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Spatial distribution and factors associated with low birth weight in Ethiopia using data from Ethiopian Demographic and Health Survey 2016: spatial and multilevel analysis

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ABSTRACT

Objective This study aimed to assess the spatial distribution, individual and community-level factors associated with low birth weight in Ethiopia.

Method Secondary data analysis was conducted using the 2016 Ethiopian Demographic and Health Survey data. A total of 2110 neonates were included in this study. Spatial autocorrelation analysis was conducted to assess the spatial clustering of LBW. Besides, the spatial scan statistics and ordinary kriging interpolation were done to detect the local level clusters and to assess predicted risk areas, respectively. Furthermore, a multilevel logistic regression model was fitted to determine individual and community-level factors associated with LBW. Finally, most likely clusters with log-likelihood ratio (LLR), relative risk and p value from spatial scan statistics and adjusted OR (AOR) with 95% CI for multilevel logistic regression model were reported.

Results LBW was spatially clustered in Ethiopia. Primary (LLR=11.57; p=0.002) clusters were detected in the Amhara region. Neonates within this spatial window had a 2.66 times higher risk of being LBW babies as compared with those outside the window. Besides, secondary (LLR=11.4; p=0.003; LLR=10.14, p=0.0075) clusters were identified at southwest Oromia, north Oromia, south Afar and southeast Amhara regions. Neonates who were born from severely anaemic (AOR=1.40, 95% CI (1.03 to 2.15)), and uneducated (AOR=1.90, 95% CI (1.23 to 2.93)) mothers, those who were born before 37 weeks of gestation (AOR=5.97, 95% CI (3.26 to 10.95)) and women (AOR=1.41, 95% CI (1.05 to 1.89)), had significantly higher odds of being LBW babies.

Conclusion The high-risk areas of LBW were detected in Afar, Amhara and Oromia regions. Therefore, targeting the policy interventions in those hotspot areas and focusing on the improvement of maternal education, strengthening anaemia control programmes and elimination of modifiable causes of prematurity could be vital for reducing the LBW disparity in Ethiopia.

What is known about the subject?

- Socioeconomic inequalities, malnutrition and inadequate access to healthcare during pregnancy are all associated with low birth weight (LBW) babies. Both mortality and morbidity are higher in LBW babies. There are significant geographical variations in the prevalence of LBW babies in Ethiopia.

What this study adds?

- Rural areas with an increased prevalence of LBW babies and hotspot clusters were identified. Besides, maternal risk factors were severe anaemia, lack of education and living in communities with high poverty.

INTRODUCTION

Globally, neonatal deaths accounted for 46% of all under-five deaths of which 38% occurred in sub-Saharan Africa. Ethiopia is one of five countries that account for about half of all global neonatal deaths.[1] The 2016 Ethiopian Demographic and Health Survey (EDHS) report shows the neonatal mortality rate to be 29 per 1000 live births. This is far from the Sustainable Development Goal target of 12 deaths per 1000 live births.[2]

Low birth weight (LBW), defined as weight at birth less than 2500 g,[3] is the leading cause of neonatal mortality. LBW babies are highly vulnerable to death than heavier ones.[4] In Ethiopia, it accounts for about 4% of total deaths.[5]

The consequence of LBW is not limited to neonatal and infant mortality but it also results in physical and developmental health problems in subsequent childhood and adulthood life. It leads to poor childhood growth and a higher incidence of adulthood chronic diseases like type 2 diabetes, hypertension and cardiovascular disease.[6] This indicates that LBW is a basement for the majority of adulthood chronic diseases. It also has long-term consequences like poor cognitive function, academic underachievement and impaired behaviour.[7,8] Moreover, LBW is a summary measure of multifaceted public health problems such as maternal malnutrition, ill-health and poor pregnancy-related health service utilisation.[6,9]

Globally, more than 20 million LBW infants are born. Among these, nearly half (48%) of the births occur in southern Asia. In sub-Saharan Africa, the number of LBW live births is estimated to have increased from 4.4 million in 2000 to 5 million in 2015.[10] These rates are high, even though the data on LBW remain limited as many deliveries occur at home or small health clinics and were not reported in official figures, which may result in an underestimation of the true prevalence. Therefore, WHO incorporated as a third target to achieve a 30% reduction in LBW incidence by 2025.[11]

Even though data on LBW was limited due to low institutional delivery in Ethiopia, the prevalence of LBW increased by 5% from 2000[12] to 2016.[13] Furthermore, the evidence from a systematic review and meta-analysis shows the pooled prevalence of LBW to be 17.3%.[14] The prevalence of LBW is different across different geopolitical regions in Ethiopia.[15–17] This indicates that the variation in the prevalence of LBW across different administrative regions could provide an insight to identify risk (hotspot) areas by using spatial technology.

Research conducted in different countries on determinants of LBW showed various socio-demographic, socioeconomic, maternal health service-related and community-related factors to be predictors of LBW.[15,18,19] In Ethiopia, prior studies have been done to identify socio-demographic, pregnancy and maternal health service-related factors.[20–23] Even though the LBW was affected by factors operating at both individual and community levels, none of the studies have tried to look at the factors that affect LBW at community and individual levels simultaneously. Furthermore, there was limited evidence on the spatial distribution of LBW in Ethiopia.

Therefore, this study aimed at identifying both individual and community-level factors associated with LBW simultaneously by applying a multilevel analysis. Besides, it tried to identify high risk (hotspot) areas of LBW through spatial analysis. Thus, the implication of this study is to provide evidence for policymakers (nationwide data) to narrow the geographical disparity of LBW across regions in Ethiopia by strengthening maternal and child health intervention programmes.

METHODS

Patient and public involvement

This study used a publicly available data set (EDHS 2016); therefore, there were no patients or members of the public directly involved.

Data source

Secondary data analysis was employed to identify spatial distribution and factors associated with LBW. An authorisation letter for the use of this data was obtained from Measure DHS and the data set was downloaded from the website; www.measuredhs.com. The survey covered all the nine regions and two administrative cities in Ethiopia (figure 1).

The participants were selected using a stratified two-stage cluster sampling technique. The survey collected information from a nationally representative sample of 16 583 eligible women within 645 enumeration areas. The full method applied to the data collection procedure for EDHS 2016 was published elsewhere.[13] A total of 2110 neonates nested within 542 communities (clusters) were included in this study. The sampling weight was applied during the analysis to produce reliable estimates.

Study variables

Dependent variable

The main outcome variable of this study was birth weight. Data on the birth weight of children were collected from mothers who gave birth within 5 years before the survey either by accessing birth weight through record review or by the mother's report by recalling the measured weight of the child at birth. The births without recorded birth weight were excluded from the study. Finally, birth weight was categorised as a birth weight of ≥2.5 kg or <2.5 kg for further analysis.

Independent variables

The determinants of LBW were extracted after reviewing literature at a global level. Maternal age, maternal education, sex of neonate, wealth index, media exposure, number of antenatal care (ANC) visits, gestational age, maternal anaemia, maternal body mass index (BMI), iron supplementation, maternal height, birth order, birth interval and caesarean delivery were individual-level predictors.

Whereas, place of residence and variables which were constructed by aggregating individual-level characteristics at the community (cluster) level were considered as community-level variables. The proportion of the aggregated variables was dichotomised after checking the distribution by using the histogram. If the aggregate variable was normally distributed mean value and if not, normally distributed median value was used as a cut-off point for the categorisation. Therefore, the community poverty level was categorised as high if the proportion of women from the two lowest wealth quintiles in a given community was 70%–100% and low if the proportion was less than 70%. Community media exposure was categorised as low if the proportion of women exposed to media in the community was 0%–83.33% and categorised as high if the proportion was 83.33%–100%, Community women education was categorised as low if the proportion of women with no formal education in the community was 14.83%–100% and categorised as high if the proportion was 0%–14.83%.

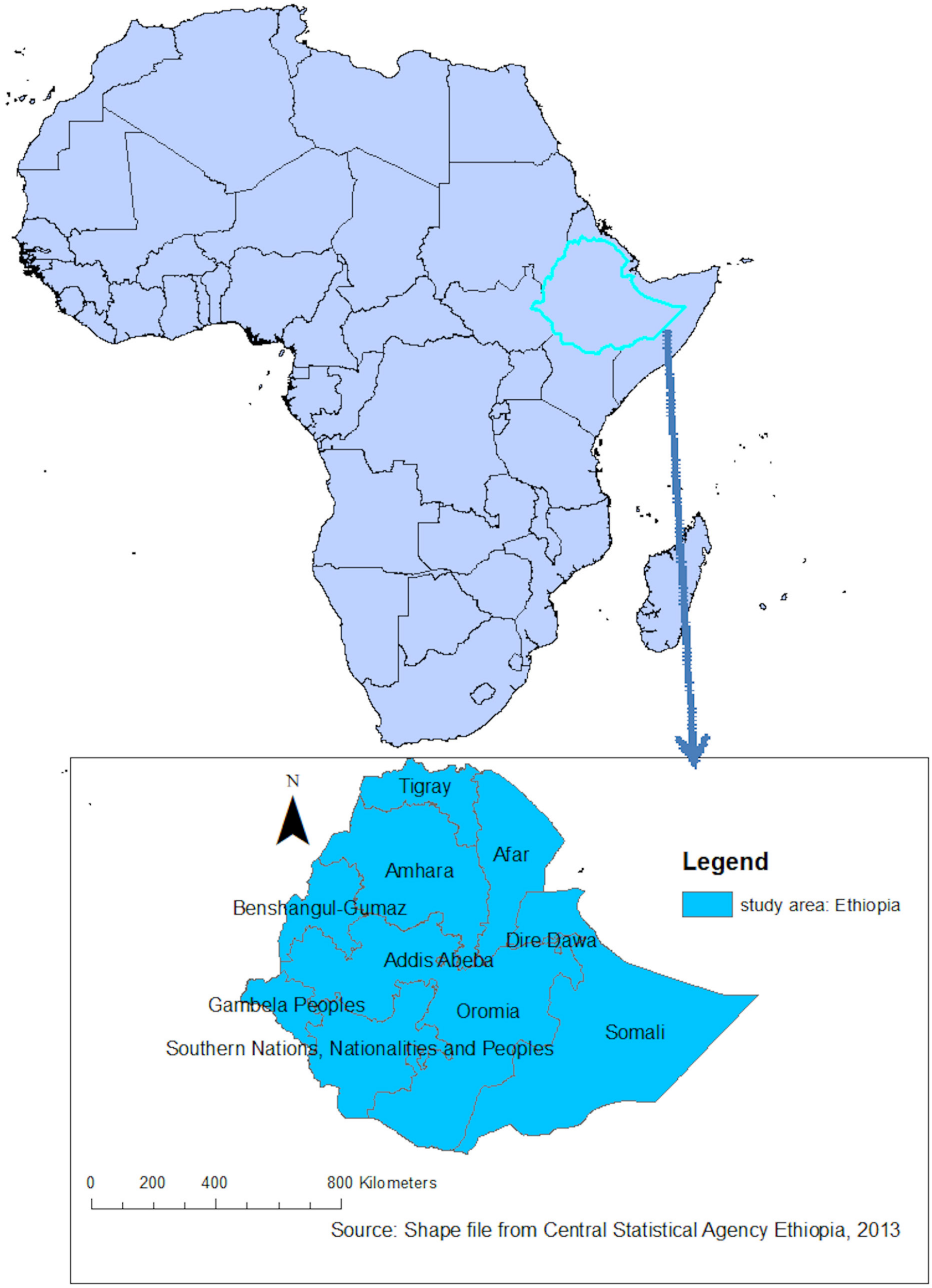

Figure 1 The nine regional states and two adminstrative cities in Ethiopia.

Spatial analysis

Spatial autocorrelation analysis

The Global Moran's I statistic test was used to measure whether the LBW patterns were randomly distributed, dispersed or clustered in Ethiopia. The calculated Moran's I values close to −1 indicate disease dispersed, whereas I close to +1 indicate disease clustered, and if the I value is close to 0 the disease is distributed randomly.[20 21] The Global Moran's I was computed as follows[22];

$$I = \frac{n \sum_i^n \sum_j^n wij \left(yi - \bar{y} \right) \left(yj - \bar{y} \right)}{\left(\sum_i^n \sum_j^n wij \right) \sum_i \left(yi - \bar{y} \right)^2}$$

Where yi represents the vector of observations at n different locations, and wij are elements of a spatial weight matrix.

Spatial scan statistical analysis

The spatial scan statistical method; a powerful method in detecting local clusters as compared with available spatial statistical methods,[23] was used to identify statistically significant spatial hotspots/clusters of LBW. This method uses a scanning window that moves across the study area.[24 25] LBW newborns were considered to be cases and those who were not born being LBW were considered to be controls to fit the Bernoulli model.

Table 1 Individual-level characteristics of participants, Ethiopian Demographic and Health Survey 2016 (N=2210)

	Low birth weight			
Variables	**Yes N (%)**	**No N (%)**	**Total N (%)**	**P value**
Maternal age				0.36
15–19	15 (28.81)	72 (71.19)	87 (3.92)	
20–24	53 (9.3)	427 (90.7)	480 (21.50)	
25–29	80 (14.36)	596 (85.64)	676 (35.68)	
30–34	49 (13.62)	413 (86.38)	462 (21.50)	
35–49	38 (23.30)	365 (88.70)	403 (12.38)	
Maternal educational level				0.02
No education	78 (18.21)	486 (81.79)	565 (28.89	
Primary	90 (11.03)	697 (88.97)	787 (38.01)	
Secondary and above	67 (11.27)	692 (88.73)	759 (33.08)	
Gestational age				<0.01
<37 weeks	23 (45.65)	25 (54.35)	40 (3.07)	
≥37 weeks	212 (12.16)	1279 (87.84)	1835 (96.93)	
Iron supplementation				
Yes	119 (12.66)	1049 (87.34)	1168 (56.79)	0.123
No	116 (13.86)	826 (86.14)	942 (43.21)	
Number of antenatal care visits				0.08
<4 visits	112 (15.95)	782 (84.05)	894 (43.41)	
≥4 visits	123 (11.05)	1082 (88.95)	1216 (56.59)	
Media exposure				0.10
Yes	151 (12.52)	880 (87.48)	1454 (66.98)	
No	84 (14.51)	424 (85.49)	656 (33.02)	
Maternal body mass index				0.46
Underweight	38 (19.02)	274 (80.98)	312 (13.65)	
Normal	150 (13.09)	1139 (86.91)	1289 (67.64)	
Overweight/obese	47 (9)	442 (91)	509 (13.32)	
Wealth index				0.02
Poor	50 (15.83)	332 (84.17)	259 (17.24)	
Middle	30 (17.22)	158 (82.78)	209 (13.91)	
Rich	155 (11.70)	1385 (88.30)	1034 (68.84)	
Maternal anaemia				0.01
Not anaemic	152 (14.78)	1305 (87.12)	1457 (75.96)	
Mild	12 (8.54)	159 (91.50)	171 (5.46)	
Moderate	13 (14.06)	95 (85.94)	108 (4.26)	
Severe	58 (16.28)	316 (83.72)	374 (14.31)	
Sex of infant				0.05
Male	106 (10.93)	972 (89.06)	1078 (51.13)	
Female	129 (15.51)	903 (84.49)	1032 (48.97)	

The default maximum spatial cluster size of <50% of the population was used. The primary and secondary clusters were detected and ranked according to the likelihood ratio test, based on 999 Monte Carlo replications.[26 27]

Spatial interpolation

The spatial interpolation technique was used to predict LBW on the unsampled areas in the country based on sampled enumeration areas. Therefore, the ordinary kriging interpolation method was employed to estimate the burden of LBW in unsampled areas since it incorporates the spatial autocorrelation and it statistically optimises the weight.

Multilevel logistic regression analysis

Because of the hierarchical nature of data and the dichotomous outcome variable, the multilevel logistic regression model was fitted after testing the significance of the community variance. The individual and community level variables associated with LBW were checked independently in the bivariable multilevel logistic regression model and variables that were statistically significant at p value 0.2 were considered for the multivariable logistic regression.

First null model (model without explanatory variables) was fitted to assess community variance and the applicability of multilevel analysis. The second and the third models were adjusted for individual and community level variables, respectively. In the fourth model both individual and community-level variables were included. The fifth model (final model) was used to estimate whether community factors moderated the association between individual factors and the dependent variable by introducing an interaction term.

The fixed effects were used to estimate the association between the likelihood of LBW and explanatory variables at both community and individual level and were reported as OR with 95% CI. To assess measures of variation intracluster correlation coefficient (ICC), proportional change in community variance (PCV) and median OR (MOR) were used.

RESULTS

In this study, a total of 2110 neonates were included. Of these, nearly half (51%) were men and 28.84% were born from mothers with no formal education. The mean age of their mothers was 29 (SE=0.13) years. About two-thirds (67%) of neonates were born from mothers who were exposed to media. About 14% and 43% of neonates were born from severely anaemic and mothers who did not receive iron during pregnancy, respectively. Regarding the ANC visits more than half (56%) of neonates were born from mothers who have more than three ANC visits. The majority (97%) of neonates were born after 37 weeks of gestation. Looking at the wealth index, nearly two-thirds (68%) of neonates were from rich households (table 1).

Community-level characteristics of participants

A total of 452 communities (clusters) were included in this study. About two-thirds (67.44%) of neonates were from a community with a low poverty level and nearly half (51.33%) of them were from rural communities. Regarding community women education, 42% of neonates were from communities with high women literacy (table 2).

Spatial distribution of LBW in Ethiopia

As indicated in figure 2, the spatial variation of the proportion of LBW was mapped. Thus, the high prevalence of LBW was observed in Afar, northwest Amhara, northeast Southern Nations, Nationalities and Peoples (SNNP), the central part of the Oromia region and Somali regional states of Ethiopia (figure 2).

Spatial autocorrelation of LBW in Ethiopia

LBW was spatially clustered in Ethiopia with Global Moran's I=0.56 and p=0.001 (figure 3). The clustered patterns (on the right sides) show high rates of LBW occurred over the study area. The z-score of 45.57 indicated that there is less than 1% likelihood that this clustered pattern could be the result of random chance.

Spatial scan statistics of LBW in Ethiopia

Spatial scan statistics identified 40 significant clusters of which 15 were primary clusters and 25 were secondary clusters. The primary clusters' spatial window was located in the northwest Amhara and northeast part of Benishangul-Gumuz, which was centred at 11.57418N, 36.498123E with 122.56 km radius, and log-likelihood ratio (LLR) of 11.82, at p<0.01. Neonates within this spatial window had 2.66 times higher risk of being LBW babies as compared with those outside the window.

Two other significant spatial windows were located in southwest Oromia and at the border of southeast Amhara, south Afar and the northern part of Oromia

Table 2 Community-level characteristics of study subjects, Ethiopian Demographic and Health Survey 2016 (N=2210)

Variables	Low birth weight: Yes N (%)	No N (%)	Total (%) N (%)	P value
Community poverty level				0.12
Low	147 (12.64)	1267 (87.36)	1414 (67.44)	
High	88 (14.32)	608 (85.68)	696 (32.56)	
Community media exposure				0.01
Low	132 (15.09)	890 (84.91)	1022 (49.41)	
High	103 (11.32)	985 (88.68)	1088 (50.59)	
Community women education				0.03
Low	102 (10.92)	953 (89.08)	1055 (48.14)	
High	133 (15.27)	922 (84.73)	1055 (51.86)	
Place of residence				0.08
Urban	130 (10.94)	1146 (89.06)	1276 (48.67)	
Rural	105 (15.31)	729 (84.69)	834 (51.33)	

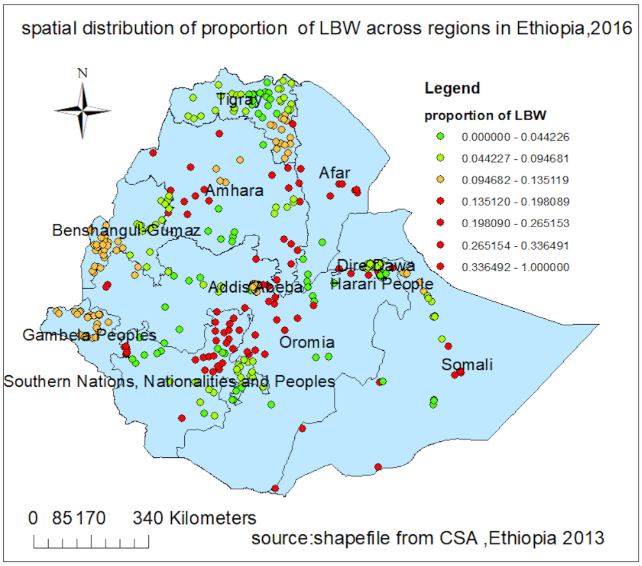

Figure 2 Spatial distribution of low birth weight (LBW) in Ethiopia.

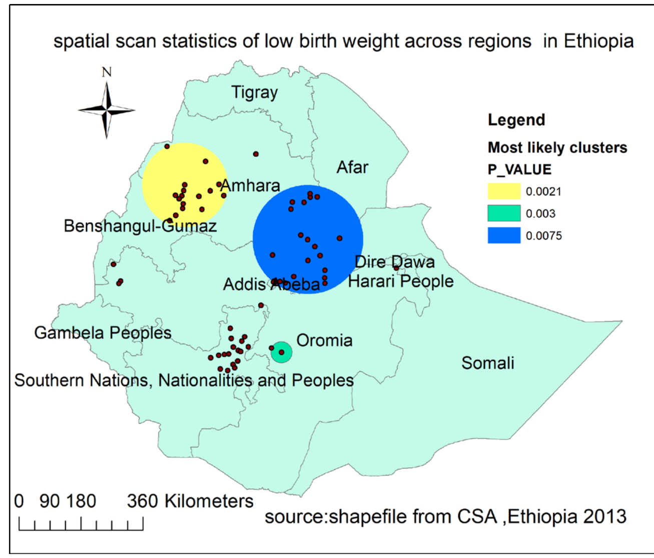

Figure 4 The spatial scanning statistics of low birth weight in Ethiopia, 2016.

regions. The one located in the southwest Oromia region was centred at 7.192884N, 39.02565E with 30.83 radius, LLR of 11.43 and p value 0.003. Neonates within this scanning window had a 4.82 times higher risk of being LBW than those outside the scanning window. The third scanning window which was located at the border of three regions (Amhara, Afar and Oromia) was centred at 10.143320N, 39.718498E with a 158.43 km radius and LLR of 10.37 at p value 0.0075. Thus, the likelihood of being LBW among neonates inside this scanning window was 2.52 times higher as compared with those outside the window (figure 4, table 3).

Spatial interpolation of LBW in Ethiopia in 2016

In ordinary kriging spatial interpolation zone 1, zone 4 and zone 5 in Afar region; Wag Himra, north Gonder and Awi in Amhara region; west Welega and west Arsi in Oromia region; Gurage, Silti and Debub Omo in SNNP region were areas at high-risk of LBW (figure 5).

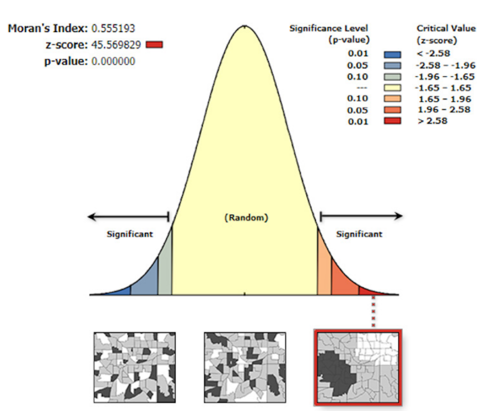

Figure 3 Spatial autocorrelation of low birth weight in Ethiopia, Ethiopian Demographic and Health Survey 2016.

Multilevel logistic regression analysis

Random effect analysis results

In the null model, variance component analysis was performed to decompose the total variance of LBW. The applicability of the multilevel mixed-effects logistic regression model in the analysis was justified by the significance of the community-level variance (community variance=0.435; SE=0.19; p value=0.001), indicating the existence of significant differences between communities regarding LBW incidence. The community variance was expressed as the ICC and the MOR. The ICC was 0.117 which revealed that 11.7% of the total variance of LBW in Ethiopia can be attributed to the context of the communities where the mothers were dwelling. Since it was greater than 0.05 the nuisance of clustering was adjusted to produce reliable estimates.[28] Moreover, the MOR was 1.88 with the 95% CI (1.27 to 2.34) which implied that the odds of having LBW was increased by 88% when mothers moved from low to high-risk communities.

In the final model the PCV was 35%. This showed that 35% of community variance observed in the null model was explained by both community and individual-level variables. For model comparison, the LLR and deviance were used. Consequently, model with the highest log likelihood or lowest deviance value (Model V) was the best-fitted model (table 4).

Fixed effects analysis results

In the bivariable mixed-effects logistic regression analysis wealth index, maternal age, number of ANC visits, gestational age, media exposure, mother's education, maternal BMI, maternal anaemia, sex of infant, iron supplementation, region place of residence, community poverty level, community illiteracy level, community media exposure and community women education were significant at p value <0.2 and fitted for multivariable analysis.

Table 3 Significant spatial clusters of low birth weight in Ethiopia, Ethiopian Demographic and Health Survey 2016

Clusters	Enumeration areas detected	Population	Cases	Log-likelihood ratio	Relative risk	Coordinate/radius	P value
1*	259, 602, 541, 386, 548, 361, 515, 498, 516, 109, 292, 533, 73, 167, 52	94	30	11.82	2.66	11.58N, 36.50E/122.56km	<0.01
2†	26589	18	11	11.41	4.82	7.19N, 39.03E/30.83km	<0.01
3†	637, 310, 295, 484, 624, 135, 617, 230, 18, 423, 121, 616, 49, 345, 254, 611, 71, 40, 303, 90, 287, 402, 560	95	29	10.37	2.52	10.14N, 39.72E/158.43km	<0.01

*Primary clusters.
†Secondary clusters.

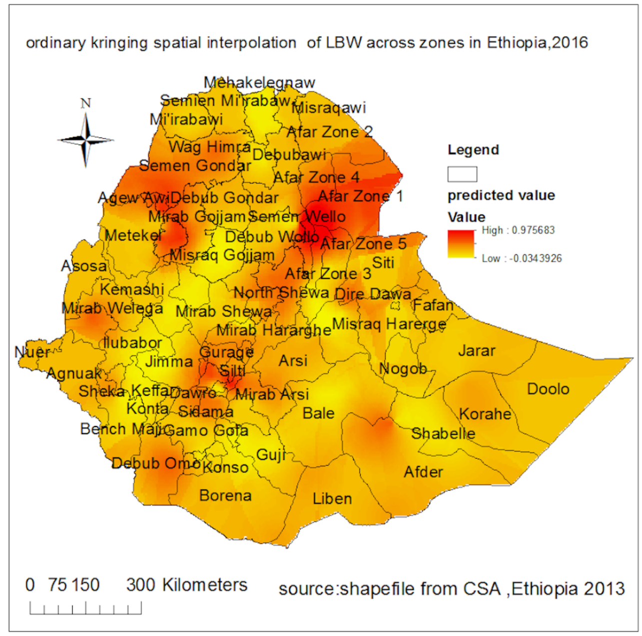

Figure 5 The ordinary kriging spatial interpolation of low birth weight (LBW) across regions in Ethiopia, Ethiopian Demographic and Health Survey 2016.

Multivariable multilevel logistic regression analysis was fitted to identify factors associated with LBW. In the final model maternal education, maternal anaemia, gestational age and sex of the neonate were significantly associated with LBW. Therefore, the odds of being LBW baby for neonates who were born from women with no education was nearly two (adjusted OR (AOR)=1.90, 95% CI (1.23 to 2.93)) times higher as compared with those born from women who had secondary and above education. The neonates who were born from women who were severely anaemic had 1.40 (AOR=1.40, 95% CI (1.03 to 2.15)) times higher odds of being LBW babies as compared with those from non-anaemic mothers.

Regarding the duration of pregnancy, the likelihood of being a LBW baby among preterm neonates was nearly six (AOR=5.97, 95% CI (3.26 to 10.95)) times higher as compared with term or post-term neonates. Moreover, the female neonate had 41% (AOR=1.41, 95% CI (1.05 to 1.89)) increased odds of being a LBW baby as compared with male neonates.

Besides, community factors had a moderating effect on the association of individual factors with LBW. The cross-level interaction between community poverty and maternal anaemia was significant. The odds of being LBW baby among neonates born from severely anaemic women was significantly increased by residence in high poverty communities (AOR=2.07, 95% CI:(1.02 to 4.31)) (table 5).

DISCUSSION

This study revealed that LBW was spatially clustered and affected by sociodemographic and pregnancy-related characteristics of mothers. The spatial scan statistics

Table 4 Random effects and model fitness

Random effects	Model I	Model II	Model III	Model IV	Model V
Community variance (SE)	0.44 (0.187)	0.32 (0.177)	0.40 (0.18)	0.31 (0.17)	0.30 (0.16)
Intracluster correlation coefficient (%)	11.70	9	10	8	0.70
Proportional change in community variance (%)	Reference	25.30	8	29.20	35
Median OR (95% CI)	1.88 (1.27 to 2.34)	1.72 (1.10 to 2.16)	1.83 (1.23 to 2.28)	1.70 (1.16 to 2.14)	1.40 (1.22 to 2.01)
Model fitness					
Log-likelihood	−732.80	−701	−729.20	−688.09	−520.12
Deviance (−2×log-likelihood ratio)	1465.60	1402	1458.40	1376.18	1040.24

identified 15 most likely clusters at the eastern part of Amhara and northern border of Benishangul-Gumuz region and 25 secondary clusters in the south Afar, southwest Amhara and the northern part of Oromia region. The possible explanation could be the large disparity in health service access and affordability, especially in those remote areas. There is evidence that health service access is the major challenge in rural health in the countries where the majority of the population lives in rural areas like Ethiopia.[29] In addition to coverage, improving the uptake of maternal healthcare services is vital to minimise the adverse outcome of pregnancy. Thus, the socioeconomic inequalities within the society might affect the accessibility of maternal health services as it happens in Ethiopia.[30] This might be the possible reason for the clustering of LBW in peripheral areas of the country. Therefore, as Ethiopia moves forward with the sustainable development agenda, these spatial patterns and clusterings of LBW events, provide important information for the development and refinement of geographically based programmes for maternal and child health to reduce LBW occurrence.

Besides, this study found that neonates who were born from severely anaemic mothers had higher odds of being LBW babies as compared with those who were born from non-anaemic mothers. This finding is consistent with studies conducted in India[31 32] and Ethiopia.[33 34] This might be because anaemia during pregnancy, especially if severe, could affect oxygen supply to the fetus and thus interferes with normal intrauterine growth or pregnancy duration which possibly leads to LBW.[35]

Similarly, the likelihood of being LBW baby was higher among neonates who were born from women with no formal education as compared with those who were born from educated women. This finding was in agreement with studies conducted in Malawi,[36] Bangladesh,[19] India[18] and northwest Ethiopia.[15] This may be since uneducated mothers are relatively at low living standards and they might have poor maternal nutrition during pregnancy. In developing countries, it was found that poor gestational nutrition was found to be a major determinant of intrauterine growth restriction which might result in LBW delivery.[35]

Regarding the duration of pregnancy, this study revealed that odds of being LBW baby among neonates who were born before 37 weeks of gestation was nearly sixfolds higher as compared with those who were born after 37 weeks of gestation. This result was concordant with studies conducted in Pakistan,[37] Kenya,[38] northwest Ethiopia[39] and southwest[16] Ethiopia. The possible explanation might be babies who were delivered in earlier periods of gestation were less likely to have full fetal development. Furthermore, evidence from the systematic review showed that gestational duration was found to be the most proximal cause of LBW.[35]

Of particular interest of this study is the association of sex of the neonate with LBW. Thus, female neonates had higher odds of being LBW babies as compared with male neonates. This result is in line with the findings in Ghana[40] and Nepal.[41] The association could be explained by the pathophysiological mechanism in the uterus. The evidence shows that women had a higher risk of developing intrauterine growth restriction than men which probably results in LBW.[35]

This study was based on the most recent EDHS data with a nationally representative large sample size using a multilevel modelling approach. The sampling weight was applied to produce appropriate SEs and then population level estimate. Despite the above strengths, the study had the following limitations. For some participants, data on birth weight was collected by mothers' reports by recalling the weight of their child at birth (recall bias) which may overestimate or underestimate the results. Second, since it is secondary data analysis, those behavioural factors such as eating habits, and use of nutritional supplements (vitamin B_{12} and folic acid) during gestation were not included.

CONCLUSION

LBW was spatially clustered in Ethiopia. High-risk areas were identified in Afar, Amhara, Oromia, Benishangul-Gumuz and the northern part of SNNP regions. Therefore, targeting the policy interventions in those geographically LBW risk areas and focusing on the improvement of maternal education, strengthening anaemia control programmes and elimination of modifiable causes of prematurity could be vital for reducing the LBW disparity in Ethiopia.

Table 5 Multilevel logistic regression analysis of factors associated with low birth weight in Ethiopia, Ethiopian Demographic and Health Survey 2016

Variables	Model I	Model II AOR (95% CI)	Model III AOR (95% CI)	Model IV AOR (95% CI)	Model V AOR (95% CI)
Maternal age					
15–19	–	1.77 (0.82 to 4.74)	–	1.90 (0.79 to 4.59)	2.01 (0.83 to 4.86)
20–24	–	1.05 (0.52 to 2.12)	–	1.01 (0.50 to 2.06)	0.98 (0.48 to 2.01)
25–29	–	1.13 (0.57 to 2.21)	–	1.09 (0.56 to 2.15)	1.10 (0.56 to 2.17)
30–34	–	0.91 (0.45 to 1.81)	–	0.90 (0.45 to 1.79)	0.87 (0.43 to 1.76)
35–49	–	1	–	1	1
Maternal educational level					
No education		1.91 (1.23 to 2.93)	–	1.82 (1.12 to 2.96)*	1.90 (1.23 to 2.93)*
Primary	–	1.32 (0.91 to 1.92)	–	1.33 (0.91 to 1.95)	1.33 (0.91 to 1.93)
Secondary and above	–	1	–	1	1
Gestational age					
<37 weeks	–	5.82 (3.18 to 10.60)	–	5.91 (3.21 to 10.10)†	5.97 (3.26 to 10.95)†
≥37 weeks	–	1	–	1	1
Iron					
Yes	–	1	–	1	1
No	–	1.15 (0.84 to 1.57)	–	1.14 (0.83 to 1.57)	1.15 (0.84 to 1.58)
Number of antenatal care visit					
<4 visits	–	1.08 (0.79 to 1.51)	–	1.11 (0.80 to 1.52)	1.10 (0.79 to 1.52)
≥4 visits	–	1	–	1	1
Media exposure					
Yes	–	1	–	1	1
No	–	0.89 (0.61 to 1.30)	–	0.84 (0.55 to 1.29)	0.89 (0.60 to 1.32)
Maternal body mass index					
Underweight	–	0.98 (0.62 to 1.42)	–	0.96 (0.63 to 1.45)	0.93 (0.61 to 1.42)
Normal		1		1	1
Overweight/obese		0.88 (0.59 to 1.42)		0.90 (0.59 to 1.42)	0.91 (0.58 to 1.39)
Wealth index					
Poor	–	1.16 (0.73 to 1.83)	–	1.26 (0.674 to 1.438)	1.30 (0.72 to 2.33)
Middle	–	1.34 (0.80 to 2.25)	–	1.28 (0.724 to 2.284)	1.41 (0.81 to 2.45)
Rich	–	1	–	1	1
Maternal anaemia					
Not anaemic	–	1	–	1	1
Mild	–	0.64 (0.33 to 1.22)	–	0.63 (0.33 to 1.22)	0.53 (0.24 to 1.18)
Moderate	–	1.07 (0.56 to 2.05)	–	1.09 (0.57 to 2.08)	1.95 (0.87 to 4.37)
Severe	–	1.48 (1.04 to 2.11)	–	1.47 (1.04 to 2.01)*	1.40 (1.03 to 2.15)*
Sex of neonate					
Male	–	1	–	1	
Female	–	1.37 (1.04 to 1.84)	–	1.38 (1.04 to 1.84)*	1.41 (1.05 to 1.89)*
Community poverty level					
Low	–	–	1	1	1
High	–	–	0.93 (0.59 to 1.47)	0.79 (0.47 to 1.35)	0.67 (0.37 to 1.23)
Community media exposure					
Low	–	–	1.34 (0.81 to 2.02)	1.20 (0.76 to 1.89)	1.19 (0.75 to 1.89)
High	–	–	1	1	1
Community women education					
Low	–	–	0.79 (0.52 to 1.20)	0.83 (0.52 to 1.30)	0.90 (0.59 to 1.35)

Continued

Table 5 Continued

Variables	Model I	Model II AOR (95% CI)	Model III AOR (95% CI)	Model IV AOR (95% CI)	Model V AOR (95% CI)
High	–	–	1	1	1
Place of residence					
Urban	–	–	1	1	1
Rural	–	–	1.09 (0.71 to 1.68)	1.01 (0.62 to 1.60)	1.01 (0.63 to 1.63)
Community poverty × maternal anaemia					
High × not anaemic		–	–	–	1
High × mild		–	–	–	1.70 (0.42 to 6.86)
High × moderate		–	–	–	0.29 (0.07 to 1.16)
High × severe		–	–	–	2.07 (1.02 to 4.31)*

*P value <0.05.
†P value <=0.01.
1, reference category; AOR, adjusted OR.

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