IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388,p-ISSN: 2320–737X Volume 6, Issue 6 Ver. I (Nov. - Dec. 2016), PP 71-74
www.iosrjournals.org

Maternal Exposure to Biomass Smoke and Reduced Birth Size in Bangladesh: Evidence from Bangladesh Demographic and Health Survey, 2011 Data

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Abstract: *Birth weight is an important indicator of a child's health status. It is a significant factor of mortality and morbidity. This paper tackles the issue of birth size using data from the Bangladesh Demographic and Health Survey (BDHS)-2011, and focuses on one important risk factor, -type of cooking fuel used in the household and its effect on low birth size at birth. In this study observes that woman's delivering a low birth weight baby is 61% greater if she lives in a household which uses biomass (such as wood, animal dunk etc) fuel, instead of clean fuel (such as natural gas, LPG, electricity). Using logistic regression model, the study establishes that the use of biomass cooking fuel (biomass fuel or kerosene) for daily use of cooking and heating is a significant risk factor of low birth size. Other demographic factors are associated with low birth weight are examined as well. Information about the effect cooking fuel on birth weight should lead the government and policymakers to make clean cooking fuel available to Bangladesh households at a cheap cost.*
Keywords - *Biomass fuel, logistic regression, low birth weight.*

I. Introduction

Birth weight is an important indicator of a newborn's health status. Biomass fuel is one of the risk factors of low birth size. Biomass fuel causes low birth size including an increased risk for pre-term birth and complications that increase the risk of low birth weight and may cause fetal death and neonatal death. Many people burn organic substance such as wood, dung or charcoal, coal and kerosene (biomass fuel) for cooking, heating and lighting. This form of energy usage is connected with high levels of indoor air pollution and an increase in the incidence of respiratory infections, including pneumonia, tuberculosis and chronic obstructive pulmonary disease, low birth weight.

This study examines the effects of cooking fuel on birth size. The main objective of the study is the systematic analysis of maternal exposure to biomass smoke and reduced birth size. So this study examines the association between pregnant mothers use biomass fuels for cooking and low birth size of her new born baby. For the analysis purpose logistic regression model is run. The report on indoor air pollution from solid fuels of the World Health Organization (WHO) observes that around half of the world's population still relies on solid fuels for everyday needs: 2.4 billion on biomass and 0.6 billion on coal, and that the impact of solid fuel smoke exposure on both low birth weight and stillbirth. Another similar study titled effects of household use of biomass fuel and kerosene on birth weight of babies in the Philippines, estimates that the odds of a woman's delivering a low birth weight baby is 77% greater if she lives in a household which uses wood fuel, instead of natural gas. Women who cooked only with wood, dung, or crop residues were significantly more likely to have experienced a stillbirth than those who cooked with electricity, LPG, biogas, or kerosene. Using biomass fuel, Mother age from 30-29, age more than or equal 35 and first birth significantly increase the probability of low birth size. Male child, Mother age from 20-29, Other than first birth, middle class household, primary, secondary, higher, from 1 to 3 numbers of antenatal visits, more than or equal four antenatal visits significantly decrease the probability of low birth size.

II. Data Source

The data utilized for the analysis are extracted from the nationally representative 2011 Bangladesh Demographic Health Survey (BDHS). Bangladesh Demographic and Health Surveys (BDHS) is a part of the worldwide Demographic and Health Surveys program, which is designed to collect data on fertility, family planning, and maternal and child health. This survey conducted under the authority of the National Institute of Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare and implemented through a collaborative effort of Mitra and Associates of Dhaka. In this survey, all ever-married men of age 15-54 who were usual members of the selected households or who spent the night before the survey in the selected households were eligible for individual interview. This study utilized the 2011 birth dataset.

III. Variables

3.1 Dependent Variable

Size of child at birth

There are five categories for this variable. These are: very large, larger than average, average, smaller than average and very small. Here, first category is made by merging very large, larger than average and average categories and the second category is made by merging smaller than average and very small categories.

3.2 Independent Variable

3.2.1 Type of cooking fuel

The main factor affecting birth weight which this paper tries to study is type of cooking fuel. This variable has been categorized into clean fuel (electricity, LPG, natural gas, or biogas), and biomass fuel (traditional biomass fuel and kerosene). The terms "clean" and "biomass" are used only for this study's purposes only. The second category, biomass fuel, includes coal, lignite, charcoal, wood, straw/shrubs/grass, agricultural crop, and animal dung. Although these are not a biomass fuel, kerosene was lumped in this category because it produces soot and other particulates when burned and is therefore not considered clean.

3.2.2 Adequate antenatal care visits

Adequate antenatal care visits combined with counseling and nutritional supplementation should be a focus to reduce adverse birth outcomes such as small size at birth, especially in the geographically and economically disadvantaged areas. The number of antenatal care (ANC) visits was recorded as a continuous variable which was then recoded based on the WHO recommendation of four visits: no ANC visit; 1-3 three ANC visits and 4 or more ANC visits.

3.2.3 Gender of child

Gender is also a factor of low birth size. So, this gender variable has 2 categories. These are: Male and Female.

3.2.4 Wealth index

In the dataset, there are 5 categories for this variable. These are: Poorest, Poorer, Middle, Richer and Richest. From the above categories, we make 3 categories for our study. By merging Poorest and Poorer categories, the first category is created, which is Poor.

3.2.5 Birth order number

The variable is used as continuous variable in the data. As according to BDHS, 2011 data, a child with first birth order are more likely to have low birth size than other remaining birth.

3.2.6 Dummy variables for level of education

The study also controls for the effect of education on birth weight. For the logistic regression run, the educational attainment variable has been categorized into four: (1) no education or incomplete primary, (2) completed primary education, (3) completed at most secondary education, (4) completed at least higher education.

3.2.7 Mother age at Birth:

A U-shaped relationship has been suggested in some studies to explain the effect of maternal age on birth weight with teenage mothers and those of higher age being at greater risk of having low birth size baby. Therefore, we recoded the variable into age groups: 15-19 years; 20-29 years; 30-34 years and > =35 years.

IV. Methodology

Logistic regression can in many ways be seen to be similar to ordinary regression. Logistic regression estimates the probability of an event occurring (e.g probability (p) that it is 1 (event occurring) rather than 0 (event not occurring)). According to Logistic Regression Model the effect of maternal using biomass fuel on reduced birth size, low birth size variable takes only two values which are low birth weight and average or above. Say, 1 if a baby is born with low birth weight and 0 if a baby is born with average weight or above.

In the logistic regression model, logit link function is used. Logit link is nothing but the natural log of odd of having y_i=1 ,baby is born with low birth weight. The model given in is called the logit regression model.

It can be easily be shown that

$$\pi_i = \frac{e^{x_i'\beta}}{1+e^{x_i'\beta}} \quad \dots (1)$$

The random variables y_i(i=12,…,n) has a probability $x_i(x_{i1}, \dots, x_{ij}, \dots, x_{ip}$)distribution associated

with scale y_i produces a linear predictor.

$$\eta_i = x_i'\beta \quad \ldots (2)$$

Where β = ($\beta_1, \ldots, \beta_j, \ldots, \beta_p$) is the regression coefficient vectors.
The model in (1) is called the logistic regression.

Table 1: Regression analysis of low size at birth with type of fuel and other variables

Variables	Variable description	Logistic regression	
Birth_size	Low birth size of child	Odds ratio	P>|t|
bio_fuel	Using biomass fuel	1.6109	0.000
age_35	Mother's age above 34	1.1339	0.272
age_30	Mother's age 30-34	1.0479	0.611
age_20	Mother's age 20-29	0.9390	0.341
higher	Mother's education	0.4940	0.000
secondary	Mother's education	0.7869	0.001
primary	Mother's education	0.9247	0.243
ante_4	More than 4 antenatal visits by mother	0.4552	0.000
ante_1-3	1-3 antenatal visits by mother	0.6932	0.000
rich	Family wealth index	1.0330	0.590
middle	Family wealth index	0.8860	0.053
sex_male	Gender	0.7166	0.000
order_birth	Birth order	0.7927	0.000

Biomass fuel, Mother age from 30-29, age more than or equal 35 and first birth significantly increase the probability of low birth size. Male child , Mother age from 20-29, Other than first birth, middle class household, primary, secondary, higher, from 1 to 3 numbers of antenatal visits, more than or equal four antenatal visits significantly decrease the probability of low birth size.

Interpretation of Logistic Regression

From table, the odds ratio of biomass fuel is 1.610 means woman's delivering a low birth weight baby is 61% greater if she lives in a household which uses biomass (such as wood ,animal dunk etc) fuel, instead of clean fuel (such as natural gas, LPG, electricity). This shows that biomass fuel has highly significant effect on small child size at birth. The relationship between maternal education and birth size shows that secondary and higher educated mothers have insignificantly 8% and significantly 22% and 51% respectively decreased the odds of giving birth to small sized babies compared to the mothers with no education. Mothers from middle households have significantly 12% reduced odds of giving birth to small sized babies compared to poor households. The link between antenatal visit during pregnancy and size of baby at birth is statistically found significant in this study. From 1 to 3 number of antenatal visits and more than or equal 4 numbers of antenatal visits 31% and 55% respectively reduced odds of giving birth to small sized babies compared to no antenatal visit during pregnancy. Child sex and birth orders are statistically significant for reducing the small size at birth. Male child has significantly 29% reduced odds of giving birth to small sized babies compared to female child with 5% level of significance .Child other than first has significantly 21% significantly reduced odds of giving birth to small sized babies compared to first birth. Mother's age at birth from 20-29 ages has insignificantly reduced odds of giving birth to small sized babies compared to mother with no education.

V. Conclusion

This study examines the effects of cooking fuel on birth weight. The main objective of the study is the systematic analysis of maternal exposure to biomass smoke and reduced birth size to see the association between maternal exposure to biomass smoke and reduced birth size. Logistic model shows that biomass fuel significantly increases the chance of low birth size. Mother age from 30-29, age more than or equal 35 and first birth also increase the chance of low birth size. Male child , Mother age from 20-29, Other than first birth, middle class household, primary, secondary, higher, from 1 to 3 numbers of antenatal visits, more than or equal four antenatal visits significantly decrease the chance of low birth size. So these results are consistent. And it can be concluded that biomass fuel is one of the risk factors of low size of child at birth. These results are also consistent with the earlier study linking biomass fuels to reduced birth size. But this study is conducted on the basis of BDHS 2011data, i.e, for the first time this study is based on Bangladesh household survey data which provides evidence that cooking with high pollution unprocessed biomass fuels can increase the risk of low birth size in Bangladesh. Information about the effect cooking fuel on birth weight should lead the government and policymakers to make clean cooking fuel available to Bangladesh households at a cheap cost.

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