, 2.04)	-	1.16 (0.74, 1.82)
<b>Number of ANC visit</b>	-		-	
None	-	1	-	1
1 to 3	-	4.49 (2.48, 8.11) ***	-	4.08 (2.25, 7.43) ***
4 and above	-	5.46 (2.97, 10.03) ***	-	4.87 (2.62, 9.05) ***
<b>Place of delivery</b>	-		-	
Home	-	1	-	1
Health institution	-	0.57 (0.25, 1.31)	-	0.52 (0.23, 1.19)
<b>Mode of delivery</b>	-		-	
Spontaneous vaginal delivery	-	1	-	1
Caesarean section	-	1.80 (1.14, 2.86) *	-	1.72 (1.08, 2.73) *
<b>Delivery attendants</b>	-		-	
Health professionals	-	1	-	1
Traditional birth attendants	-	0.68 (0.29, 1.59)	-	0.72 (0.31, 1.68)
Others	-	0.33 (0.13, 0.86) *	-	0.29 (0.12, 0.77) *
<b>Mentioned at least 3 pregnancy danger signs</b>	-	-	-	
No	-	1	-	1

Yes	-	0.74 (0.54, 1.02)	-	0.75 (0.55, 1.02)
<b>Region</b>	-	-	-	
Tigray	-	-	1	1
Afar	-	-	0.22 (0.09, 0.50) ***	0.27 (0.12, 0.64) **
Amhara	-	-	0.65 (0.32, 1.30)	0.67 (0.34, 1.34)
Oromia	-	-	0.49 (0.24, 0.98)	0.57 (0.28, 1.13)
Somali	-	-	0.16 (0.06, 0.41) ***	0.33 (0.12, 0.86) *
Benshangul Gumuz	-	-	0.38 (0.17, 0.84) *	0.42 (0.19, 0.91) *
SNNPR	-	-	0.65 (0.33, 1.29)	0.85 (0.43, 1.68)
Gambella	-	-	0.55 (0.25, 1.17)	0.64 (0.29, 1.36)
Harari	-	-	0.78 (0.37, 1.63)	0.86 (0.41, 1.78)
Addis Ababa	-	-	0.97 (0.43, 2.21)	0.90 (0.41, 2.01)
Dire Dawa	-	-	0.82 (0.39, 1.17)	0.82 (0.40, 1.69)
<b>Place of residence</b>	-	-		
Urban	-	-	1	1
Rural	-	-	0.76 (0.49, 1.17)	1.03 (0.66, 1.62)

#### 4.9. Random effect analysis result

The result of random effect estimates obtained after fitting the four models (Null model, Model I, Model II and Model III) were depicted in the Table 4. The presence of likelihood of PNC service utilization variation within the 9 regions and 2 city administration of the country was shown by the ICC of the Null model (ICC=20.2%). This indicates that 20.2% of the variation

in PNC service utilization among mothers of children less than 2 years old was attributed to the difference between the regions. Additionally, the highest PCV (49.39%) in the final model (Model III) implies the majority of variations of PNC service utilization among mothers observed in the null model was explained by both individual and community-level factors. Also, the lowest deviance in the last model showed that the model III was the best fitted model (**Table 5**).

**Table 5:** Random effect analysis result.

Parameters	Null model	Model I	Model II	Model III
Community level variance (SE)	0.83	0.54	0.52	0.42
ICC (%)	20.2	14.2	13.7	11.2
PCV (%)	Reference	34.94	37.35	49.39
MOR	2.36	2.01	1.97	1.86
Log-likelihood	-770.93	-726.18	-750.69	-717.09
Deviance	1,541.86	1,452.36	1,501.38	1,434.18
AIC	1545.86	1474.24	1527.38	1478.19
BIC	1557.21	1536.68	1601.18	1603.08

## 5. Discussion

From the analysis, the proportion of PNC service utilization in Ethiopia was 11.91% (95% CI: 10.54%, 13.28%). It is 6.9% from 2016 EDHS<sup>11</sup>; however, it is contradicting with finding reported the proportion of 9.7% to 2011<sup>19</sup>. From small scale studies it is less than 29.7% proportion in Sidama region<sup>20</sup> and 28.4% in Northern Shoa<sup>21</sup> and 36.8% in the country sample<sup>22</sup>. This finding is also less than the East African countries proportion and sub some studies. It is less than 90.4% proportion in Sierra Leone<sup>23</sup> and 52.48% sub-Saharan magnitude<sup>10</sup>. The difference indeed worrying as the increase from 2011 to 2016 and 2016 to 2019 were just unconceivable. The coverage decreased from 2011 to 2016 by 3% and increased from 2016 to 2019 only by around 4%. It is an indication of unstable and not directed improvement that requires another stair effort. From this analysis, ANC is only 30.95%. This is less than 44% finding from Ethiopia<sup>19</sup>, 91.2% finding from the study conducted in four regions (Oromia, Amhara, SNNP and Tigray)<sup>10</sup> and is also less than the 78% finding in Sierra Leone<sup>23</sup>. The finding was also very small compared to other small scale and large-scale studies.

It is consistent with other maternal factors in this study, which enquire attention diversion for all fallouts. Such impression has been since so long and might continue unless those grasses rooted problems in pastoralists region resolved. The country is in multifactorial problems when we see 30.46% of births still attended by traditional birth attendants and home delivery remained at 45.74%. This situation is not much different from other studies with in the same period showed another 64.31% and 52.50%<sup>24-26</sup> and traditional birth attendance is remained at 44.08% from another study<sup>26</sup>.

Overall, place of delivery, postnatal care, antenatal care and birth attendants' causes unprecedented health problem to mother-child in the country and without interruption if these things go on, the future is very difficult to see any optimism as per these evidences. Maternal education is always in the equation although the improvement similarly remained under par where 49.07% of women were uneducated. It is also supported by loads of evidence in the available literature<sup>20,22,26-29</sup>. There many factors might be causing such problems like number of ANC visits, mode of delivery, delivery attendants and geographic regions

were identified statistically associated. One-three and four or above ANC clearly influenced up taking of PNC. This finding is supported by many studies in the country and region<sup>10,25,27-29</sup>. The consistent information might indicate maternal education should always come first to start from. The fact that caesarean section is the only delivery procedure which cannot be performed outside health institutions and since it requires highly trained health professionals, its positive association with increased PNC shows its importance<sup>21,22,28</sup>. The relationship of PNC with the delivery performed by trained health professionals was also manifested, when it is decreased by 71% if carried out by non-trained individuals. This is also consistent with other studies in the country which indicate the time mothers pass with trained health professionals worth everything<sup>19,28</sup>. As a big headache for the pastoralists and semi-pastoralist regions are always riding down from the improvement.

In this study compared to the Tigray region, pastoralists regions like Somali and Afar had a decreased PNC by 73% and 67% respectively followed by 58% decrease in Benishangul Gumuz which loads of literatures in Ethiopia say the same thing all around<sup>11,22</sup>. This may indicate that missing spicy is focusing these regions to increase national coverage. Even though this study used the most recent data from DHS national survey, it has some drawbacks that need consideration during using. Disproportional nature of sampling, secondary nature data and cluster nature of the data. We, strictly followed analysis guidelines commonly applied internationally, weighted the data considering both strata and primary sampling units and applied multilevel analyses, which considered clustering nature of data.

## 6. Conclusion

The postnatal care service in Ethiopia was very small compared to findings both in the country and in Sub-Saharan region. Variables like number of ANC visits, mode of delivery, delivery attendants and geographic regions were identified statistically associated. One-three and four or above ANC clearly influenced up taking of PNC and should be consider during the next intervention planning. Pastoralists regions carry much of the burden posed by the problem and women in this region might suffer a lot from the problem. Improvement in these regions might also raise the regional and national coverage and a great deal from the policy makers. Overall, postnatal care, antenatal care, increasing exposure of women through institutional delivery and maternal education might deserve separate intervention that might enquire government commitment and international community support.

## 7. Abbreviation/Acronyms

Ethiopian Demographic Health Survey (DHS); Ethiopian Mini Demographic Health Survey (EMDHS); World Health Organization (WHO); United Nation Children's Fund (UNICEF); South Nations Nationalities and Peoples Region (SNNPR); Confidence Interval (CI); Antenatal Care (ANC); Postnatal Care(PNC); Log Likely-hood (LL); Akaike Information Criterion (AIC); Baye's Information Criterion (BIC); log-likelihood(-2LL); Intra-class Correlation Coefficient (ICC), Proportional Change in Variance (PCV), Median Odds Ratio (MOR)

## 8. Declarations

### 8.1. Ethics approval and consent to participate

This study used secondary data from demographic and

health survey data files. Initially, the MEASURE DHS team was formally requested to access the datasets by completing the online request form on their website ([www.dhsprogram.com](http://www.dhsprogram.com)). Accordingly, permission to access the data and the letter of authorization was obtained from ICF international. Therefore, for this study consent to participate is not applicable. We kept all data confidential and no effort was made to identify households or individuals. The Ethiopian Health Nutrition and Research Institute (EHNRI) Review Board and the National Research Ethics Review Committee (NRERC) at the Ministry of Science and Technology of Ethiopia, approved EMDHS 2019. The authors also confirm that all methods were carried out in accordance with relevant guidelines and regulations.

### 8.2. Consent for publication

Not applicable.

### 8.3. Availability of data and materials

The survey dataset used in this analysis is the third-party data from the demographic and health survey website ([www.dhsprogram.com](http://www.dhsprogram.com)) and permission to access the data is granted only for registered DHS data user.

### 8.4. Competing interests

The authors have declared that no competing interest existed.

### 8.5. Funding

The authors received no specific funding for this work.

### 8.6. Authors' contribution

GG has analyzed the EMDHS data while, SS was equally involved in the conception of the study, interpreted the results, drafted and critically revised the manuscript and YA was involved in spatial analysis and critically revised the manuscript. All authors have read and approved the final version of the manuscript.

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