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ORIGINAL ARTICLE

SOCIO-ECONOMIC INEQUALITY IN THE OCCURRENCE OF LOW BIRTH WEIGHT IN ETHIOPIA: ANALYSIS OF THE 2016 ETHIOPIA DEMOGRAPHIC AND HEALTH SURVEY DATA

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ABSTRACT

Background*: Low birth weight (LBW) occurrence has steadily risen in Ethiopia over the last five years, from 11% in 2011 to around 13% currently. Understanding the socio-economic gradient involved in LBW occurrence is vital to plan equitable strategies to help eliminate unjust inequalities in LBW between the poor and rich.*
Objective*: The study aimed to assess socio-economic inequalities in LBW occurrence in Ethiopia.*
Methods: *The dataset for the analysis came from the 2016 Ethiopia Demographic and Health Survey. The prepared version of the dataset was transferred to RStudio software for analysis. Socio-economic inequalities in the occurrence of LBW were measured through the computation of a concentration index using 'decomp' package. Decomposition analysis was done to evaluate the percentage contributions of the explanatory variables to the observed inequalities in LBW.*
Results: *LBW appeared to be slightly concentrated among poorer families. The disparity in LBW along the socio-economic spectrum was mainly accounted for by differences in ethnicities.*
Conclusion and recommendation: *LBW was concentrated among the poor in the studied population. The observed disparity in the distribution of LBW across wealth categories was majorly attributed to uneven distribution of LBW-reducing strategies among ethnicities. Equitable strategies that can function well in all ethnic groups are recommended to end the poor-rich inequality in the prevalence of LBW.*
Key words*: Low Birth Weight; socio-economic inequality; Ethiopia*

INTRODUCTION

Babies who weigh less than 2500g at birth are classified as Low Birth Weight (LBW) babies(1). LBW carries along with it various health complications and death. Lasting neurologic damage and weakened communication were reported in neonates with low birth weight(2). LBW was reported to have also exposed babies to varying types of non-communicable diseases(3, 4). In terms of death, newborn babies who have low weight at birth have huge risk of death compared to babies whose weight is greater than 2.5kg at birth(5, 6). The 2015 *Lancet* report exposed that prematurity, which inevitably leads to low birth weight, is the foremost reason of death in the under-five population(7). Estimated global prevalence of LBW varies between 15% and 20%, with largest percentage being concentrated in low and middle income countries (LMIC) (8).

Sub-Saharan Africa contributes one-third to the overall proportion of babies born with low birth weight globally(8). Magnitude of LBW in Ethiopia has seen a steady rise over the last five years, from 11% in 2011(9) to around 13% currently(10).

The best way to prevent LBW is to first exhaustively profile all possible causes and then provide the evidence to policy makers to help them launch strategies that aim to prevent those causes. In this regard, researchers investigated the potential predictors of LBW and widely disseminated their conclusions to help child health decision makers consider the evidence. Extensive compilation on determinants of low birth weight has been issued by the Bulletin of the World Health Organization(5).

The Bulletin identified 43 factors which fall under different categories. Nutrition related problems and having low weight before a mother becomes pregnant substantially contributed to the occurrence of LBW in developing countries(5). Other empirical evidence showed that maternal individual level factors such as being old, not married, and history of complication of pregnancy are associated with an increased risk of LBW(11). Similarly, maternal age, parents' social class and occupation influenced the occurrence of LBW(12).

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There is copious literature on the level-analysis of possible risk factors of LBW in both developed and developing nations. On the contrary, gap-analysis in the socio-economic status (SES)-based disparity in the occurrence of LBW is quite few and is mainly done in the developed nations. Further, most available SES-based inequalities around LBW are based on the classic regression approach where the computation of inequalities do not takes into account information from the entire SES groups. Investigating the influences of a wide range of factors on the wealth-based inequalities in the occurrence of LBW has important implications from at least the public health perspective. For instance, assessing the socio -economic inequality in ill-health has profoundly assisted public health researchers to prove where an ill health outcome is concentrated along the socio-economic spectrum of population groups, and to subsequently decompose observed ill health inequality into underlying social and economic determinants. Available evidence documented the existence of palpable socio-economic gradient in LBW (13, 14).

Melissa L. Martinson and Nancy E. Reichman have recently reported that socio-economic inequality in LBW appeared in UK, Canada, USA and Australia, though extent of the disparity was not uniform across these countries(15). The presence of uneven distribution of LBW in North West China across socio-economic standing of the studied population was documented to the disadvantage of the poor. Certain demographic factors also contributed to this poor-rich gap in LBW (16).

Apart from small scale-studies that summarized the common risk factors of LBW (17-21), socio-economic inequalities involved in the occurrence of LBW were not thus far documented in Ethiopia. Yet, understanding the socio-economic gradient in the occurrence of LBW is vital to plan equitable strategies to help eliminate unjust inequalities in LBW between the poor and rich. Further, socio-economic based analysis of risk factors of LBW is very essential especially for resource-strapped countries such as Ethiopia to help the countries consider redistribution of budgets towards determinants with the most influence on the observed inequality.

This study therefore aims to undertake examination of SES-based inequalities in LBW using the best available socio-economic inequality measure that uses information from all people in all categories of a SES measure, wealth index in this study.

The study plans to provide policy makers with up-to-date evidence on the extent of socio-economic inequality in LBW, and on the individual percentage contribution of risk factors identified to be associated with LBW.

METHODOLOGY

Study setting

Ethiopia makes up the horn of East Africa and is known to be the cradle of mankind and is lately being promoted as the “Land of Origins”(9). Ethiopia is home for various ethnic groups and cultural diversity, with its population speaking more than 80 different languages(9). Nine regions and two City Administrations make up the country's federal administration. Economically, agricultural activities take the lion's share of the country's Gross Domestic Product, with 38.8% share(22).

Data source and ethical issues

For this study, the data came from the 2016 Ethiopia Demographic and Health Survey (EDHS). The dataset was accessed from the DHS website upon registering to the website(23). Since the DHS dataset is freely available to the public domain, there is no ethical barrier that prevents interested researchers from using the data as far as they are officially registered on the web site. The detailed sampling procedure and data collection process of the survey are found elsewhere(10), but briefly, a two stage stratified cluster sampling technique was used to enroll participants into the study. In the first stage, each of the regions was stratified to urban and rural strata. Altogether, 645 clusters (Enumeration Areas, EAs) were selected out of the total 84,915 EAs across the country. In the second stage, a pre-specified number of 28 households was selected from each EA. Low Birth Weight in the survey was determined based on mother’s report on weight of her baby at birth or from records written in the log book. Based on this, information was available for only 2110 births (14% of total births). Analysis was made on children who were born five-years preceding the survey.

Data analysis steps and statistical method

First, the author officially registered to the DHS web address, and received the dataset in SPSS file type. The prepared data was transferred into RStudio programming environment to do concentration indices of LBW and determinants, and to subsequently decompose concentration index of LBW into underlying socio-economic inequalities. The outcome variable, LBW, was dichotomized to assume 1 if weight is < 2.5 kg and 0 otherwise.

Explanatory variables used in the analysis were: preceding birth interval, skilled antenatal care attendance, presence or absence of TV or radio, child wanted or not, ethnicity, education of mother, wealth, residence, sex of child, age of mother at delivery, birth order and mother's religion. Household level wealth was computed based on sets of household possessions and assets such as TV, radio, sanitation facilities and water supply(24). DHS used the statistical procedure, Principal Component Analysis (PCA), to produce wealth index, and this study used the wealth index already available in the accessed EDHS dataset. Antenatal care attendance was considered skilled if the woman was attended by doctor, nurse, midwife or health officer. Preceding birth interval was recoded as < 33 months and 33 or more months. This classification was in accordance with the World Health organization (WHO)'s recommendation on the minimum inter-pregnancy interval of 24 months(25). Nine months was added for period of gestation to 24 months to obtain 33 months.

Concentration index(26) was applied to measure socio-economic inequality in LBW. This method of socio-economic inequality measurement has been fully expounded in various easily accessible documents(27-29). In brief, values of concentration index are calculated from relative concentration curve. Concentration curve graphs cumulative proportion of populations under investigation in x axis, put in order from poorest to richest and cumulative percentage of health outcome or variable under caption (LBW and its determinants for this study) in the y axis. Relative concentration index (C) is assumed as twice area between the plotted concentration curve and the 45 degree line. When there is no disparity in health outcome variable of interest, then C is just zero. If the concentration curve lies below the line of no inequality (diagonal line), then C becomes positive and health variable being studied is more concentrated among richer families. C is negative when the curve lies above the diagonal line and indicates pro-poor dominancy of the variable of interest. Availability of different variants of concentration indices has made it possible to widely apply the indices in most health care variables. Measurement property of a variable and a researcher's reply to inequality should be in the center stage during choice of the proper variant of concentration index (30-32). For variables with bounded upper limits such as LBW, computation of inequality is cumbersome (32) and standard concentration index could not be used unless 'relative invariance' principle is given superior preference over other criteria(33). Types of variant of C to be used in a study are largely normative decision and standard concentration index which exhibits relative invariance criterion was preferred for this study.

Generalized Linear Model (GLM) with binomial function specified was fitted to predict log odds of LBW. Regression coefficients were estimated for all explanatory variables that went into the model. The overall concentration index of predicted LBW was computed. Concentration index for predicted outcome is defined by the following formula:

$$C = \frac{\sum_k (\beta k \, xk) \, ck}{\mu}$$

The formula explains that the predicted health outcome (LBW in this study) is a result of summation of contributions made by all explanatory variables under investigation (k variables)(29). Determinants contribute to the overall C through a combination of their concentration index (ck), regression coefficient (βk), mean (xk), and mean of health outcome (μ) which was predicted by these determinants(34). Weight variable already available in the DHS dataset was used for analyses. The 'decomp' package was used to do both concentration indices and decomposition analysis. 'Survey' package was used to create 'survey design object' to account for stratification and two-stage clustering pursued in the DHS methodology. In the package, primary sampling unit as cluster, household as secondary sampling unit and strata as stratifying variable were specified to create survey design object which was later called in the GLM to estimate regression coefficients, predicted concentration index of outcome variable and both concentration index and percentage contributions of all explanatory variables selected in the analysis. 'Strata' variable was created by combining residence and region variables together. Cut-off for statistical significance was p-value= 0.05.

RESULTS

Concentration index of LBW and regression coefficients of its determinants

The analysis returned a concentration Index (C) of -0.012 for low birth weight. This showed that babies who weigh less than 2500g at birth are slightly more concentrated among the worse-off households. The concentration curve confirms this pro-poor dominance of low birth weight, with the curve lying slightly above the diagonal line (Fig1).

The coefficients of 12 variables were analyzed in the Generalized Linear Model (GLM) to predict logit of Low Birth Weight. Variables' influences on children's ill health was estimated by both calculating each variable's regression coefficient (Table. 1) and by studying how unequally distributed those variable are between the poor and rich, a phenomenon determined using concentration index (Table 2.).

The age of the mother exhibited significant positive relationship with LBW, with the log odds of LBW found highest among mothers aged between 36 and 46 years(P-value<0.001).

Babies born from ethnic groups Tigre (β=-1.15;P-value=0.008), Keficho (β=-3;P-value=0.03), Gamo (β=-15;P-value<0.001) and Gedeo (β=-15;P-value<0.001) had all been negatively associated with low birth weight.

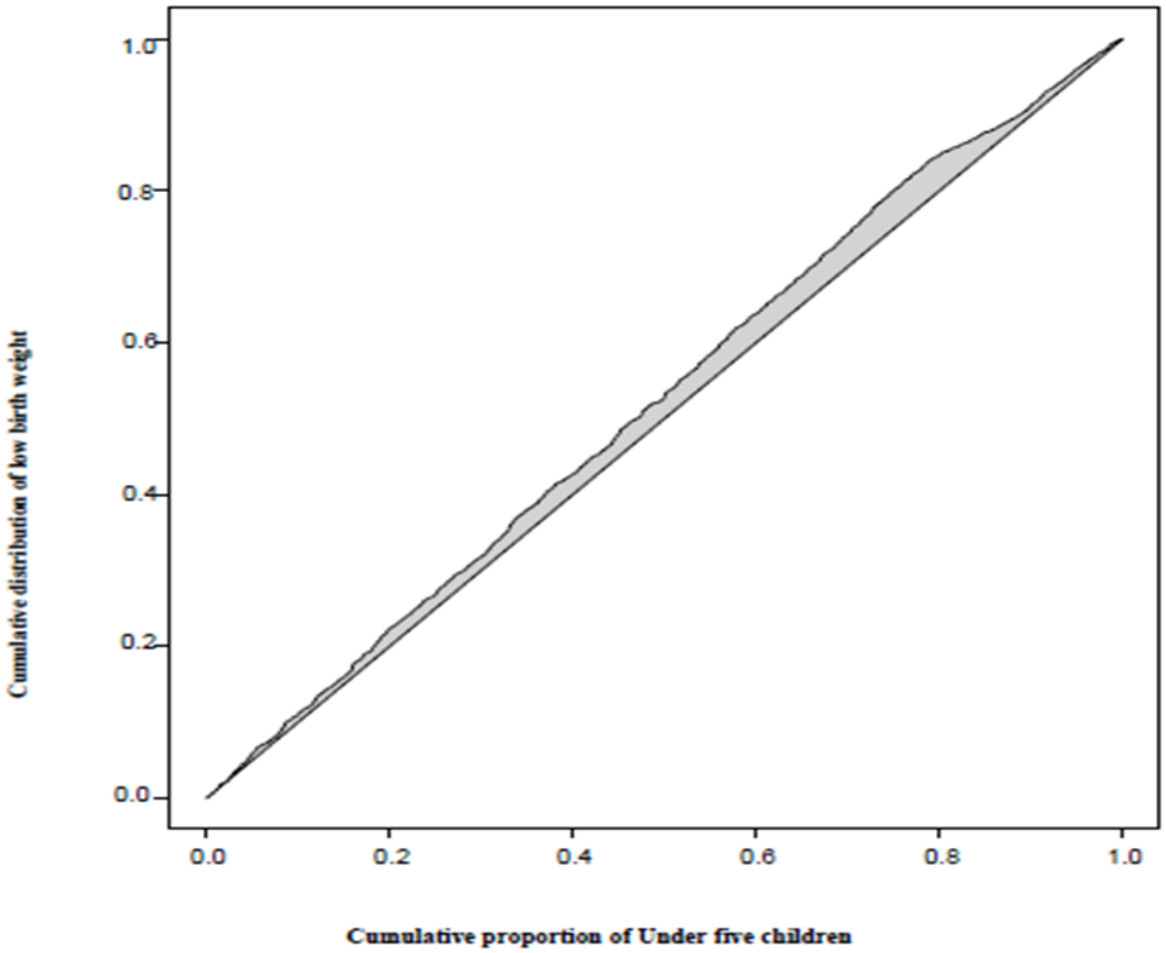

Fig.1 a concentration curve showing the wealth-related inequality in the occurrence of low birth weight, Ethiopia DHS 2016.

Table1. Regression coefficients of selected variables that went into the logistic regression model in the estimation of the log odds of low birth weight, 2016 Ethiopia DHS.

Variables	coefficients	95%CI	P-value
Household wealth			
Poorest(ref)			
Poorer	0.19	-0.9, 1.3	0.74
Middle	0.08	-1.02, 1.18	0.89
Richer	0.3	-0.8 ,1.4	0.6
Richest	-0.07	-1.5, 1.4	0.93
Urban	0.15	-0.8,1.2	0.75
Age of mother at delivery (in years)			
14-17(ref)			
18-19*	13.5	10.7, 16.4	<0.001
20-25*	14.6	12.9, 16.3	<0.001
26-30*	14.6	12.9, 16.2	<0.001
31-35*	14.5	12.8, 16.1	<0.001
36-46*	14.9	13.1, 16.6	<0.001
Religion of mother			
Orthodox(ref)			
Protestant	-0.5	-1.44, 0.4	0.27
Muslim	0.06	-0.6, 0.77	0.86
Ethnicity of mother			
Amhara(ref)			
Oromo	-0.02	-0.7, 0.68	0.96
Tigrey*	-1.15	-1.99, -0.3	0.008
Somalia	-1	-2, 0.07	0.07
Guraghe	0.047	-0.9, 1	0.9
Sidama	-0.7	-2.7, 1.35	0.5
Wolaita	0.49	-1.2, 2.2	0.57
Keficho*	-3	-5.7, -0.31	0.03
Hadiya*	1.7	0.45, 3	0.009
Gamo *	-15	-16,-13.5	<0.001

* indicates variables associated with LBW at p-value <0.05.

Table 1 (continued)

Silte	-1.3	-3.6, 1.1	0.29	
Gedeo*	-15	-17, -13	<0.001	
Sex of child				
Female(ref)				
Male	-0.23	-0.76, 0.3	0.39	
Education of mother				
No education(ref)				
Primary	-0.5	-1.16, 0.07	0.08	
Secondary	-0.75	-1.6, 0.16	0.11	
Higher	-0.46	-1.3, 0.41	0.3	
Preceding birth interval (in months)				
<33(ref)				
33 or more	-0.4	-0.9, 0.12	0.13	
Skilled ANC attendance				
No(ref)				
Yes	0.44	-0.5, 1.38	0.36	
Presence of TV or radio in household				
No(ref)				
Yes	-0.44	-1.07, 0.19	0.18	
Child born wanted or not				
Wanted(ref)				
Unwanted	-1.1	-2.47, 0.33	0.13	
Birth order				
1-4(ref)				
5-13	-0.46	-1.2, 0.27	0.22	

** indicates variables associated with LBW at p-value <0.05.*

Percentage contributions of determinants and their concentration indices

Over all, wealth index helped the pro-poor inequality in LBW to narrow down by about 88% (sum of contributions made by all categories of wealth index). The contribution is by shrinking the gap, because the sign is negative. Urban residence is occupied by individuals who are relatively wealthier (positive C) and had positively contributed about 60% to the wealth-based disparity in LBW to the good deed of well-off households. Certain variables like age of mother seemed to have large contributions, but their concentration indices are not different than zero and it cannot be concluded that age had any contribution to the existing inequality, except age between 18 years and 19 years, which hugely contributed to the inequality.

Muslim religion had negatively contributed for the poor-rich inequality in the prevalence of LBW. Birth order of greater than 4 and Ante-Natal Care attendance has positively contributed to the inequality. Because the sign is positive, the contribution is by widening the poor-rich gap in LBW occurrence (See table 2).

Table 2. Contributions to low birth weight inequality and concentration indices (C) of selected socio-economic determinants, 2016 Ethiopia DHS.

Variables	Contribution (%)	Concentration index (C)	95%CI	
Household wealth*				
Poorest (ref)				
Poorer	-26	-0.76	-0.8	-0.73
Middle	-9.4	-0.55	-0.6	-0.5
Richer	-22	-0.3	-0.36	-0.26
Richest	-30.5	0.41	0.39	0.42
Residence				
Rural (ref)				
Urban*	59	0.37	0.36	0.39
Age of mother at delivery (in years)				
14-17(ref)				
18-19*	-125	-0.48	-0.82	-0.14
20-25	17	0.0024	-0.06	0.065
26-30	57.6	0.006	-0.05	0.06
31-35	359.8	0.055	-0.008	0.12
>=36	-293.5	-0.07	-0.17	0.02
Religion of the mother				
Orthodox (ref)				
Protestant	2.87	-0.02	-0.11	0.06
Muslim	-3.67	-0.1	-0.16	-0.03
Ethnicity				
Amhara (ref)				
Oromo	0.45	-0.06	-0.14	0.02
Tigrey*	61	-0.11	-0.17	-0.048
Somali*	31	-0.24	-0.41	-0.06
Gurage*	1.5	0.21	0.1	0.3
Sidama*	11.6	-0.3	-0.51	-0.09
Wolaita	-1.19	-0.06	-0.28	0.16
Keficho*	39	-0.4	-0.6	-0.18
Hadiya	6	0.14	-0.09	0.38
Gamo*	95	-0.23	-0.42	-0.029
Silte*	-14.2	0.24	0.07	0.42
Gedeo*	75.6	-0.48	-0.68	-0.27

Table 2 (continued)

Sex of child				
Female (ref)				
Male	1	-0.005	-0.04	0.03
Education of mother				
No education (ref)				
Primary	-3.8	0.01	-0.04	0.07
Secondary*	-87.4	0.39	0.34	0.45
Higher*	-34.3	0.33	0.26	0.39
Preceding birth interval				
<=32.9 months (ref)				
33 or more months	-15.5	0.03	-0.002	0.06
Skilled ANC attendance				
No (ref)				
Yes*	15.6	0.02	0.0014	0.042
Have TV or radio				
No (ref)				
Yes*	-133.24	0.25	0.23	0.27
Baby born wanted or not				
Wanted (ref)				
Unwanted	-1.1	0.01	-0.13	0.15
Birth order				
<=4(ref)				
5-13*	65.8	-0.31	-0.38	-0.23

Note: * refers variables that had significant concentration index at 95%CI; CI=Confidence Interval; ref=reference

DISCUSSION

Analysis of the latest round of Ethiopia Demographic and Health Survey data revealed that LBW had pro-poor dominance by both concentration index and concentration curve. The finding clearly showed that LBW is mainly a problem of the poor though the disparity was not big enough to cause significant concern to decision makers and researchers. That is, since the concentration curve was not far removed from the line of perfect equality i.e., the 45 degree line that runs from left bottom to the right upper corner, one can deduce that the pro-poor concentration of the problem did not wildly deviate from the equality line. The fact that LBW exhibited disproportionate concentration along Socio-Economic Status (SES) to the disadvantage of the poor in this study compares well with other studies where an apparent socio-economic gradient in LBW was reported (13, 14).

The regression based decomposition analysis of concentration index of LBW showed that few socio-economic characteristics had explained the largest part of wealth-based inequality in LBW. For a variable to significantly contribute to an inequality, it should have non-zero regression coefficient and as the same time it needs to be more concentrated in one group over the other group (34). Four ethnic groups namely Gedeo, Gamo, Keficho and Tigrey had met both these criteria. These social characteristics were found to hugely positively influence the poor-rich inequality in LBW. Stated in another way, babies from mothers in these ethnic groups are more likely to have LBW and the rich-poor discrepancy of LBW in the studied population was mainly accounted for by differences in these ethnicities.

However, the superficial association of ethnicity with inequality in LBW between poor and rich can be caused by several underlying factors, which themselves are unevenly distributed between the poor and rich. For instance, knowledge about proper nutrient intake throughout pregnancy time is not the same among women. Even if intake of the recommended amount of balanced nutrient could reduce proportion of babies that would be born with low weight, only few women implement this practice. While the above mentioned characteristics had typically widened the inequality, age of the mother (18-19 years) contributed to this inequality negatively, i.e., it operated its contribution through reduction of the disparity in the LBW condition. This happened because these mothers give birth to babies with normal birth weight. Inconsistent with another study(35), it was found in this study that oldest mothers (36-46 years) were running the highest log odds of LBW.

However, age (with the exception of 18-19 years) was found not to vary by SES and its observed contribution to LBW inequality might simply be spurious.

Wealth was found contributing to the observed inequality though it had non-significant regression coefficients. The striking finding from this study was that disparity in SES serves as a vehicle within which inequalities in other social characteristics function to cause wealth-based inequality in LBW. Inequality in wealth creates the condition for other inequalities to increase and cause measurable LBW disparities across SES groups. Existing evidence(13, 15, 36), however, reported that SES variation itself significantly affected LBW. The current finding could not conclude that wealth has provided material contribution to the inequality (since the regression coefficients for all categories of wealth are not different from zero), and justifications can be made for these dissimilar results between current and previous studies.

In DHS, wealth is computed based on constellation of durable household possessions and household characteristics (24). It normally measures not absolute deprivation of basic necessities, but relative poverty. Individuals in the poorest quintile may not necessarily be destitute enough to cause Low Birth weight. Further, other variables whose effect on LBW was measured together with wealth could have an important influence on the wealth vs. LBW inequality relationship. Therefore in this research, disparities in the aforementioned social characteristics were more important to cause inequality in the occurrence of LBW between better-off and marginalized population groups than that of inequality in wealth.

Also, other determinants such as education of mother, skilled ANC attendance, presence of TV or radio in the household, birth order of five or higher and urban residence had made significant contribution to the inequality but without their regression coefficient statistically associated with log odds of occurrence of LBW. Women from well-to do families are more likely to get ANC service and this skilled service during pregnancy helped those women to give birth to normal weight babies, which led to widening of poor-rich disparity in the magnitude of LBW to the rich. Birth order of 5 or higher similarly played a big role in enlarging the gap, but the mechanism by which it operates to widen the inequality is different. Being more prevalent among the poorer people, higher birth order caused LBW babies to be more accumulated in lower socio-economic groups.

Unsurprisingly, economically strong families had a higher chance of possessing TV or radio. Yet, it functions by shrinking the difference in percentage of low birth weight babies between poor and rich. This seems justifiable since the sheer existence of communication devices in one's household does not guarantee uptake and implementation of messages being broadcast from these mass-media. Similar to the mechanism of action of presence of TV or radio to the LBW differential is that of education level of the mother. Secondary and higher level of schooling is disproportionately higher among the better-off and works to reduce the inequality in LBW. For individuals to benefit from their knowledge in combating LBW, they need to attain health-specific know-how. This however often happens at university or college and not in secondary or preparatory schools. LBW reduction strategies therefore need to be regularly mass broadcast to all women in the reproductive age group irrespective of their level of education to help them develop proper feeding behavior before and during pregnancy.

People who live in urban areas are likely to be relatively wealthier and about 60% of disparity around LBW was accounted for by urban residence. Since wealth itself was not responsible for the disparity as discussed above, urban residence-associated inequality could be explained through differences in other characteristics. For instance, most health care services and health information are more abundant at urban sites than in rural areas.

Policy implications

The disproportionate distribution of LBW between poor and rich people is not just an inequality; but inequity as well. Inequity is the avoidable version of inequality. It is unfair to see more babies born with low weight at the poorer end of the SES. This is where policy makers and researchers have joint professional responsibilities to combat SES-associated inequity in LBW in Ethiopia. To facilitate possible elimination of the inequity in LBW along the socio-economic spectrum, the government of Ethiopia should first consider elimination of inequalities such as in ANC attendance and ethnicity-associated disparity in the provision of healthy messages which aim to prevent LBW.

Limitation

The incorporation of more determinants would have yielded better understanding about wealth based inequality in LBW.

In a nutshell, occurrence of LBW appeared to be slightly concentrated among poor households. The observed poor-rich inequality involved in the occurrence of LBW was due mainly to underlying inequalities in ethnicities, ante-natal care attendance and other residence driven disparities.

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