Geographical inequalities and determinants of stunting among under-five children in Ethiopia, 2016 EDHS, General Estimating Equation Model

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Abstract

Background Globally, more than 165 million children were stunted. However, the distribution of stunting across the globe was not clearly known. Therefore, this study was aimed at assessing spatial distribution and determinants of stunting among under-five children in Ethiopia.

Methods Ethiopian demography and health survey 2016 data set was used. A two stage stratified cluster sampling technique was used to include 8,855 under-five children. ArcGIS10.1 was used to visualize the distribution of stunting in Ethiopia. Getis-Ord statistics was used to identify whether the distribution of cases is randomly distributed, clustered, or dispersed. Getis-Ord statistics was used to identify hot spot and low spot areas. Generalized estimating equation (GEE) model was used to identify determinants. Adjusted odds ratio (AOR) and 95% confidence interval (CI) were used to measure the strength of the association.

Results In the study the overall prevalence of stunting was 38.4% (37.4%-39.4%). Significantly primary clusters were found in Amhara, Southern Tigray, and Western Afar. Secondary clusters were found in Tigray, Afar, Benishangul, South-Eastern SNNPR and South-Western Oromia. Factors of a child lived in a region of Tigray [AOR = 2.3(CI = 1.53-3.46)], Afar [1.9(1.21-2.86)], Amhara (AOR=2.85, 95%CI: (1.9-4.29)), Oromia (AOR=1.71, 95% CI: (1.13-2.46)), Benishangul (AOR=2.61, 95% CI: (1.72-3.95)), SNNPR (AOR=2.04, 95% CI: (1.36-3.06)), Harari (AOR=1.63, 95% CI:(1.03-2.57)) and Dire-Dawa (AOR=2.25, 95% CI: (1.44-3.51)), HHs had television and/or radio (AOR= 1.61, 95% CI: (1.12-2.82)), poor wealth index (AOR=1.4, 95% CI: (1.2-1.6)), stunted mother (AOR=1.9, 95% CI: (1.62-2.14)), under-weight mothers (AOR=1.2, 95% CI: (1.03-1.32)), anemic mother (AOR=1.32, 95% CI (1.1-1.62)), child being male (AOR=1.2, 95% CI: (1.19-1.32)), age of child (AOR=1.25, 95% CI: (1.19-1.39)), mothers delivered at home (AOR=1.16, 95% CI: (1.04-1.33)), low birth weight of child (AOR=1.5, 95% CI (1.29-1.65)) and anemic child (AOR=1.6, 95% CI (1.43-1.79)) were significantly associated risk factors.

Conclusions In Ethiopia the distribution of stunting was not randomly distributed and varies across regions. Region, wealth index, maternal, and child factors were independent predictors of stunting. Federal ministry of health with other concerned body need to prioritize hotspot areas to address contributing factors of stunting among under-five children.

Introduction

Stunting is defined by a height-for age (HFA) z-score below minus two standard deviations (SDs) of the median WHO standards (1). In under-five children the magnitude and distribution of stunting varies across various regions of the world (2–4). Globally, more than one quarter (26%) of children under-five years of age were stunted in 2011, roughly 165 million children worldwide were stunted, but this burden is not evenly distributed around the world. Sub-Saharan Africa and South Asia were account to three fourths of the world's stunted children. In sub-Saharan Africa, 40 percent of children fewer than 5 years of age were stunted. Including Ethiopia fourteen countries were the home to 80% of the world's stunted children.

The World Health Assembly has set the goal of achieving a 40 percent reduction in the number of stunted children by 2025, or around 70 million children saved from the misery of stunting (5). Whereas the projections indicate that 127 million childhood stunting in 2025 (6). The prevalence of stunting in Ethiopia was declined from 58% to 38.4% from 2000 to 2011 (7, 8).

The factors influencing stunting among children 0–59 months were multiple. Among these complementary feeding and breastfeeding practices (9), diseases and infections (10), dietary diversity (11, 12), and household food insecurity (13).

The Government of Ethiopia try to minimize its burden by took special commitment in SEQOTA declaration with the goal of achieving Zero stunting by 2030. According to the declaration there is a fixed and critical window to address under nutrition in is the first 1000 days (270 pregnancy, 180 of six months child age and 550 of 6–24 months child age) that has a devastating impact on the future of children potential as its effect on the physical stature, the physical work ability, and the cognitive development can lock children into poverty and entrench inequalities (14).

Identification of geographical areas and clusters for high spot areas and high burden of disease using geographical information system has an important role in the controlling and prevention of stunting. However, previous studies were limited on determining the magnitude and possible factors of stunting. Besides, findings from prevalence studies were not sufficient to provide appropriate evidence and capture the geographical distribution of stunting. Therefore, this study was aimed at exploring spatial distribution and to identify determinants of stunting among children 0–59 months old in Ethiopia.

Methods And Materials

Study design, setting, and period

A community based cross sectional study was conducted from January 18 to June 27 2016 (15). Ethiopia is situated in the Horn of Africa between 3 and 15 degrees of north latitude and 33 and 48 degrees of east longitude. It has great geographical diversity which ranges from the highest peak at Ras-Dashen (4,550 meters above sea level) down to the Afar Depression at 110 meters below sea level (16). Ethiopia is one of the least urbanized countries in the world; only 16 percent of the population lives in urban areas. The majority of the population lives in the highland areas. The main occupation of the settled rural population is farming, while the lowland areas are mostly inhabited by a pastoral people, who depend mainly on livestock production and move from place to place in search of grass and water. More than 80 percent of the country’s total population lives in the regional states of Amhara, Oromia, and SNNP (17). Ethiopia has nine regions and two administrative cities.

Population and sample

All under-five children in Ethiopia were the source population and all under-five children in selected EAs were the study population. Therefore, all under-five children in the selected clusters were included in the study. Respondents were excluded in case of flagging of either nutritional indices and/or absence of geographical location data. In 2016 EDHS 10,752 children aged 0-59 months in 645 EAs (202 in urban and 443 in rural areas) were eligible for height and age measurements. However, only 8855 children in 642 EAs were used for analysis. Hence, a total of 1897 children were excluded from the analysis because of incompleteness and misclassifications (8). A two-stage stratified cluster sampling technique was employed.

In the first stage, 645 EAs were selected with probability proportional to the EAs size and with independent selection in each sampling stratum with the sample allocation. The EA size is the number of residential households (average 181 each) in the EA as determined in the 2007 PHC (8). In the second stage of selection, a fixed number of 28 households per cluster were selected with an equal probability systematic selection from the newly created household listing. This survey took only the pre-selected interviewed households of EDHS Geo-reference data. Based on a fixed sample take of 28 households per cluster, the survey selected 645 EAs, 202 in urban areas and 443 in rural areas. The survey considered 16,650 residential households, 5,232 in urban areas and 11,418 in rural areas (15) **(Figure 1).**

Figure 1: Schematic presentation of sampling procedure of spatial distribution and associated factors in Ethiopia, 2018 (15).

Variables of the study

In this study, the dependent variable, childhood stunting was defined as the percentage of children aged 0 to 59 months whose height for age is below minus two standard deviations (moderate and severe stunting) and minus three standard deviations (severe stunting) from the median of the WHO Child Growth Standards (18). The independent variables included: socio-demographic and economic factors (age, sex, residence, occupation, educational status, wealth index, and religion), geographical factors (region, cluster, and temperature), maternal health service utilization factors (ante natal care, place of delivery, and postnatal care), nutritional status of mother (BMI and HFA), birth weight, timing of breast feeding, clinical factors (anemic status of mother, anemic status of child), drinking safe water, and media exposure of respondents. Early initiation of breastfeeding –infants who are sucking the breast milk within one hour of birth (18). Introduction of solid, semi-solid or soft foods (6–8 months) – Percentage of children aged 6–8 months who received solid, semi-solid or soft foods during the past 24 hours (18).

Data collection and extraction procedure

The 2016 EDHS sample was selected based on a two-stage stratified cluster sampling and EAs are the sampling units for the first stage and households was used for the second stage of sampling. Height was measured for children 2 years and above using a measuring board and length was measured for children under the age of 2 years in lying down recumbent position (16). Weight measurements were obtained using light weight, SECA mother-infant scales with a digital screen, designed and manufactured. For all indices of childhood stunting, Z score less than -2 SD from the median of the WHO Growth Reference Population was considered as stunted. Geo-reference coordinates were collected using hand-hold GPS tool.

The EDHS team cleaned the data and calculated the Z-score for all childhood nutritional status indices. Childhood nutritional status data from the 2016 EDHS clusters were characterized by unique latitude and longitude location coordinates. Then, the EDHS cluster nutritional data and location file data were cross linked using the ArcGIS10.1 in making maps (19). The existing childhood nutritional indices Z-score was used to determine childhood nutritional status.

The data were obtained from the 2016 EDHS datasets, which are publicly available on the MEASURE-DHS program website (http://www.dhsprogram.com/Data). The Ethiopia DHS sub-national shape file was downloaded from the spatial data repository website of MEASURE-DHS program (http://www.spatialdata.DHSprogram.com) (20). Then Geo-reference data and other related data were extracted.

Data management and analysis procedure

The collected data was checked for consistency and missing. Descriptive and summary measures were done using STATA version 14 software. Means and percentages were used for continuous and categorical variables, respectively. ArcGIS10.1 was used to visualize the geographical distribution of cases across the regions.

In EDHS data, children within the cluster may be more or less similar to each other and may vary across clusters. Hence, the simple logistic regression model may not be appropriate because of violation of independence. Therefore, Generalized Estimating Equation (GEE) model was fitted to analyze factors associated with childhood stunting at two levels: individual and household levels. Exchangeable correlation structure with binomial logit probability distribution was used. in GEE. A P-value of less than 0.05 was used to define statistical significance. Adjusted odds ratios (AOR) with their corresponding 95% confidence intervals (CIs) were calculated to identify the independent predictors of childhood stunting.

Spatial autocorrelation and spatial scan analysis

The Global Moran's I spatial autocorrelation test was used to identify the pattern of stunting whether it was dispersed, clustered, or randomly distributed in the study area. Accordingly, if the Moran's I values was close to 0 indicated stunting is distributed randomly, whereas I value close to −1 indicated stunting was dispersed and I close to +1 indicated stunting was clustered. A statistically significant Moran's I ($p < 0.05$) led to the rejection of the null hypothesis and indicated the presence of spatial autocorrelation.

The spatial scan statistical analysis was performed to identify significant clusters. ArcGIS10.3 software was used for identifying significant clusters. Accordingly, clusters were defined as positive autocorrelation (High-High or Low-Low autocorrelation) and negative autocorrelation (High-Low or Low-High). A scanning window that moves across the study area was used. Both primary and secondary clusters were identified using p-values and likelihood ratio test.

Children with stunting were taken as cases and those without the disease as controls to fit the model. Default maximum spatial cluster size of less than 50% of the population was used as an upper limit, allowing both small and large clusters to be detected, and ignored clusters that contained more than the maximum limit. To determine whether the number of observed stunting cases within the potential cluster were significantly higher than the expected or not Likelihood ratio test statistic was used. Z-scores and P-values were used to determine the significance of these statistics. A Z-score near zero indicated that no apparent clustering within the study area. A positive Z-score with P-value of less than 0.05 indicated that statistical clustering of hotspots of childhood stunting whereas a negative Z-score with p-value of less than 0.05 indicated statistical clustering of children who are normal. Finally, interpolation was done using Inverse Distance Weighted (IDW) techniques.

Results

Socio-demographic and economic characteristics

A total 8,855 under-five children were included in the final analysis. The mean age of under-five children in Ethiopia was 1.99 years (±1.45 SD). The mean age of respondents was 29 years (±6.5SD). Nearly 90% of respondents were rural residence. Nearly a quarter of respondents were poorest by wealth index. The majority (94.9%) of respondents were married. About two-third (66.1%) of respondents were non educated **(Table 1).**

Nutritional status on background characteristics

The prevalence of stunting among under-five children in Ethiopia was 38.4% (37.4% - 39.4% at 95% CI). The prevalence of severely stunted among under-five children in Afar, Amhara and SNNPR was 21.7%, 20% and 20.4%, respectively. Among male under-five children, 19% were severely stunted.

Spatial analysis

Cluster level Getis-Ord Gi* identified that hot spot areas (primary and secondary), statistically significant clusters of high proportion stunted (too short for their age and severely stunted) children and cold spot areas (primary and secondary), statistically significant clusters of low proportion of stunted children were identified. The primary hot spot areas were detected in central Northern, eastern and southern Amhara, some part of southern Tigray and western Afar regions. Secondary hot spot areas were detected in most parts of Tigray, Afar and Benishangul, south-eastern SNNRP and south-western Oromia regions. Cold spot of stunting among under-five children was observed at Addis Ababa, Oromia (near to Gambella boundary and North-East near to Somalia), Somalia (Northern and Eastern) and Gambella (**Figure 2)**.

Figure 2: Clusters of stunting within five kilo meter radius in Ethiopia, Geo-reference EDHS 2016 data perspective.

The regional level of empirical Bayesian kriging of Geo-statistical analysis identified high cluster of stunting among under-five children at Amhara, Benishangul, Western Oromia, Addis Ababa, Tigray, Afar, and some part of southern Ethiopia. Low cluster of stunting among under-five children was identified at Somalia, Dire-Dawa, Gambella, Oromia (near to Gambella boundary and Somalia boundary) and Afar, near to Somalia boundary (**Figure 3**).

Figure 3: Clusters of stunting of EBK at regional level within five kilo meter radius in Ethiopia, 2018: Geo-reference EDHS 2016 data perspective.

Analysis of factors associated with spatial distribution of stunting

In the bi-variate GEE model region, age of mother, HHs had television and/or radio, number of children, wealth index, currently pregnant women, stunted mother, mothers being underweight, mother with anemia, sex of child, child weight, place of delivery, and child with anemia were significant determinants of stunting in Ethiopia.

However, in the multivariable analysis region of Tigray (AOR=2.3, 95% CI: (1.528-3.46)), Afar (AOR=1.9, 95% CI: (1.205-2.858)), Amhara (AOR=2.85, 95% CI: (1.9-4.29)), Oromia (AOR=1.71, 95% CI: (1.13-2.455)), Benishangul (AOR=2.61, 95% CI: (1.72-3.949)), SNNPR (AOR=2.04, 95% CI: (1.364-3.063)), Harari (AOR=1.63, 95% CI: (1.034-2.572)) and Dire Dawa (AOR=2.25, 95% CI: (1.443-3.511)), HHs had television and /or radio (AOR=1.61, 95% CI: (1.119-2.824)), poor wealth index of HHs (AOR=1.4, 95% CI: (1.202-1.6)), stunted mother (AOR=1.9, 95% CI: (1.62-2.14)), underweight mothers (AOR=1.2, 95% CI: (1.029-1.321)), mother with anemia (AOR=1.32, 95% CI: (1.1-1.62)), sex being male childhood (AOR=1.2, 95% CI: (1.19-1.32)), age of childhood (AOR=1.25, 95% CI: (1.19-1.29)], mothers delivered at home (AOR=1.16, 95% CI: (1.04-1.33)), low birth weight of childhood (AOR=1.5, 95% CI: (1.29-1.65)) and child with anemia (AOR=1.6, 95% CI: (1.427-1.795)) were significant determinants of stunting in Ethiopia (**Table 2**).

Discussion

This study revealed that the distribution of stunting among under-five children was varied in the country. The global Moran I value 0.4 indicated that there was a significant clustering of stunting in under-five stunting in Ethiopia. Therefore, statistically significant hotspot areas of childhood stunting were identified in Amhara, Tigray, Afar, Benishangul, Oromia, and SNNPR. This finding was congruent with the study conducted in Meskane Mareko district, Gurage Zone (21) and northern part of Ethiopia Somalia region. In addition, this finding was supported by study conducted in Ghana which states that the distribution of stunting was random (22). However, the finding was contradictory to the study conducted in Rwanda (23) and in Sub Saharan Africa (24). These could be implementation of nutritional control intervention and childhood stunting strategies in some selected clusters only. The second reason could be variation from temporal and environmental factors may trigger the clustering of cases in a certain geographical area.

This study revealed that the spatial variation of childhood stunting was attributed to both individual and household level factor in GEE binomial logit model. Region, wealth index, house hold having radio or television, HFA of mother, BMI of mother, mother having anemia, sex of child, birth weight, child having anemia, and met minimum acceptable diet were significantly affect the distribution of stunting among under-five children in Ethiopia.

Region of respondents was significantly affecting the distribution of stunting in Ethiopia. This finding was consistent with the study done from Malawi (25). Being in poor wealth index of household was associated with higher odds of developing stunting. This finding is consistent with the spatial study conducted in different period of time in Ethiopia (21, 26). This finding is also supported by the study conducted in Rwanda (23) and in SSA (24). This could be low socioeconomic status of households was associated with the poor access to nutritious foods at household level (27). Moreover, due to the fact that low socioeconomic status of household affects providing of diet diversity and frequency which in turn influence the nutrient intake and nutrition status of child (28).

Stunted mothers were at higher odds of developing a stunted child compared to mothers with normal counter parts. This finding is consistent with the study conducted in Rwanda (23) and in India (29). Anemic mothers were at higher odds of developing stunted child compared to normal mothers. This is congruent the study in Rwanda (23). Ethiopian demographic health survey final report revealed that more than half (56%) mothers have not taken iron during pregnancy i.e. five percent women took iron tablets for 90 and more days in their most recent pregnancy while six percent of recent pregnant women were deformed (15). Hence, this might be due to weak intervention of iron supplementation, education on feeding iron-rich foods and deworming in their recent pregnancy.

The odds of having stunted children among mothers being overweight were reduced by 26% compared to mothers with normal BMI. This finding is consistent to the study conducted to the five year prior national spatial study in Ethiopia (26) and the study conducted in Rwanda (23).

The odds of stunting among male child were increased by 20% compared with female counter parts. This is supported with systematic and meta-analysis in Sub-Saharan Africa (24). However, this finding was in contrast with studies conducted from Kenya (30) and Tanzania (31) which reported female children as being more likely to be stunting. The possible reason could be child morbidity is higher among male than female child in the Kenya and Tanzania studies (32, 33). However, this difference based on sex parameter might not be useful for targeting in terms of interventional program.

For every one year increased of childhood age, the odds of childhood stunting were increased by 1.25 times. This finding was against a study done from Rwanda in which younger childhood were susceptible for stunted (23) and is supported with systemic/meta-analysis in SSA (24). This could be the loss of care as age of childhood increased especially in the developing countries because of short birth interval. The odds of childhood stunting with anemic children were higher than non-anemic children. This findings is congruent with a study in Ethiopia (26) and systematic review conducted in SSA (24).

A childhood with low birth weight was at higher odds of stunting compared to childhood with normal birth weight. This is consistent with a study from Rwanda (23). This could be birth weight of childhood is affected by multidimensional factors which can longer affect the child and leads to be stunted (34). The odds of childhood stunting were higher in mothers who did not meet minimum acceptable diet compared to mothers who meet minimum acceptable diet. This is contradictory with the finding of household, maternal and child dietary study conducted in Ethiopia which revealed that child dietary diversity score has not correlated with childhood stunting (35). The odds of childhood stunting were higher in households not having radio and/or television compared to households having radio and/or television. This finding is in line with the study in Malawi(25). The findings of this study will provide valuable policy implications and offer targeted interventions by identifying hot spot areas. However, the cross- sectional nature of the study may affect the cause effect relationship.

Conclusions

The spatial distribution of stunting among under-five children was not randomly distributed across the country. A child lived in Tigray, Amhara, Benishangul and dire Dawa, age of mother being high, increased number of household members, place of birth, being stunted mother, being underweight mother, mother with anemia, a child with higher age, low birth weight of child were predictors of stunting in Ethiopia.

Declaration

Ethical approval and consent to participate

Ethical clearance was obtained from University of Gondar in institute of Public Health. The data was downloaded after the purpose of the analysis communicated and approved by MEASURE-DHS. The downloading and analysis were conducted after getting authorization letter from archive@dhsprogram.com MEASURE-DSH program. The dataset is publicly available in the MEASURE-DHS website [http://www.measuredhs.com/data] in different formats (15). Permission was obtained to download and use the data. The shape files for Ethiopia's administrative boundaries is obtained from the open-AFRICA website ttps://africaopendata.org/dataset/ethiopia-shapefiles (20). The detailed information on ethical issues was published in the 2016 Ethiopian Demographic and Health Survey final report (15).

Consent to publication

Not applicable

Availability of data and material

All data will be available as per requested me or the website of demographic health survey (DHS) MEASURE-DHS website [http://www.measuredhs.com/data] since the source of data is national representative.

Competing Interests

There is no any competing of interests related with this work.

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No funding was obtained for this study.

Authors’ contributions

YWD: contributed in writing protocol, extracted geocoded and non-spatial data, analyzed both spatial and non-spatial data, interpretation of the results and preparation to submitting a manuscript. MKY and TYA: contributed in reviewing the protocol and the report and the manuscript.

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Abbreviations

AOR: Adjusted Odds Ratio, BMI: Body Mass Index, CI: Confidence Interval, COR: Crude Odds Ratio, CSA: Central Statistical Agency, DHS: Demographic Health Survey, EAs: Enumeration Areas, EDHS: Ethiopia Demographic Health Survey, GEE: Generalized Estimating Equation, HFA: Health for Age, HH/s: Household/s, IYCF: Infant Young Child Feeding, Kg/M2: Kilo Gram Per Care Meter, SD: Standard Deviation, SNNPR: Southern Nation Nationalities Population Republic, SSA: Sub Saharan Africa, U5C: Under-fives Children, UNICEF: United Nations Children’s Fund, WHO: World Health Organization, and WHO-UNICEF JMP: World Health Organization-United Nations Children’s Fund Joint Monitoring Program.

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Tables

Table 1: Socio-demographic and economic characteristics of respondents and under-five children in Ethiopian, EDHS 2016.

Variables (n = 8855)	Frequency Weighted (n = 9588)	Percent (Weighted)
Residence		
Urban	1216	11.00
Rural	9807	89.00
Wealth index		
Poorest	2636	23.9
Poorer	2520	22.9
Middle	2780	20.7
Richer	1999	18.1
Richest	1588	14.4
Mother's marital		
Never union	178	1.6
Married	10462	94.9
Widowed	120	1.1
Divorced	263	2.4
Education status		
Non educated	7284	66.1
Primary+	3739	33.9
Age of respondent		
15-24	2446	22.2
25-34	5843	53
35-49	2734	24.8
Father's occupation		
Employed	7304	69.8
Self employed	2354	22.5
Not had work	805	7.7
Mother's occupation		
Employed	2618	23.7
Self employed	2278	20.7
Not working	6127	55.6
Religion		
Christian	6204	56.8
Muslim	4561	41.8
Others	150	1.4
Sex of child		
Male	5725	51.9
Female	5298	48.1
Age of child		
Under 2 years	6219	59.7
Above 2 years	4199	40.3

Note: Others religion = Traditional and unclassified. Christian = Orthodox, Catholic and Protestant

Table 2: GEE binomial logit of associated factors of spatial pattern of stunting, Ethiopia, 2018

Variables	Frequency	COR (95% CI)	AOR(95% CI)
Region			
Tigray	936	1.91(1.16-3.13)	2.3(1.53-3.46)
Afar	829	1.37(0.81-2.30)	1.9(1.21-2.86)
Amhara	887	2.36(1.46-3.81)	2.85(1.9-4.29)
Oromia	1378	1.27(0.79-2.06)	1.71(1.13-2.46)
Somali	1154	0.95(0.57-1.59)	1(0.66-1.55)
Benishangul	731	2.14(1.31-3.49)	2.61(1.72-3.95)
SNNPR	1103	1.63(1.01-2.64)	2.04(1.36-3.06)
Gambella	560	1.12(0.66-1.8)	1.1(0.69-1.71)
Harari	461	1.16(0.68-1.96)	1.63(1.03-2.57)
Dire Dawa	418	1.84(1.09-3.11)	2.25(1.44-3.51)
Addis Ababa	398	1	1
Age of mother		5.73(1.03-31.86)	1(0.99-1.01)
Household had radio and / TV			
No	5889	1.5(1.35-1.68)	1.61(1.12-2.82)
Yes	2882	1	1
Number of children		1.81(1.197-2.87)	0.96(0.89-1.03)
Wealth index of households			1
Poor	6001	1.40(1.185-1.60)	1.4(1.20-1.6)
Rich	2854	1	1
Currently pregnant mother			
Yes	871	1.27(1.05-1.55)	1.08(0.93-1.27)
No	7984	1	1
HFA of mother			
Below -2 SD	1406	2.05(1.74-2.43)	1.9(1.62-2.14)
Above -2 SD	7357	1	1
BMI of Mother			
25+	823	0.73(0.55-0.96)	0.74(0.61-0.93)
<18.49	2080	1.26(1.18-1.47)	1.2(1.03-1.32)
18.5-24.99	5857	1	1
Mothers with anemia			
Yes	2996	1.204(1.134-1.40)	1.32(1.1-1.62)
No	5630	1	1
Sex of child			
Female	4344	1.164(1.067-0.27)	1.2(1.19-1.32)
Male	4511	1	1
Age of child		1.501(1.402-.609)	1.25(1.19-1.29)
Place of delivery			
Home	5983	1.634(1.459-.829)	1.63(1.4-2.33)
Institution	2872	1	1
Birth weight			
<2500 gram	2391	1.625(1.393-.895)	1.5(1.30-1.65)

2500gram+	6376	1	1
Child with anemia			
Yes	4568	1.517(1.31-0.765)	1.6(1.43-1.80)
No	3052	1	1
Meet minimum acceptable diet			
No	820	3.985(1.532-.687)	3.89(1.49-9.60)
Yes	8035	1	1

Note: • Model: Intercept. GEE = Generalized Estimating Equation. HFA = Height for Age.

Figures

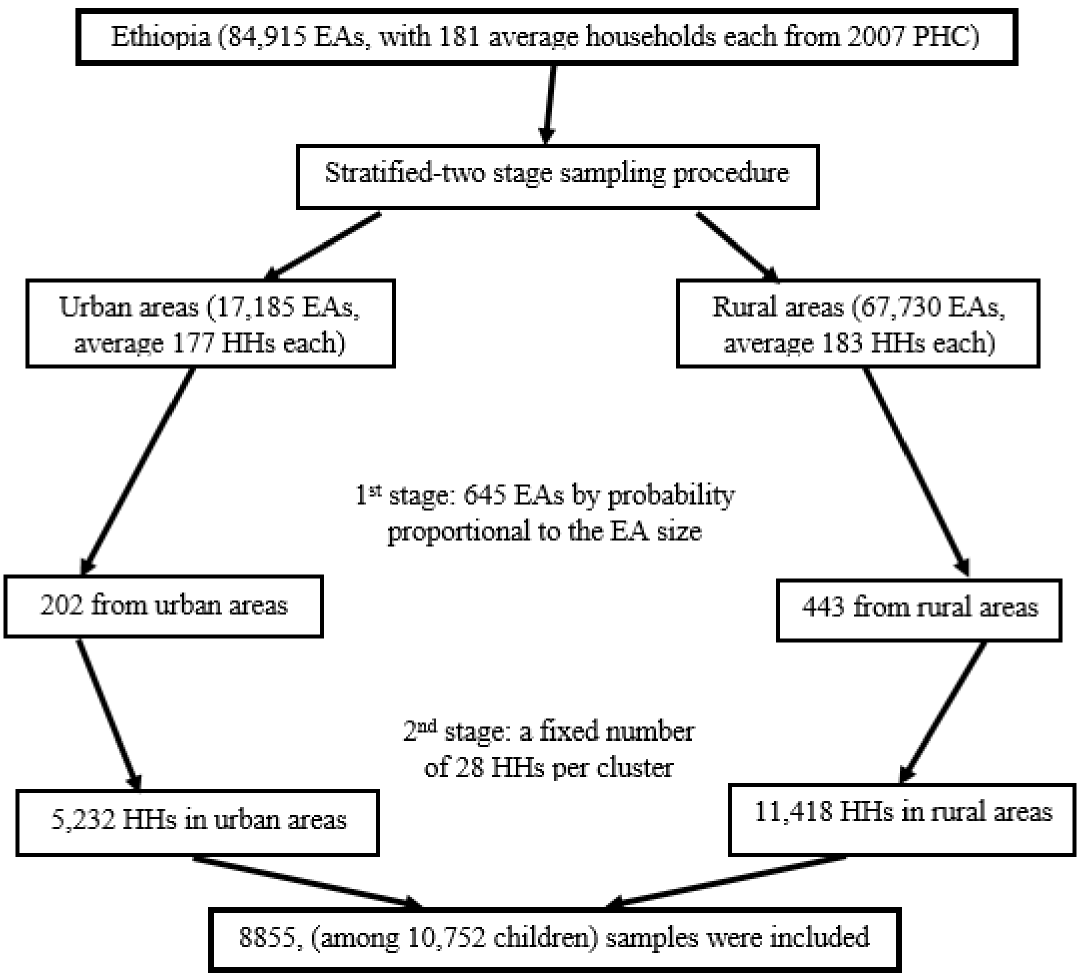

Figure 1

Schematic presentation of sampling procedure of spatial distribution and associated factors in Ethiopia, 2018 (15).

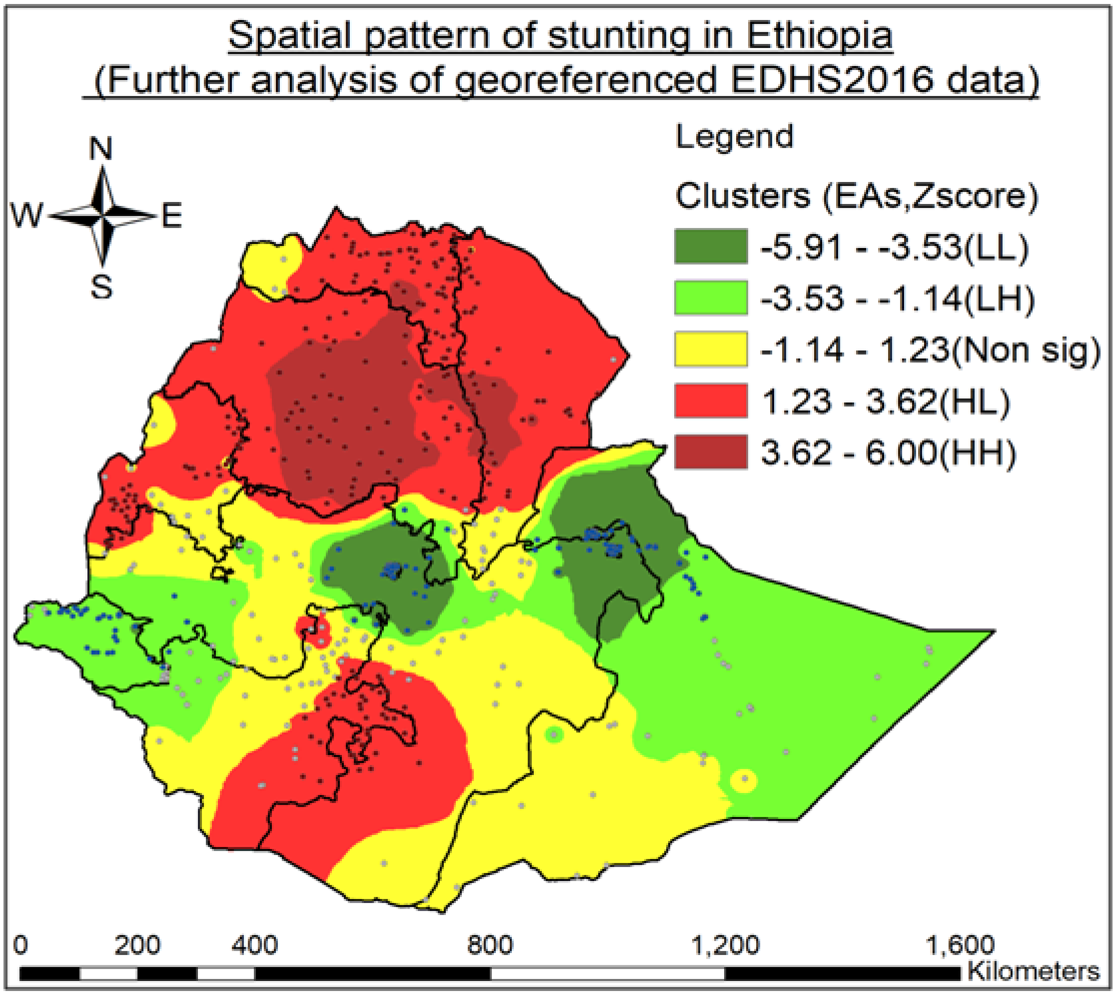

Figure 2

Clusters of stunting within five kilo meter radius in Ethiopia, Geo-reference EDHS 2016 data perspective.

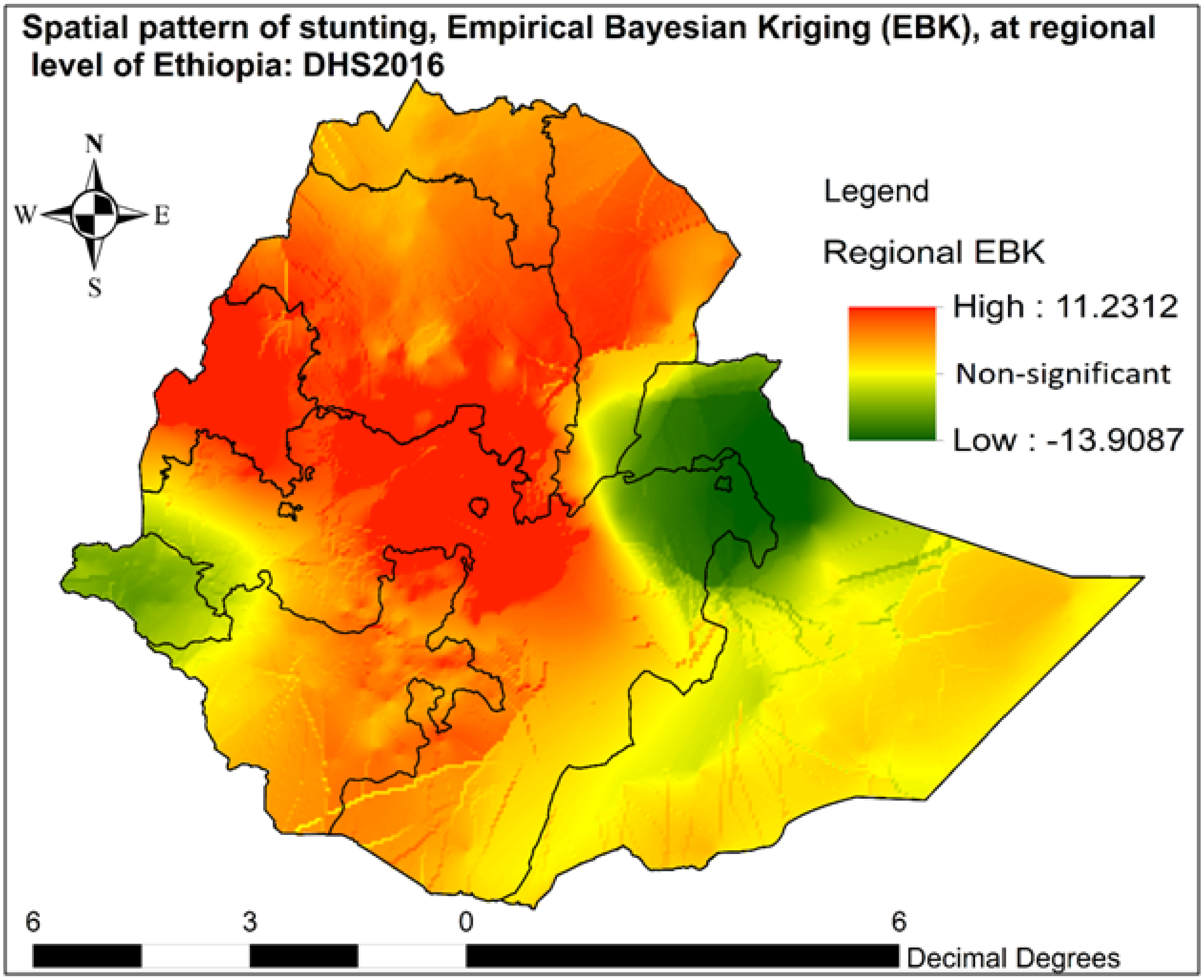

Figure 3

Clusters of stunting of EBK at regional level within five kilo meter radius in Ethiopia, 2018: Geo-reference EDHS 2016 data perspective.