

Determinants and spatial distribution of institutional delivery in Ethiopia: evidence from Ethiopian Mini Demographic and Health Surveys 2019

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1 **Title: Determinants and spatial distribution of institutional delivery in Ethiopia: evidence**
2 **from Ethiopian Mini Demographic and Health Surveys 2019**

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24 **Abstract**

25 **Background:** over the past few decades, maternal and child mortality had drawn the attention of
26 governments and policymakers. Institutional delivery has been among the implementations to
27 reduce maternal and child mortality. The fact that the problem was persisted made studies
28 research for more factors. Thus, the current study was intended for further analyses of EMDHS
29 to identify the magnitude and its spatial patterns and predictors of in institutional delivery.

30 **Methods:** A cross-sectional survey data from EMDHS 2019 was analyzed involving 5,488
31 reproductive-age women regarding institutional deliveries. We presented descriptive statistics
32 using mean, standard deviations, and proportions. To check the nature of the distribution of
33 institutional delivery, we applied the global Moran's I statistics. Getis-Ord Gi statistics was
34 applied to detect spatial locations, and we applied spatial interpolation to predict unknown
35 locations of institutional delivery using the Ordinary Kriging method. Kulldorff's SatScan was
36 also applied to identify the specific local clustering nature of institutional delivery using the
37 Bernoulli method. We applied multilevel binary logistic regression for the scrutiny of Individual
38 and community-level factors. We applied $P < 0.25$ to include variables in the model and $P < 0.05$
39 to declare associations. AOR with 95% CI was used to describe variables

40 **Results:** The prevalence of institution/facility delivery was 2,666.45(48.58%) in the survey. The
41 average number of children was 4.03 ± 2.47 , and most women in this survey were in the age
42 group of the 25-29years (31.84%) and 30-34 years (21.61%). Women who learned primary
43 education (AOR=1.52; 95% CI 1.20-1.95), secondary education (AOR=1.77; 95% CI 1.03-3.07),
44 and higher education (AOR=5.41; 95% 1.91-15.25), while those who can read and write
45 sentence (AOR=1.94; 95% 1.28-2.94), Rich (AOR=2.40 95% CI 1.82-3.16), and those followed
46 1-2 ANC (AOR=2.08; 95% CI 1.57-2.76), 3 ANCs (AOR=3.24; 95% CI 2.51-418), and ≥ 4
47 ANCs (AOR=4.91; 95% CI 3.93-6.15) had higher odds of delivering at health institutions.

48 **Conclusion:** The institutional delivery was unsatisfactory in Ethiopia, and there were various
49 factors associated differently across the regions. Pastoralist regions showed high home delivery
50 than institutions which invites further interventions specific to those regions. Factors like age,
51 highest education level achieved, preceding birth interval, literacy status, wealth status, birth
52 order, regions, and rural residences were all affected institutional delivery so that interventions
53 considering awareness, access, and availability of the services are vital.

54 **Keywords:** institutional delivery; spatial distribution; Ethiopia; EMDHS data

55 **Plain English summary**

56
57 Maternal and child mortality had drawn the attention of governments and policymakers
58 internationally since 1990s. A lot has been said and tried to reduce maternal and child mortality
59 rates by the government of Ethiopia. Initially, toward the end of MDGs, the country has been
60 successful in achieving some of the goal related to child and maternal mortality. However, after
61 scene of many implementations, now everything looks downcast again. This fact sparked the
62 need to re-assess the status of the country and provide information for further policy decisions.
63 Currently, we were aimed at providing country representative information from EMDHS
64 analysis regarding the magnitude and its spatial pattern and predictors of in institutional delivery.
65 Factors like age, highest education level achieved, preceding birth interval, literacy status, wealth
66 status, birth order, regions, and rural residences were all affected institutional delivery. However,
67 the fact that home delivery instead of institutional was higher in pastoralist regions in the country
68 should draw more attentions to make interventions considering awareness, access, and
69 availability of the services in vital areas.

70 **Background**

71 The safety of the mother and newborn is always the target during delivery and can be improved
72 by institutional delivery. Developing countries have many constraints in reducing maternal and
73 newborn problems due to access, availability, and awareness(1). As a country in the Sub-Saharan
74 region, Ethiopia got similar limitations regarding maternal and child cares. Henceforth, the
75 country planned to increase institutional delivery from 20% in 2011 to 60% in 2015(2). Because
76 of the various factors, the country wasn't able to achieve as planned. Many studies indicated that
77 there was a high proportion of home delivery in the country(3,4,5,6,7,8,9,10). There were
78 various factors cited affecting women to prefer home over institutions for delivery. A study
79 conducted in the Farta district indicated that the magnitude of institutional delivery was 64.4%.
80 Family size, accessibility of transportation, planned pregnancy, information about the place of
81 delivery, participation of women in monthly health conference (PWMHC), information about

82 exempted service, and having antenatal care (ANC) follow up during their last pregnancy were
83 predictors(11,12). In other studies, institutional delivery was 38.9% and influenced by focused
84 antenatal care, multiple gestations, urban residence, and formal education of the women(13,14).

85 Residence, region, maternal education, wealth status, ANC visit, preceding birth interval, and
86 community media exposure were all predictors of the institutional delivery from other
87 studies(15,16,17). Institutional delivery was 18.2% in Oromia regional state, where urban
88 residence, maternal education, pregnancy-related health problems, previous history of prolonged
89 labor, and the decision made by the husbands or relatives put forth a positive correlation(18).

90 There was a high variation throughout different administrative levels in the country. For
91 instance, institutional delivery was 72% in Bule Hora in Oromiya(19); 89.1% in Damot district
92 in SNNP(20); 61.5% in North-Western part of the country(21); 76% in Southwest Ethiopia(22);
93 71.7% in Dejen Woreda; 78.8% in Bahir Dar(23); 18.3% in Dangila woreda; 47% in semi-urban
94 parts of the country(24); 38% in Mandura district(25); 53% in Hossana town(26); 74% in
95 Dallocha town (27) and 49% in Hetosa district (28). The rate of increase was 5.4% in 2000 and
96 11.8%,2011 (29). Ethiopia showed a good achievement toward the millennium development goal
97 five (31), although the contextual facts look unchanged significantly. The plan to upsurge
98 institutional delivery from 20% in 2011 to 60% in 2015 was not adequately achieved until
99 recently from the above literature. In the countries like Ethiopia where resources are very
100 limited, there were limited chances to collect country representative data; however, analyzing the
101 data from EMDHS enabled us to provide the country-level figures. And it is paramount to
102 identify modified and persistent factors for unsuccessful next health plans. Therefore, our study
103 was aimed at identifying the prevalence and factors through spatial, descriptive, and multilevel
104 analyses to support further policies.

105 **Methods and Materials**

106 **Data source and participants**

107 For this analysis, we used Ethiopia Mini Demographic Health Survey (EMDHS) 2019 data.
108 Ethiopia is the country located at (3o-14oN, 33o – 48°E). EMDHS is an interim survey carried
109 out between EDHSs with the country representative sample. All nine regions and two city
110 administrations were involved in the data collection. The regions were further categorized as
111 agrarian (Benishangul-Gumuz Amhara, Southern Nations, Nationalities, and People Gambela,
112 Oromia, Harari, Region (SNNPR), and Tigray), pastoralists (Afar and Somali), and city
113 administrations (Addis Ababa and Dire-Dawa) contextually. We retrieved the data from the DHS
114 website: (www.dhsprogram.com) after the measure program allowed us to download the
115 datasets. The weighted sample became 5,488 women who had live births in the last five years
116 before the survey. They conducted the interview on the permanent residents and visitors who
117 stayed the day before the survey in the residences, and it was a face-to-face manner. Socio-
118 demographic characteristics, fertility determinants, child vaccination, family planning, infant and
119 child mortality, maternal and child care, and nutrition of children were some variables included
120 in the questionnaire (32).

121 **Study variables**

122 The outcome variable for this study was the health institutions/facilities delivery, which was
123 coded as “0” if the women gave birth at home and “1” if the women gave birth at a health
124 facility. Institutions/facilities delivery was stated as the births at health institution/facility within
125 five years afore the survey.

126 **Individual-level (covariates) variable:** Maternal education, maternal age, religion, ANC
127 follow-up, sex of household head, literacy, the total number of children, birth order, preceding
128 birth interval, the timing of 1st ANC visit, wealth index, and marital status were the variables.

129 **Community-level variable:** region and place of residence

130 **Statistical analysis**

131 **Descriptive statistics**

132 Before we conducted the descriptive data analysis, we weighted the data to adjust the non-
133 proportional allocation of samples to strata and regions. Then, descriptive statistics were
134 presented using weighted frequencies, mean \pm (standard deviations), and percentage, while all
135 analyses were performed using STATA version 15 (STATA Corporation. IC., TX, USA). The
136 mean-variance inflation factor also was checked to be 3.53, which was in the acceptable range.

137 **Spatial analysis**

138 For spatial analysis, we used ArcGIS 10.7 that determined the clustering, dispersion, and random
139 distribution nature of the institutional delivery. Moran's I output lies between (-1 to +1). The
140 values close to -1 indicated dispersed institutional delivery, and those closes to $+1$ indicated
141 clustering distribution. After discovering significant global autocorrelation, we tested the local
142 Getis Ord statistics to identify the areas with high and low institutional deliveries (33).

143 **Spatial interpolation**

144 For statistical optimization of the weight, the Ordinary Kriging spatial interpolation method was
145 applied, and that was enabled the prediction of institutional delivery for un-sampled areas of the
146 country.

147 **SaTscan analysis**

148 SaTScan Version 9.6 software was used for the local cluster detection. A circular window that
149 moves systematically throughout the study area was used to identify a significant clustering of
150 institutional delivery. We presented the results of primary and secondary observed clusters using
151 log-likelihood (LL) and p-value <0.05.

152 **Multilevel binary logistic regression**

153 Since the data from country representative surveys are usually clustered or have hierarchical
154 structure, we applied multilevel analysis. To make supplementary intellect from the data, we also
155 applied spatial analyses. The log of the probability of the institutional delivery was modeled
156 using multilevel binary logistic regression as:

$$157 \log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + \beta_1 X_{ij} + \beta_2 Z_{ij} + u_{ij}; \text{ where, } i \text{ and } j \text{ are the level 1 (individual) and level 2}$$

158 (community) units; X and Z refer to individual and community-level variables, in sequence. π_{ij} is
159 the probability of the institutional delivery for the i^{th} mother in the j^{th} community. We resolute

160 random effect using Intra-community Correlation (ICC), $ICC = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_b^2}$; where, σ_a^2 is the

161 community level variance and σ_b^2 indicates individual level variance. (σ_b^2) is equal to which is

162 the fixed value. Likelihood Ratio (LR) test for model comparison and deviance (-2LL) for the

163 goodness of fit check were calculated, while Median Odds Ratio (MOR) and Proportional

164 Change in Variance (PCV) were also estimated (34).

165 Finally, the mixed effect model, which included both fixed and random effect variables were

166 fitted. To include variable in the model p-value < 0.25 and to declare association p-value < 0.05

167 were used.

168 AOR with 95% CI was also used to articulate the results.

169 **Descriptive statistics**

170 **Institutional delivery**

171 We analyzed the data on 5,488 weighted reproductive-age women who gave birth in the last five
172 years earlier the survey and found 2,666.45(48.58%) of them delivered at health
173 institution/facility.

174 **Individual-level characteristics:** The average number of children in the survey was 4.03 ± 2.47 ,
175 and the average preceding birth interval was 40.61 ± 26.30 months. Most women in this survey
176 were in the age group of the 25-29years (31.84%) and 30-34 years (21.61%). In other words,
177 53.55% and 35.47% were learned no education and primary education, respectively. Similarly,
178 47.45% of the women had no ANC follow-ups, while 30.52% of women were followed ANC of
179 ≥ 4 visits. Economically, 45.53% of the women were poor, while 35.57% were in the rich
180 category. Nearly two-thirds of the women cannot read and write (64.34%), and those who can
181 read or write the complete sentence were 20.83%.

182 **Community-level characteristics:** The higher portions of the women were from Oromia
183 (40.17%), SNNP (19.94%), and Amhara (18.82%) regions. Three-fourth (75.20%) of the women
184 were from rural-based places of residences (Table 1).

185 **Table 1: Socio-demographic characteristics of women aged 14-49 year in Ethiopia, EMDHS**
186 **2019**

187 **Spatial analysis**

188 **Moran analysis:** Examining spatial autocorrelation, we recognized that the distribution of
189 institutional delivery was non-random in Ethiopia. We also learned that the global Moran's I test
190 was 0.66($p < 0.0001$). As global Moran's I is significant and greater than zero, we concluded that
191 the distribution was clustered. By this, the null hypothesis which stated random distribution of
192 institutional delivery was rejected at Moran's I test of 0.66($p < 0.001$) (Fig.1).

193 **Spatial distribution of institutional delivery:** The geo-distribution of institutional delivery was
194 clustered in some parts of the country. Based on the Gettis-OrdGi statistical analysis, Addis
195 Ababa city, Dire Dawa city, Hawassa town in SNNP, some places in Benishangul Gumuz, and
196 few places in the Oromia region displayed the highest prevalence of institutional delivery
197 showing a significant Z-score with 90% and above confidence levels (Fig.2).

198 **Ordinary Kriging interpolation:** to determine the occurrence of institutional delivery
199 throughout the un-sampled areas, Ordinary Kriging interpolation measured the distance from the
200 known point to predict unknown points/areas and indicated the point in the ranges of the event
201 occurrences. The evidence from Fig.3 showed that the possible areas for the event happening
202 were Addis Ababa, Dire Dawa, Benishangule, Tigray, and some parts of Gambella.

203 **SaTscan statistics:** In all spatial analyses above, we tried to identify the nature of institutional
204 delivery distribution in the country; furthermore, SaTscan statistics enabled us to identify
205 specific local clusters, which are necessary for specific local interventions. According to Table 2
206 and Figure 4, there were one primary/most likely and six secondary and significant clusters in the
207 country. Totally 27 locations with Coordinates/radius - (6.639662 N, 44.465853 E) / 390.28 km)
208 with relative risk (RR) of 1.80 and LL of 187.82 were included in the primary cluster. The
209 cluster was located in the Somali region including some borders of Oromia. It means these areas
210 were 1.80($p < 0.001$) times more at risk of home delivery. The remaining clusters are secondary
211 and presented in Table 2 and Fig.4.

212 **Table 2:** most likely clusters of institutional delivery among women of childbearing age in
213 Ethiopia based on the EMDHS 2019

214 **Multilevel Modeling of the institutional delivery:** During multilevel modeling: age, highest
215 education level achieved, preceding birth interval, literacy status, wealth status, and birth order at

216 the individual level and place of residence and region at community level were significant
217 associated with institutional delivery.

218 **Individual-level:** Women in the age group of 20-24, 25-29, and 30-34 years were 2.87, 2.70, and
219 2.92 times more likely to deliver in institutions with AOR of 2.87(1.02-8.10), 2.70(0.93-7.90),
220 and 2.92(1.29-6.61) respectively. Women who learned primary, secondary and higher education
221 had higher odds of delivering in institutions with AOR of 1.52(1.20-1.95), 1.77(1.03-3.07), and
222 5.41(1.91-15.25) respectively relative to those not educated. The odds of delivering in health
223 institutions were also increased as the preceding birth interval increased with AOR of 1.01(1.01-
224 1.02). Women who can read and write sentences had a high tendency of delivering in health
225 institutions with AOR of 1.94(1.28-2.94) unlike those who can't. Rich women had higher odds
226 of delivering in health institutions with AOR of 2.40(1.82-3.16). Birth order of second had
227 higher odds to happen in institutions than the first birth with AOR of 1.86(1.41-2.44). Moreover,
228 women who followed 1-2, 3, and ≥ 4 ANC visits had higher odds of delivering in health institutions
229 with AOR of 2.08(1.57-2.76), 3.24(2.51-4.18), and 4.91(3.93-6.15) respectively.

230 **Community-level:** women in Tigray, Amhara, Benishangul, SNNP, Gambella, Harari, Addis
231 Ababa, and Dire Dawa had higher odds of delivering in institutions compared to those in Afar
232 with AOR of 9.35(3.83-22.90), 3.82(1.67-8.73), 13.00(5.89-28.69), 4.89(2.21-10.81), 4.22(1.75-
233 10.17), 3.67(1.60-8.42), 13.15(3.22-53.57), and 4.83(2.05-11.38) respectively, while women in
234 those regions who live in a rural area had 78% reduced chance of delivering in health institutions
235 with AOR of 0.18(0.11-0.31) (Table 3).

236 **Table 3: Multilevel modeling of institutional delivery among women aged 15-49 years in**
237 **Ethiopia, 2019**

238 The application of multilevel binary logistic regression was proved vital by abridging the ICC
239 (the variation observed only due to the differences among clusters) from 61% to 28%. The
240 remaining 28% unexplained inter-community variation can be reduced by including more other
241 community-level factors in the model. The increased log-likelihood and decreased deviance were
242 an indication of good model fitness (Table 4).

243 **Table 4: Model comparison and random effect distribution institutional delivery among**
244 **reductive age women in Ethiopia in 2019**

245 **Discussion**

246 **Institutional delivery:** Of the 5,488 women involved in the current study, 48.58% were given
247 births in health institutions. Evidence from other studies in the country unveiled institutional
248 delivery was 71.7% in Dejen(35), 78.8% in Bair Dar(23), 38% in Mandura district(21), and
249 38.9% in 2016 EDHS(13). There was a high variation from pocket studies but it showed good
250 improvement from EDHS 2016. All the inconsistencies might be an indication of inconsistent
251 interventions that need consideration during the next interventions (Table 1).

252 **Individual and community level characteristics:** Although there was no adequate evidence to
253 support, the average number of children was 4.03 ± 2.47 in the current study. In Mizan Tapi
254 SNNP, 40% of the women had 3 to 4 children(36). It was 1 to 4, 2 to 4, and 4 to 6 children in
255 other studies in the country(16,36,37). There were many inconsistencies, but our study might
256 show the representative national figure. In other words, the average birth interval was
257 40.61 ± 26.30 months. Evidence indicated that 43% of women in Ethiopia had an average
258 preceding birth interval of 24-48 months, and in East Africa, 82.1% had a preceding birth
259 interval of ≥ 24 months (39). In Ethiopia and even in the East of Africa, the average ranged
260 between 24 and 48 months that is a good improvement over decades. However, the numbers of

261 uneducated (53%) and economically poor (45.53%) women in this study were still very high.
262 One study indicated that 79.2% of women in Ethiopia were uneducated(39) and resides in poor
263 households(13)(14). The consistent finding might be an indication of unsuccessful previous
264 efforts and need more considerations recently. In the same way, a large proportion of women had
265 no ANC follow-up (47.45%) and 64.34% of them were unable to read and write. Evidence from
266 other studies also showed that 54% of the women giving birth in Ethiopia were unable to read
267 and write(40) and 56% of them followed no ANC(41). Overall, women's literacy status and
268 ANC follow-up have remained below par and invite more intervention. The fact that more than
269 75% of women residing in the rural parts of the country might also contribute to the above
270 findings as indicated in similar studies(16,40) (Table 1).

271 **Spatial distributions:** The attempt of localizing the findings to the specific regions for enhanced
272 interventions was successful; the distribution of institutional delivery could guide interventions
273 as it showed clustering in some parts of the country. The significant Moran's test of positive and
274 greater than zero, the hot/cold spot areas identified with significant z-score, the predictions made
275 from known spatial location of event occurrence (spatial interpolation) of $\geq 0.56\%$, and spatial
276 scan statistics which encircled significant areas were enabled us to identify the regions needed
277 more attention of improving institutional delivery in the country and were supported with other
278 studies(15)(17). From Table 2 and Figures 1, 2, 3, and 4, we recognized the clustering nature of
279 institutional delivery in Ethiopia. Accordingly, Addis Ababa, Hawassa, Dire Dawa, some parts
280 of Benishangule Gumuz, and Oromia were found to be areas with a high proportion of
281 institutional deliveries. However, Somali, Afar, some parts of SNNP, Oromia, and Amhara also
282 showed low institutional delivery. This finding is also consistent with a systematic review done

283 in the country(9), EDHS 2016(5), spatial variation study in Northern Ethiopia, and EDHS 2005-
284 2011 (41,42,43)

285 **Multilevel analysis of predictors:** According to multilevel binary logistic regression analysis,
286 women in the age group of 20-24, 25-29, and 30-34 years had higher odds of institutional
287 delivery. Similar evidences were found in other studies in the country(45, 40). The consistent
288 information might indicate institutional delivery increased at the time women might take more
289 responsibilities for their births in the middle ages of the childbearing period. In other words,
290 women's education and literacy were independent predictors of institutional delivery. This is a
291 very global finding and common in most studies(37,46,47) and might indicate that improving
292 mothers' educational and literacy status might be very vital to robust institutional delivery.
293 Mothers who had any ANC visits showed a high correlation of delivering in institutions. The
294 finding was also supported with plenty of evidence from similar studies(46,37,27). The exposure
295 of mothers to health professional counseling might be a factor that spurred the utilization;
296 however, it might also be because they were the only mothers who had access. Additionally,
297 mothers with rich wealth status had a higher tendency of delivering in institutions as is also the
298 case in other studies(38)(39). This might show that in addition to access and availability,
299 affordability could be considered during interventions. In this study, mothers tend to give birth at
300 health institutions for later pregnancies which were also common to other studies(48) (Table 3).

301 Contextual analysis indicated that except Oromia, all agrarian regions and city administrations
302 showed good institutional deliveries; however, pastoralists regions (Somali and Afar) showed
303 high home deliveries; henceforth, the home delivery was also higher in rural areas. Other studies
304 also supported this finding(17)(5). During this analysis, we recognized many limitations. Using

305 third-party or secondary data and disproportionate sampling were some of the limitations. We
306 applied weighting and multilevel analyses to account for these limitations.

307 **Conclusions**

308 After 2016 EDHS, EMDHS was the first country representative data to make an impression
309 about distribution and factors associated with institutional deliveries in Ethiopia. According to
310 our analysis, although there was good progress from some previous evidence, institutional
311 delivery was still low and requires enhanced further interventions. Factors that contributed to
312 low prevalence were age, highest education level achieved, preceding birth interval, literacy
313 status, wealth status, birth order, regions, and rural residences. The positive correlation of
314 institutional delivery with educational/literacy status, ANC, might invite further interventions in
315 the area of awareness, access, and availability of the service. Regional disparities need specific
316 interventions as pastoralist regions showed poor institutional delivery, while economic support
317 for women in the rural area needs to be in the equation as the part of the further policy
318 interventions.

319 **Abbreviations**

320 WHO = World Health Organization

321 EDHS= Demographic Health Survey

322 EMDHS = Ethiopian Demographic Health survey

323 ANC= Antenatal Care

324 AOR = Adjusted Odds Ratio

325 CI = confidence interval

326 SNNPR /SNNP = South Nations Nationalities people Region

327 EHNRI = Ethiopian Health Nutrition and Research Institute
328 NRERC = Review Board and the National Research Ethics Review Committee
329 ICC= Intra-Cluster Correlation
330 LL=Log likelihood
331 RR=Relative Risk
332 MOR= Median Odds Ratio
333 PCV= Proportional Change in Variance
334 MDG=Millennium Development Goals

335 **Declarations**

336 **Ethics approval and consent to participate**

337 We kept information regarding respondents confidential. We exposed household or individual
338 identifying information neither during analysis nor during the publication. For EMDHS data
339 collection, the Ethiopian Health Nutrition and Research Institute (EHNRI) Review Board and the
340 National Research Ethics Review Committee (NRERC) at the Ministry of Science and
341 Technology were provided permission. After clearing the purpose of the study, verbal informed
342 consent was collected from the participants and all participants' rights were respected.

343 **Consent for participation**

344 Not applicable

345 **Availability of data and materials**

346 The data used in this study are the third-party data available from the Demographic and Health
347 Survey (<http://www.dhsprogram.com>) and can be easily accessed by following the protocol
348 indicated in the methods and materials section.

349 **Competing interest**

350 The authors declare that they have no competing interests.

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352 We received no funds for this work

353 **Authors' contribution**

354 GG developed the proposal, writing results, drafting the manuscript, SH was involved in the
355 conception, analysis, and revising of the final manuscript and BTS was also involved writing
356 results, analysis and drafting manuscript.

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359 gratitude should also goes to the other stakeholders who involved directly or indirectly.

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507

508 **Tables and legends**

509 **Table 1:** Socio-demographic characteristics of women aged 14-49 year in Ethiopia, EMDHS
510 2019

511 **Table 2:** most likely clusters of institutional delivery among women of childbearing age in
512 Ethiopia based on the EMDHS 2019

513 **Table 3:** Multilevel modeling of institutional delivery among women aged 15-49years in
514 Ethiopia, 2019

515 **Table 4:** Model comparison and random effect distribution institutional delivery among
516 reductive age women in Ethiopia in 2019

517 **Figures and legends**

518 **Fig.1:** spatial autocorrelation institutional delivery in Ethiopia, EMDHS 201

519 **Fig.2:** spatial distribution of institutional delivery in Ethiopian, EMDHS 2019

520 **Fig.3:** Ordinary Kriging interpolation of institutional delivery in Ethiopia, EMDHS 2019

521 **Fig.4:** SaTScan scan statistics of institutional delivery in Ethiopia, EMHS 2019

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Figures

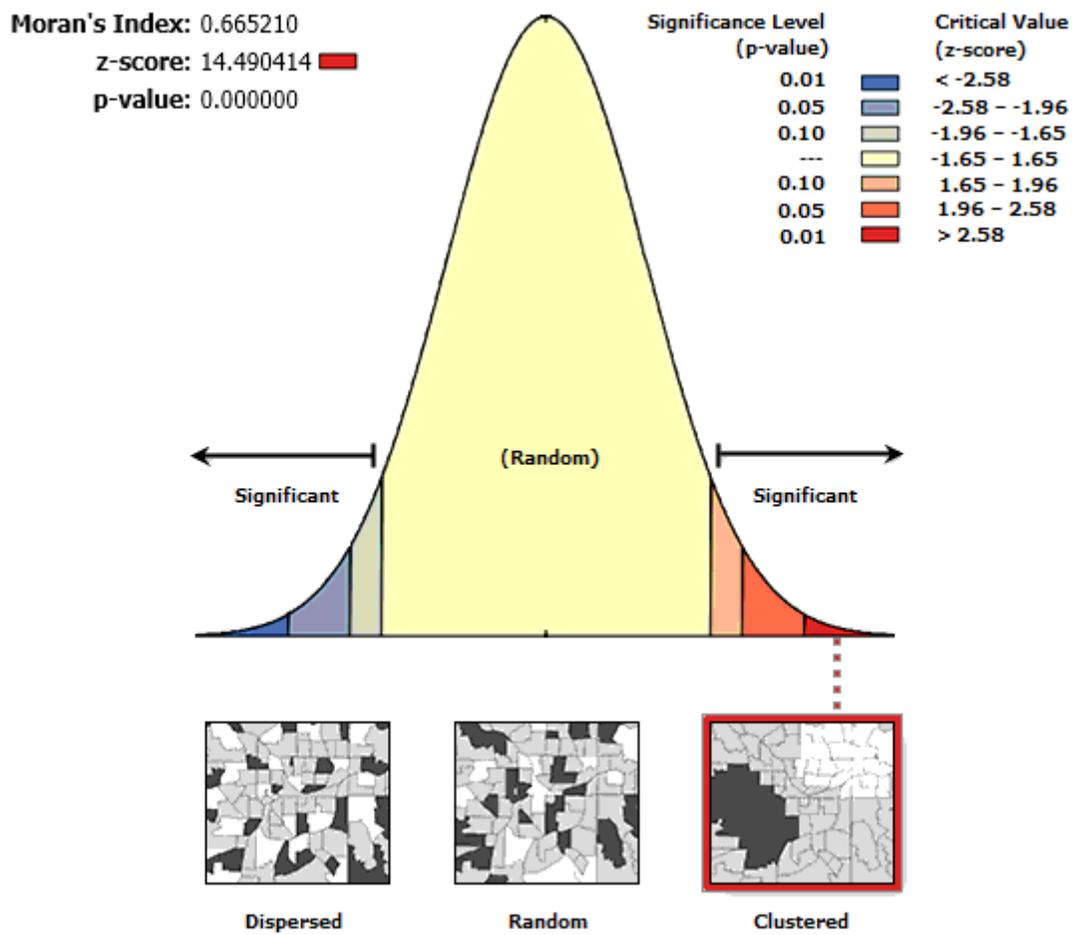


Figure 1

spatial autocorrelation (Moran I) of institutional delivery in Ethiopia, EMDHS 201

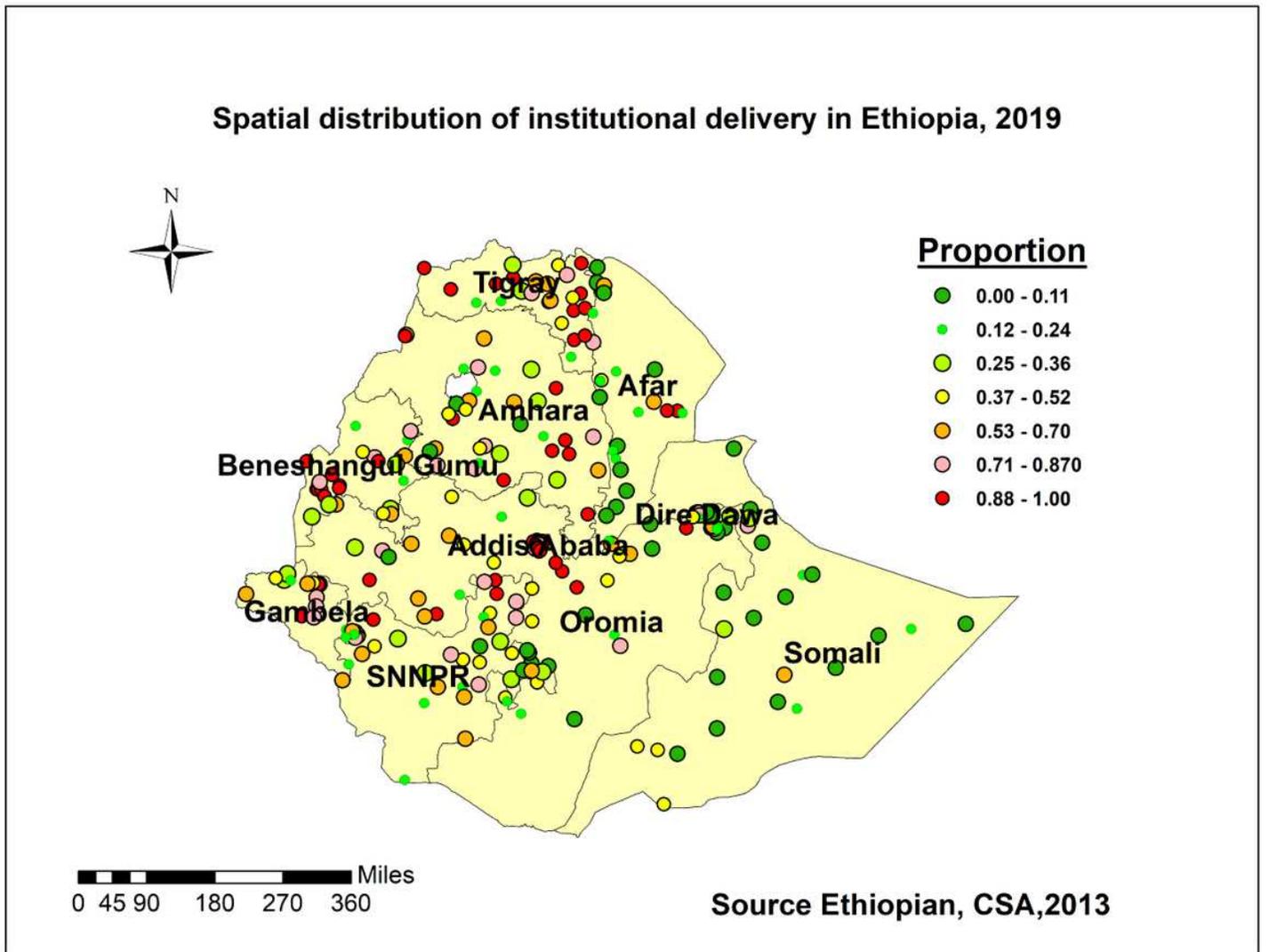
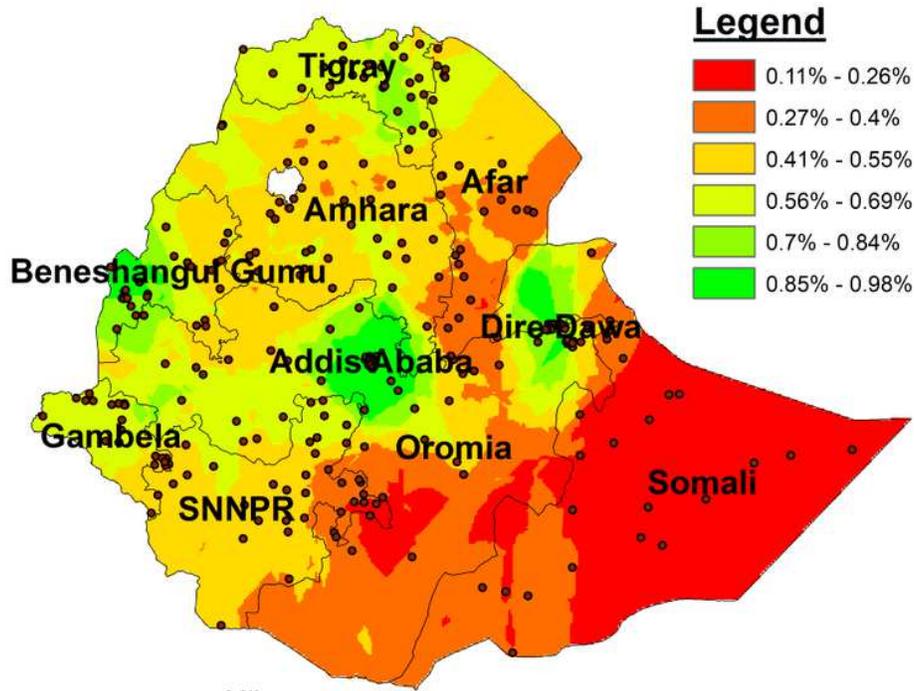


Figure 2

spatial distribution of institutional delivery in Ethiopian, EMDHS 2019

Interpolation analysis of institutional delivery in Ethiopia, 2019



Legend

- 0.11% - 0.26%
- 0.27% - 0.4%
- 0.41% - 0.55%
- 0.56% - 0.69%
- 0.7% - 0.84%
- 0.85% - 0.98%

0 45 90 180 270 360 Miles

Source Ethiopian, CSA, 2013

Figure 3

Ordinary Kriging interpolation of institutional delivery in Ethiopia, EMDHS 2019

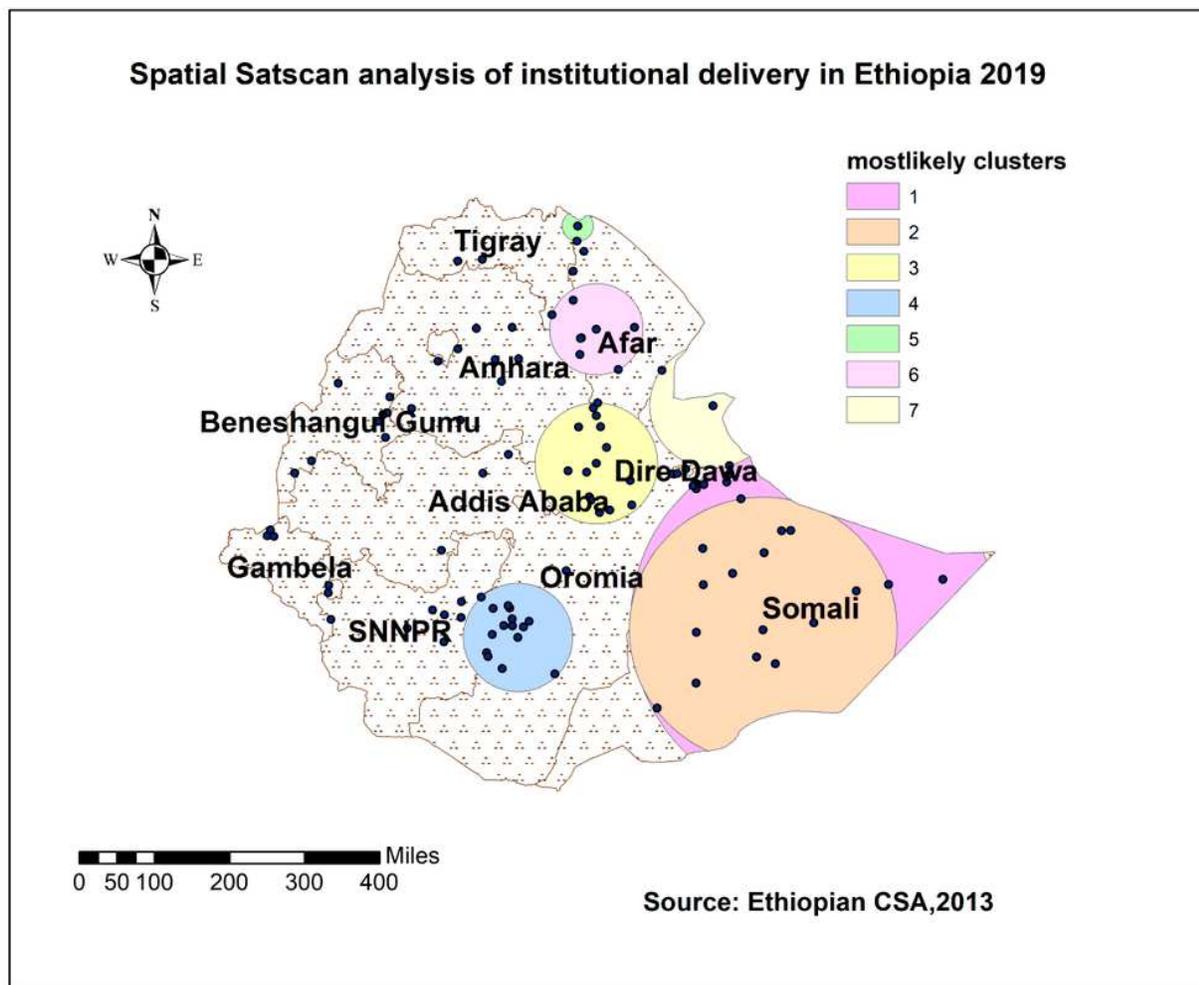


Figure 4

SaTScan scan statistics of institutional delivery in Ethiopia, EMHS 2019