Determinants of Under-Five Child Mortality in Benishangul-Gumuz Regional State of Ethiopia

Kidist Demirew Getachew

Abstract

Under-five Mortality (U5MR) in Benishangul-Gumuz is the highest among Ethiopia's regional states, next to the Afar region. The risk of a child dying before completing five years of age in Benishangul-Gumuz region is 72.8 per 1000 live births. This paper aims to verify the main determinates, socioeconomic, demographic and environment factors, of U5MR in Benishangul-Gumuz Regional State using data from the Ethiopian Demographic and Health Survey (2016). The method of analysis is descriptive and econometric employing Probit model estimation. The result reveals that "Mother's educational level" "Preceding Birth Interval", "Duration of breastfeeding", "Income or wealth of the household" and "Married Marital Status" have a negative and statistically significant relationship on Under-five Mortality. The policy implications of the results of the analysis emphasize that empowering women through education, health and income provide very important instruments to reduce Under-five Mortality in the region.

Key words: Socio-economic; Demographic; environment; Determinants; Under-five mortality; Benishangul-Gumuz Regional
JEL Code: I15

1. Introduction

Child Mortality is the main indicator of the level of health status and welfare of the population. It reflects a country's level of socio-economic development and quality of life and is used for monitoring and evaluating population and health programs and policies (WHO, 2013). There are a number of different types of child mortality rate indicators, including neonatal and post-neonatal, infant, and under 5 mortality rates. Among these the Under 5 Child Mortality Rate (U5MR) is often identified in many researches and policy

statements as the best concept for capturing mortality risks during the susceptible years of childhood. It has now been used as one of the indicators of the United Nation 2015 Millennium Development Goals.

Given the importance of child mortality, many studies have been undertaken to define its determinants. Fitsum (2011), Ayichew (2011), and Kumar and File (2010) have looked at the determinants of child mortality in Ethiopia identifying such factors as the importance of health facilities, diseases, urbanization, birth intervals, living standards and mother's education while Iram and Butt's work on Pakistan underlined the importance of household, demographic and environmental factors, including breast feeding as well as prenatal care, income and environmental contamination.

According to UNICEF's 2015 figures, about 5.9 million children worldwide still die every year before their fifth birthday, 16,000 every day. At the prevailing rate of progress, it will take to 2025 to reach the global target (UNICEF, 2015). Ethiopia, for example, has made good progress in reducing child mortality but the problem still remains serious. It is still one of the countries with the highest U5MR in the world. So, identifying and assessing factors affecting child mortality should be the first step in planning the reduction of child mortality and promoting the health of society. Understanding the determinants help policy makers to make more cost-effective interventions and policies for reducing child mortality, and the aim of this study was to investigate the determinants of U5MR using descriptive and comparative analysis and econometrics models in the Benishangul-Gumuz Regional State.

The result of this research is expected to give information about the determinants or risk factors of under-five mortality. It will also provide information to the Regional Government and other concerned bodies to make enabling environment for the intervention to reduce under-five mortality and add to the existing literature. The study also fills the gaps that are found in the earlier studies where most of them focused on national level disregarding the regional disparities in terms of cultural, social and economic differences. In particular, the study has tried to examine the determinates of under-five child mortality in the one of the least developed regions of the country, Benishangul-Gumuz Regional State. Moreover, the study is superior as it used the recently released EDHS (2016).

2. Literature Review

2.1 Empirical Review

Fitsum (2011) identified preventable and curable diseases as the main causes of death in early childhood and this is why childhood mortality is treated as a development issue rather than a simple health problem. Ethiopia is among the place where the rate of such deaths is high, which is an indicator of poor standards of living. Fitsum used descriptive statistics and Probit model regression analysis to assess the structural relation between childhood mortality and maternal, child specific and household related variables. He chose infant and under-five child mortality as dependent variables with maternal characteristics of total number of children born, maternal educational level, maternal age at first born, child characteristics of gender and twin, and household characteristics of safe water, access to toilet facility, electricity, technology and information, floor material, fuel and other variables as explanatory variables that might contribute to under-five child mortality. His results indicated that the total number of children born has a negative and significant effect on child's chance of mortality. Furthermore, maternal education, age at first birth, access to toilet, safe water, power and radio lowered the chance of mortality. However, multiple births, boys, children living in houses with dirty floors or using polluting cooking fuels faced a high chance of childhood mortality. Some variables showed a low-level significance depending on different approaches of defining childhood mortality. Fitsum recommended interventions designed to reduce child mortality should pay attention to socioeconomic factors while designing and implementing prevention and curative healthcare interventions designed to consider the peculiarities of each society and villages. The source of the data for his study was the Ethiopian Demographic and Health Survey (EDHS, 2011).

Ayichew (2011) emphasized that infant and under-five child mortality was an important indicator of socioeconomic development. His study, analyzing the determinants of interregional variation in infant and child mortality rates, indicated that although Ethiopia had registered improved infant and child health, the gain was not uniformly shared across regions. The study analyzed the determinants of interregional variation in infant and child mortality rate in Ethiopia. The main purpose of the study was thus to fill the gap of information by explaining regional infant and under-five mortality rates using regional level panel data spanning 9 years (1999/2000 to 2007/2008). He employed both

random effect and fixed effect models to address the panel nature of data, the most widely used panel data estimation method in applied economic research. The study also used econometric estimates of infant and under-five mortality. However, the Hausman test result indicated that the fixed effect model was more suitable than the random effect model for the panel data analysis. In the study, infant and under-five mortality rates were taken as dependent variables while health infrastructure variables, socioeconomic and demographic variables and regional location or geographic variables were all considered as independent variables. The data was extracted from different sources; health and health related indicators from the publications of the Ministry of Health, educational statistics from the Ministry of Education and regional location from the Ministry of Foreign Affair website. The estimated results indicated that infant and under-five child health outcomes were strongly sensitive to the availability of skilled health professionals and health facilities; increasing real per capita public health spending was important to infant and child health outcomes; and the share of population living in urban areas had strong effects on both infant and child mortality rates. These findings suggest that much of the observed regional disparities could be reduced through public policy interventions aimed to increase the supply of health resources while at the same time equalizing their distribution across regions.

Kumar and File (2010) investigated the predicators of child (0-5) mortality in Ethiopia. Their main objective was to identify the factors that reduced child mortality and suggest viable strategies to increase health services and reduce child mortality in Ethiopia. The study used a cross tabulation technique to estimate the predicator of child mortality and showed that birth intervals and the mother's standard of living index were the vital factors associated with child mortality. Although there had been a reduction of in child mortality rates, they found the level of mortality was worsened by poverty and inadequate maternal education. Education could indirectly decrease mortality rate and fertility rates by reducing desired number of children. Kumar and File examined the predicators of child mortality using secondary data from the EDHS (2005) and the interlink ages between child mortality and socioeconomic, bio-demographic and maternal health care variables. The linkages were tested by applying cross tabulation analysis using SPSS. The variables involved were the education of the mother, the standard of living index, place of residence, birth order, sex of child, birth intervals, and mother's age at birth of child. Their findings suggested that the

most important socioeconomic predictor of child mortality was a mother's education, with the mortality rates decreasing along with increases in mothers' education levels. Birth intervals also played a significant role in reducing the risk of child mortality. Other characteristics that effected child mortality were the place of residence and mother's age at birth. A mother's standard of living index was found to have a significant effect. So, attention should be given to mothers' education, birth intervals and the standard of living index factors to reduce the risk of child mortality in Ethiopia.

Iram and Butt (2008), undertook a study to identify and quantify the relative importance of various socioeconomic factors and maternal care practices in determining child mortality at different ages in Pakistan. Using a sequential probit model that took into account the cause of death they examined the role of household, demographic and environmental factors as determinants of early child mortality. A number of individuals, household and local characteristics related to the probability of child mortality and they identified mother feeding as a protection from early exposure to disease and ill-health in different ways. The result of the analysis also indicated that the mother's education was strongly related to a reduction of neonatal mortality, infant mortality as well as child mortality, through improved child caring practices and through other proximate determinants such as prenatal care, income and environmental contamination.

2.2 Literature Gap

Fitsum (2011), though the study has relatively used good methodology and delivered expected results, the following can be mentioned as the limitation of the study. First, it has given an aggregated overview of the children mortality of under-five for Ethiopia as a whole. For a big sized county, Ethiopia, which has diverse culture, demographic and standard of living across different regions, the result may not uncover the main factors that contributed for children mortality in a specific region and not identified in his paper, like Benishangul-Gumuz region. Thus, specific study on Benishangul-Gumuz region will have a value addition in this regard. Secondly, the study used 2011 EDHS which is relatively old as compared the new data set of 2016 EDHS. Thus, using the latest data set, it is possible to come up with better result.

Ayichew (2011), though this study has tried to address regional variation in the incidence infant and under-five child mortality, still it has some limitation.

The study is mainly focused on the variation in health and education infrastructure that existed across region as explanatory variables disregarding the behavioral differences such as cultural and demographical. Moreover, the study used different administrative data sources. It would have been better if the study employed survey data such as EDHS which is compressive and tested.

Kumar, P. and File, G. (2010), It has some limitations. First it is crude generalization using SPSS tabulation analysis. If it is supported with econometrics analysis, it would have been relatively more accurate and acceptable. Secondly, it employed old data (EDHS 2005) as compared with the new EDHS (2016). Moreover, since the study is focused on Ethiopian as a whole, its conclusion cannot be taken for granted for regions which have differences in the explanatory variables of child mortality.

Iram and Butt's (2008), the study appears useful but it has a limitation by not incorporating social policies that promote early initiation of mother feeding and utilization of prenatal care which have major contribution to the reduction of under-five years mortality. Whereas our research has tried to absorb, advocate and clarify the problems for better understanding for policy implementation.

3. Data and Methodology

Data obtained from complete registration of births and deaths is the best source for direct estimation of child mortality. Unfortunately, this is unavailable in Ethiopia, and estimation of child mortality has to be based on cross-sectional surveys collecting complete birth histories from respondents. This study is based on a database compiled as part of the 2016 Ethiopian Demographic and Health Survey (EDHS). The data set consists of a national representative sample of household level data. The EDHS was conducted by the Central Statistical Agency (CSA) in collaboration with the Ministry of Health. Prior to the 2016 survey, EDHSs were conducted in 2000, 2005 and 2011. Here, we have used intensively the 2016 EDHS. In addition to EDHS data, we have also used World Bank, UNICEF and other reports.

As we are dealing with determinants of U5MR, there are households which lost their child/children and others which did not. The dependent variable under investigation is therefore a dichotomous variable that takes values 0 and 1 only. This research employed the Probit model, one of the estimation methods of binary variables. The model takes the form

$$\Pr(Y = 1/X) = \phi\ (X^T \boldsymbol{\beta})$$

Where Pr denotes probability and ϕ is the cumulative distribution function (CDF) of the standard normal distribution. The parameters $\boldsymbol{\beta}$are estimated by maximum likelihood.

Structurally, the Probit model can be described as follows. Let the observed outcome (whether the child is alive or not in this case) be yi. As referred from Fitsum (2011), there exists an unobserved threshold level that marks a child's survival (or not) to his/her fifth birthday. This underlying latent variable, say $\boldsymbol{Y_i^*}$ i, is assumed to be a function of several observed personal and socioeconomic factors, say a vector of $X_i{}'S$ and unobserved characteristics, say ε_i for individual i, this can formally be expressed as:

$$\boldsymbol{Y_i^* = x_i' \beta i + \varepsilon_i, \quad \varepsilon_i \sim NID(0, \sigma_\varepsilon^2)} \qquad i=1, 2, 3, \ldots 13 \qquad \textbf{(1)}$$

If this threshold level is set to zero, without loss of generality, then the Probit model can be fully described as;

$$y_i^* = x_i^{'} \beta i + \varepsilon_i, \varepsilon_i \sim NID(0, \sigma_\varepsilon^2) \qquad i=1, 2, 3, \ldots 13 \qquad \textbf{(2)}$$

And

$$y_i = \begin{cases} 1 \ \ if \ \ y_i^* > 0 \\ 0 \ \ if \ \ y_i^* \le 0 \end{cases} \qquad \textbf{(3)}$$

This model assumes that $E[\varepsilon / x] = 0$. In otherwords it means that the independent variables are exogenous.

The variables in this study include the Dependent Variable with the response (outcome) variable in this study Under-five mortality; Independent (predictor) Variables, that might be expected to be associated with under-five mortality rate. These include:

- Mother's Educational Level (with additional categories of No Education, Primary, Secondary and Higher),
- Duration of Breastfeeding,
- Birth Interval,
- Marital Status,
- Income/Wealth of the Household,
- Mother's Age at First Birth,
- Getting medical help for self and distance to health facility,
- Family Size in Number,
- Place of Residence (Urban or Rural),
- Sex of Child,
- Source of Drinking Water,
- Sanitation, and
- Type of Birth (Single/Multiple)

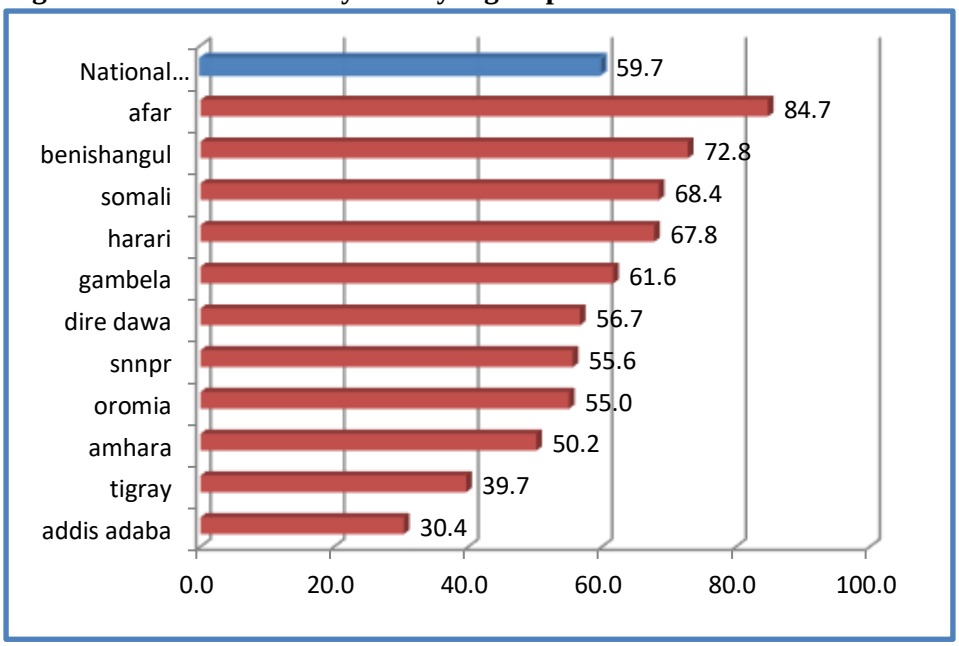
4. Data Analysis

4.1 Descriptive Analysis

Generally, the risk of a child dying before completing five years of age is still high in less developed countries. WHO Global Health Observatory (GHO) data (2016) indicated that African U5MR was 76.5 per 1000 live births, almost 8 times higher than the European Region (9.6 per 1000 live births). In addition, imbalances in child mortality between high-income and low-income countries remain large. In 2016, U5MR in low-income countries was 73.1 deaths per 1000 live births, almost 14 times the average rate in high-income countries (5.3 deaths per 1000 live births).

In Ethiopia, although U5MR has reduced over the years, it remains high with significant regional variations. At the national level, U5MR is about 59.7 per 1000 live births (Figure 1). Looking at the regional comparisons, the highest U5MR are found in the most underdeveloped regions, Afar, Benishangul-Gumuz, and Somali. The lowest mortality rate has been observed in Addis Ababa which has better health and socio-economic infrastructure. After Addis Ababa, the more developed regions, Tigray, Amhara, Oromia, SNNP and Dire Dawa, show U5MR below the national average.

Figure 1: Under 5 mortality rate by region per 1000.



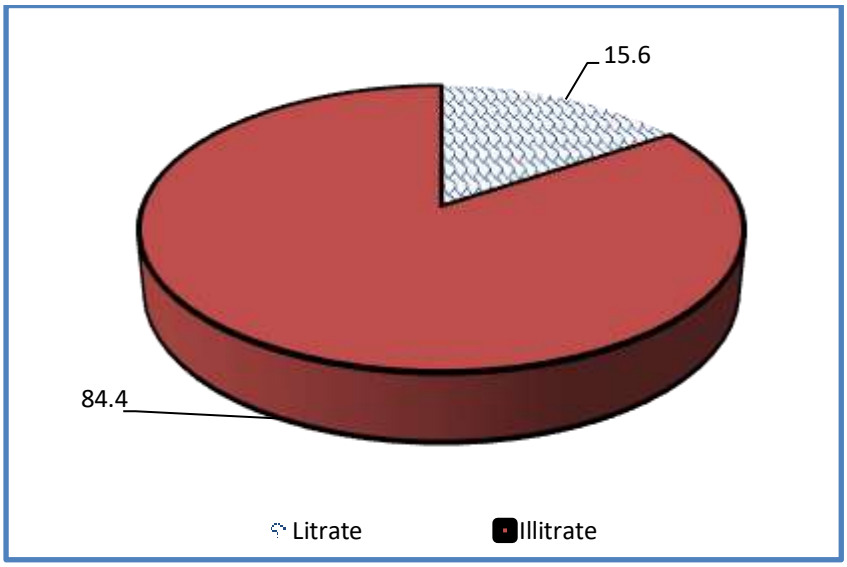
Source; EDHS (2016)

U5MR in Benishangul-Gumuz is second next to Afar. The risk of a child dying before completing five years of age in Benishangul-Gumuz is 72.8 per 1000 live births, almost 22 percent higher than the national average. This raises the question of why the U5MR in Benishangul-Gumuz region is so high; and this study assesses a range of possible contributing factors. These include the mother's educational level, birth interval, duration of breastfeeding, income/wealth of household, family size, mother's age at first birth, marital status, types of birth (single/multiple), place of residence, sex of the child, source of drinking water, sanitation, and distance from health facility. Among these, the variables most closely linked with mothers' empowerment for child care are the main focus of this research - mother's educational level, birth Interval, duration of breastfeeding, income/wealth of the household, family size, mother's age at first birth, and types of birth (single/multiple). Other variables are included to make the model complete and stable.

4.1.1 Mothers' Education Status

Mothers' educational status is a very important factor to reduce child mortality rate. Better educated mothers can take care of children more effectively; the risk of a child dying in an educated mother's family is very low. Using the EDHS (2016) data, we can see the negative correlation of mothers' educational status and child deaths in Benishangul-Gumuz region, with a correlation coefficient of -0.11. Figure 2 shows that 84.4 percent the total under-five child deaths, came from families where the mothers were illiterate; only 15.6 percent of deaths were from the families of literate mothers. Literate mothers have better capability to raise their children and provide healthy living compared to illiterate mothers

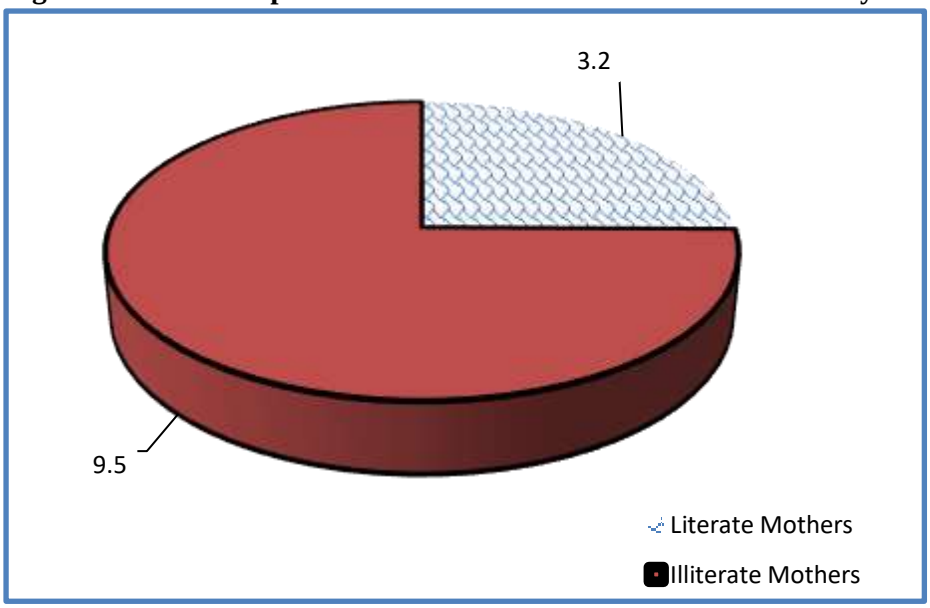
Figure 2: Mother's literacy by U5M (in %)



Source: *Author's* computation based on EDHS (2016)

Figure 3 demonstrates the correlation that exists between mothers' education and Under-Five Mortality in relation to total births. Out of 100 births in educated mothers' family, 3.2 percent of the children died before their fifth birthday; the figure for families of illiterate mothers was nearly 10 percent. It is clear that as mothers become educated, Under-five Mortality tends to decline.

Figure 3: Relationship between Total Birth and Under Five Mortality

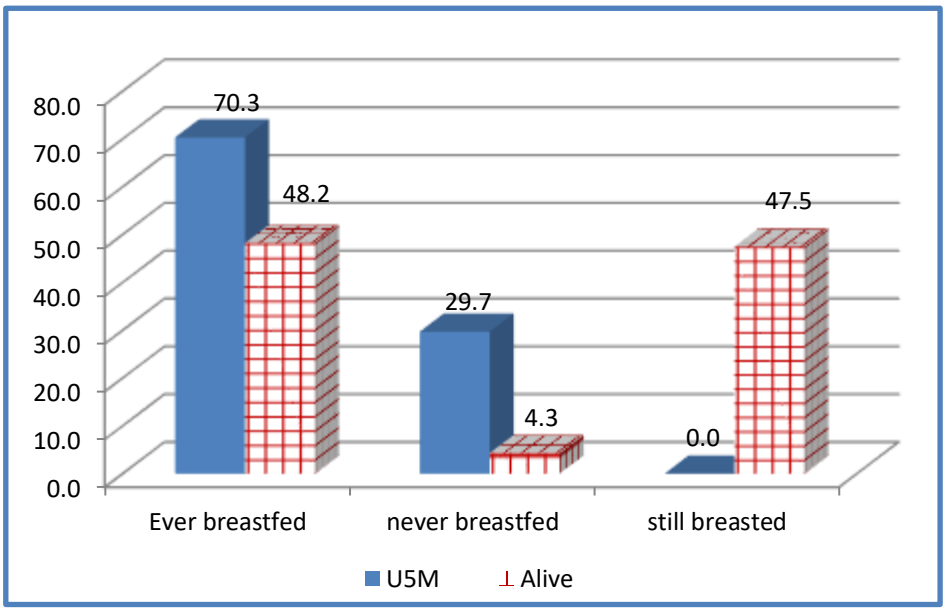


Source: Author's computation based on EDHS (2016)

4.1.2 Duration of Breastfeeding Status

Figure 4 shows the highest mortality rate is found among those who never practiced breastfeeding; about 35 percent of children who were never breast-fed died. Of those breast-fed for the first six months, only 10 percent died, while from the cohort that still breastfed almost none died. Mothers' breast milk contains antibodies to help children fight off viruses and bacteria and, as health workers attest, it also lowers the risk of having asthma or allergies, ear infections, respiratory illness or bouts of diarrhea. Children who never get breast milk do not receive minerals, vitamins, proteins or immunity against many diseases. The correlation of the duration of breast feeding and U5M is negative with a correlation of coefficient of -0.19. This means that as the duration of breastfeeding increases, the Under-five Mortality tends to decrease.

Figure 4: Duration of breastfeeding with under-five mortality and alive children

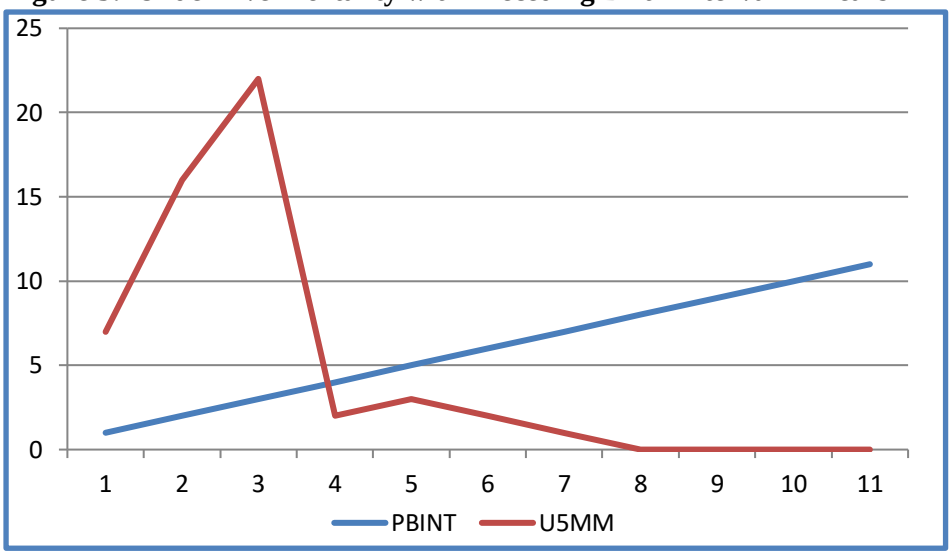


Source: Author's computation based on EDHS (2016)

4.1.3 Preceding Birth Interval

The length of a Preceding Birth Interval is one of the determinants of the Under-five Mortality in Benishangul-Gumuz region. The relationship between the Preceding Birth Interval and Under-five Mortality is negative; the correlation coefficient of the two variables is -0.13. Figure 5 shows that when as the birth interval is low, the Under-five Mortality Rate is relatively high, and as the interval increases, the chance of children below five dying declines. A birth interval of two years appears to be the most dangerous.

Figure 5: Under-five Mortality with Preceding Birth Interval in Years



Source; Author's computation based on EDHS (2016)

4.1.4 Marital Status

Figures 6 and 7 demonstrate that about 95.9% of the total of 879 observations are married families; 4.1% are of single parent or divorced families. In married families, about 7.1% of children died before their 5th birthday; in single or divorced families about 11.1% died. Respondents make it clear that marriage is highly valued in the Benishangul-Gumuz region and an unmarried woman who has a child is out-caste and a shame to her parents. The percentage of woman's either never married, or living with parents, widowed or divorced is 4.1%. Interviews underline the culture of Benishangul-Gumuz encourages couples to remain together in marriage and single or divorced families are limited in number. Under-five mortality in married families is relatively low, compared to single or divorced families.

Figure 6 shows the distribution of the population with regard to marital status among married people or single/divorced/widower. Figure 7 shows the percentage of under-five mortality among married mothers (11.1 percent) and single mothers (7 percent.).

Figure 6: Marital Status

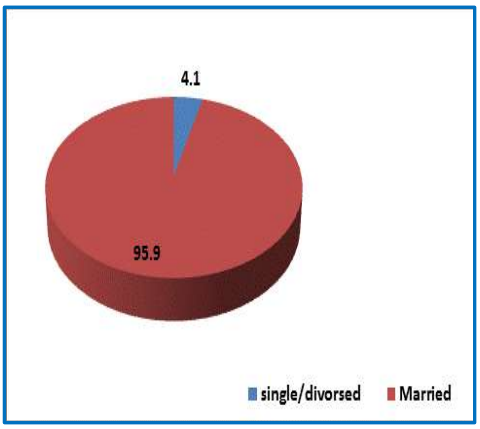
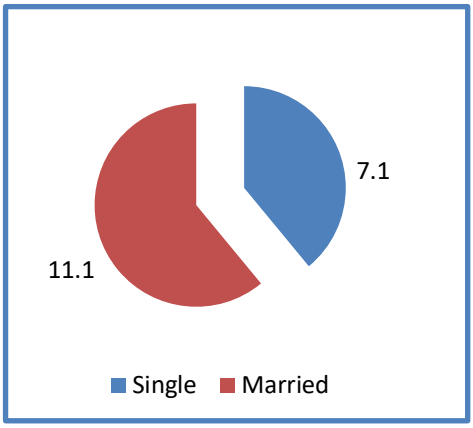


Figure 7: Under-five Mortality/Marital Status

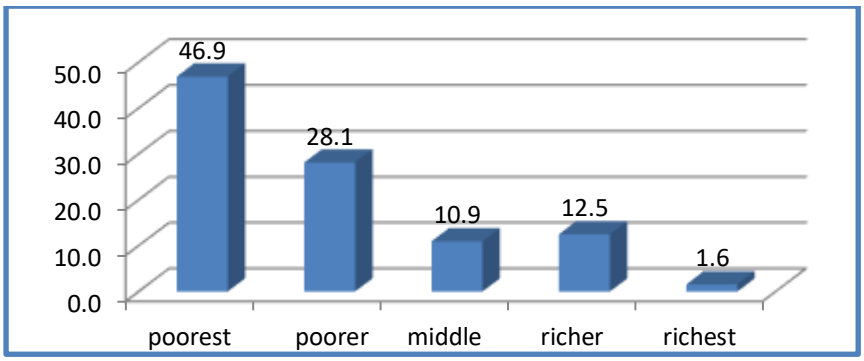


Source; Author's computation based on EDHS (2016)

4.1.5 Income/wealth index

We used the wealth index as a measure of income as one of the key variables that have a positive impact on the welfare of children. The wealth index is calculated from a score given to households on the basis of the number and kind of consumer goods. Figure 8 shows that as the income of the family increases, the incidence of child death decreases. 46.9% of child death occurred in the poorest families while only 1.6% of deaths occurred in the richest families. The correlation coefficient between the wealth index and Under-five Mortality is negative at -0.08, showing the treatment, value and care given to children rises as income increases.

Figure 8: Relationship between Wealth Index and U5M

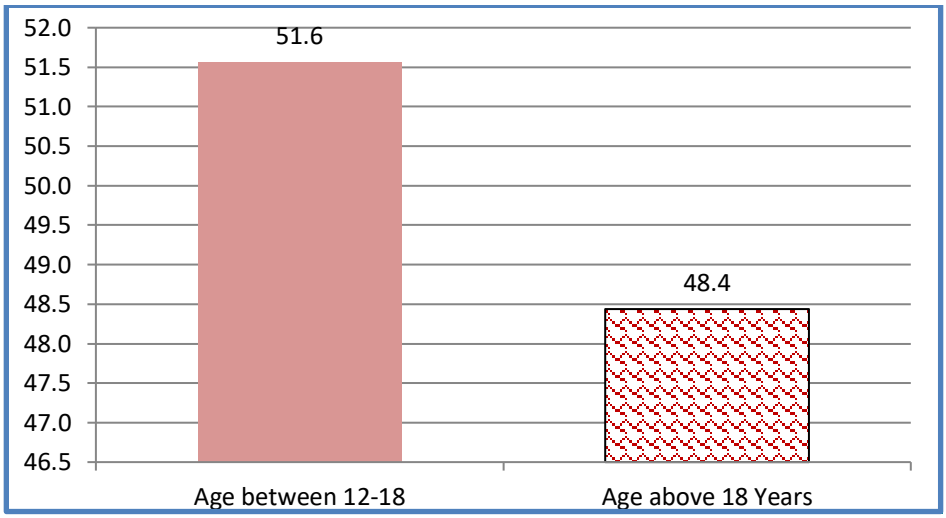


Source; Author's computation based on EDHS (2016)

4.1.6 Mothers' age at first birth

The age of a mother at first birth is an important variable to determine the cause of high mortality because mothers, at a first birth, are often not mature physically or mentally; informants make it clear the survival rate of both mother and child is relatively lower as compared to matured mothers. That is why health workers as well as the government and NGOs which work with children and mothers argue strongly against early marriage. It is also forbidden in the Constitution (Article 34, 1995) with the aim of protecting mothers' and preventing child mortality. Despite this, as Figure 9 shows, out of 879 mothers, 53.3% first gave birth between 12-18 years and nearly 52% of Under-five Mortality is associated with these mothers. For cultural reasons, early marriage in Benishangul-Gumuz is a common practice and it certainly contributes to a higher U5MR in the region.

Figure 9: Relationship between age of mother at first birth and U5MR



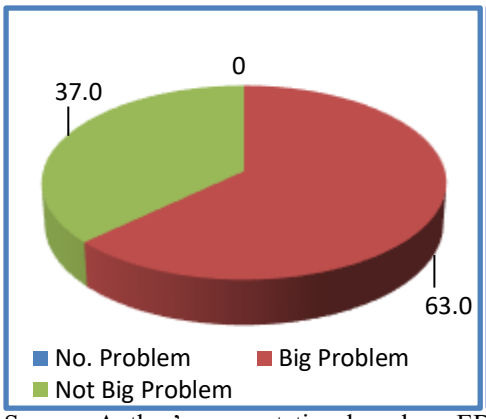
Source; Author's computation based on EDHS (2016)

4.1.7 Access to Health Facilities (HFs)

Access to Health Facilities is another key variable to address Under-five Mortality and access in the Benishangul-Gumuz region is a crucial problem. As Figure 10 demonstrated, out of a total of 879 respondents, none agreed that they had good access to HFs. 63 percent of respondents said they had severe access problems; and the other 37 percent classified problems in accessing the HFs as

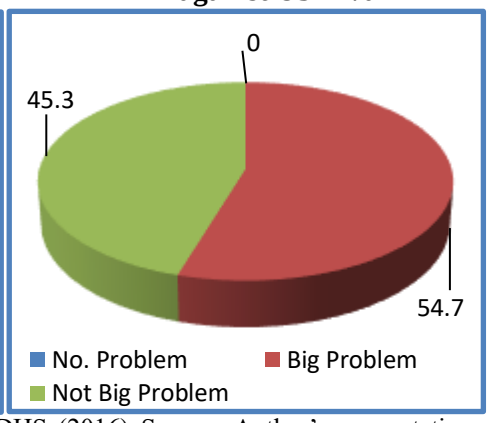
mild. Figure 11 relates Under-five Mortality associated with severs and mild problems to HFs access, underlining that the access to HFs is very poor and Under-five Mortality was directly linked to the problem of access. Benishangul-Gumuz region's access to health facilities is one of the least in the country.

Figure 10: Response to HFs Access in %



Source: Author's computation based on EDHS (2016)

Figure 11: Response to HFs Access against U5M %

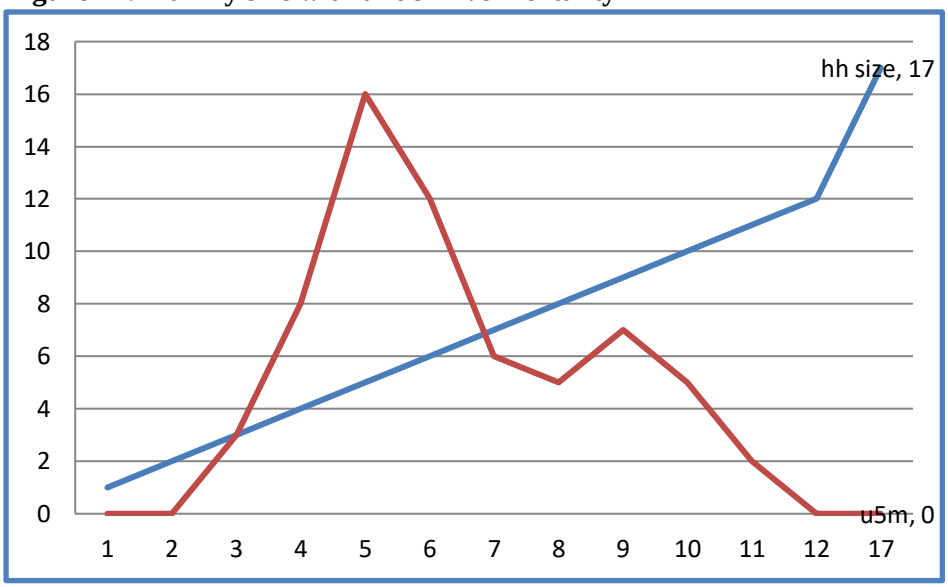


Source: Author's computation based on EDHS (2016)

4.1.8 Family size

As the size of a family increases up to 5 (Figure 12), Under-five Mortality also increases. Above five U5M tends to decline. This may be because of the difficulty of managing the family and provide the domestic protection required to raise healthy children. Women have the responsibility to cook, clean and provide for the household, and it is hard to perform all these activities along with raising many children. When the number of household members is greater than five, there are likely to be other grownups to help to siblings or share responsibilities for domestic activities.

Figure 12: Family size with under-five mortality



Source: Author's computation based on EDHS (2016)

4.1.9 Place of residence (urban/rural)

Benishangul-Gumuz region is largely rural Health and education facilities and other socio-economic infrastructures are very limited and there is high probability of child illness leading to death. Out of the total sampled children, 5.7 percent lived in urban areas (Table 1), the remainder in rural areas, and most Under-five Mortality occurred in rural areas. In Benishangul-Gumuz region, Under-five Mortality is largely a rural phenomenon.

Table 1: Children by Residence

Description	Urban	rural	Total
Under-five Mortality (U5M) (%)	1(1.6%)	63 (98.4%)	64 (100%)
Alive Child	49 (6%)	766 (94%)	815 (100%)
Total	50	829	879
% of	**5.7%**	**94.3%**	

Source: Author's computation based on EDHS (2016)

4.1.10 Sex of the Child

Sex preference may be one of the contributing factors to higher Under-five Mortality in Benishangul-Gumuz region. The analysis of both dead and alive children found 53.1% of deaths were of male children and 46.9% female (Figure 13). In addition, out of the total children who reached their fifth birthday 48.6% were male and 51.4% are female. Of total births, 7.9% of those who died were male, 6.7% female (Figure 14). This raises the suspicion of existence of a cultural preference for female children in Benishangul-Gumuz region. Interviews with native residents note that the family of the groom is obliged to provide cattle to the family of the bride, which means female children are considered as a source of wealth to their family.

Figure 13: Sex Composition in relation to U5M and living from Total Birth

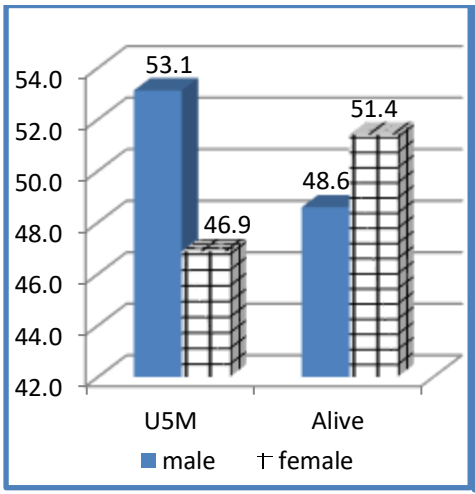
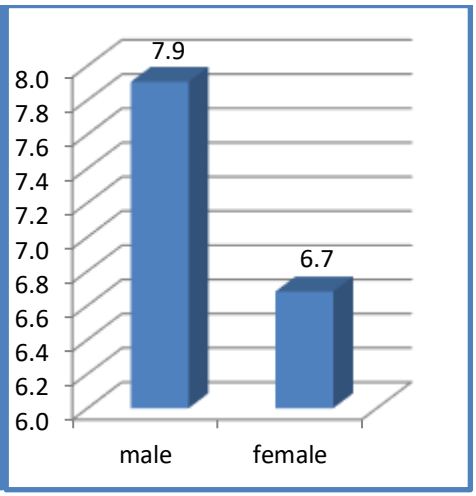


Figure 14: Percentage of death



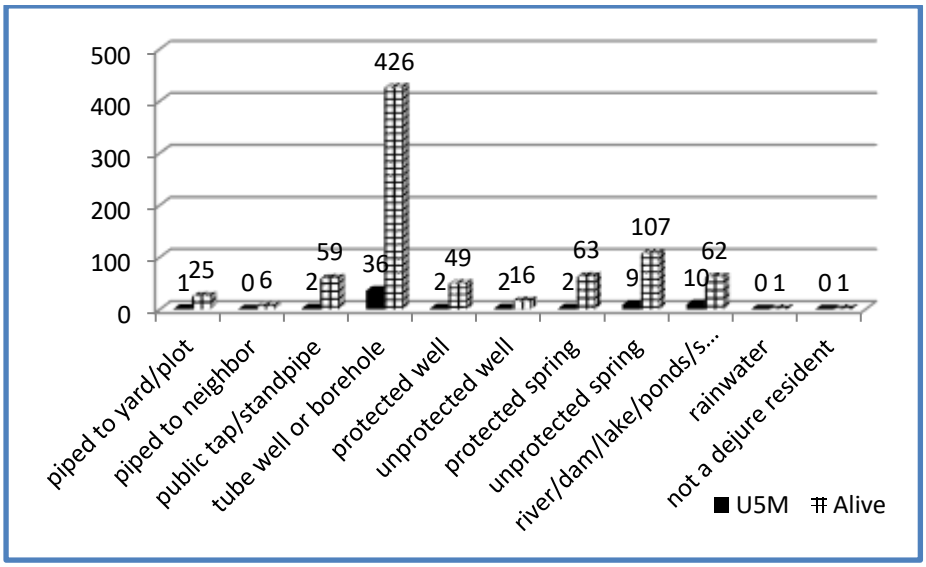
Source: Author's computation based on EDHS (2016)

4.1.11 Source of Drinking Water

Rural areas in Benishangul-Gumuz region have low standard infrastructure with limited clean water access. Figure 15 shows many families use unsafe sources of drinking water. Access to piped water (private or public) is limited while unsafe sources of drinking water, rivers, dams, lakes, ponds, streams, irrigation canals, unprotected springs, tube wells or boreholes are common. It is observed that

families of both dead and living children used more unsafe sources of drinking water though there were differences between the two groups. Higher mortality was found where the sources of drinking water were tube wells or boreholes and other unprotected sources which can carry different kinds of diseases like diarrhea, cholera, guinea worm, typhoid, dysentery and others and under-five children have low fighting capacity.

Figure 13: Sources of Drinking Water



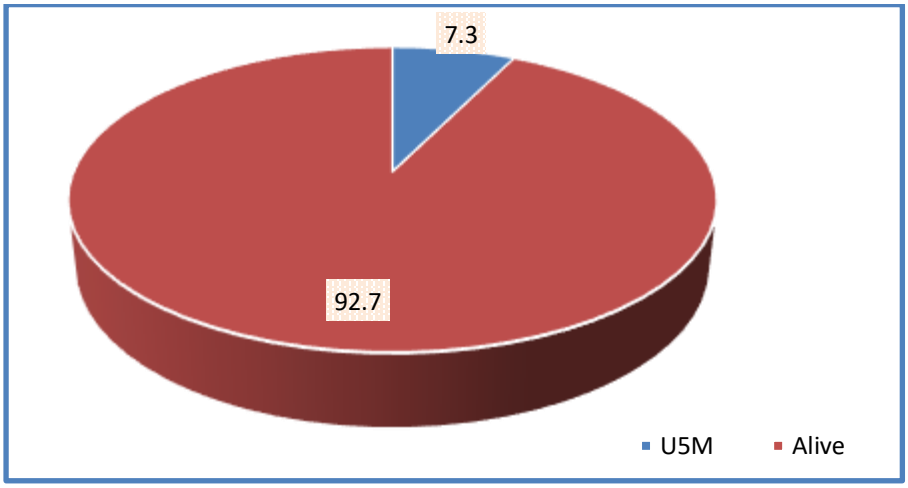
Source: Author's computation based on EDHS (2016)

4.1.12 Access to Toilet Facilities and Sanitation

Sanitation is another variable that can determine the health status of children and their families. Families follow a unsafe hygiene system. Because of their toilet facilities, they are likely to be exposed to illness or death. The major types of toilet facilities used by U5M families are open pit and open field, classified as traditional, or flush or pit latrines, ventilated and improved pit latrines or pit latrines with slab defined as modern facilities and rarely available. The situation of families with living children is not much different but those families do have relatively better access to safer sanitation. 92.7% of the under-five deaths occurred in families using traditional and unhygienic facilities (Figure 16) which allow for numerous contagious diseases, including cholera, typhoid, infectious hepatitis, polio, cryptosporidiosis, ascariasis, pneumonia, and worm

infestations. Children under the age of five are particularly susceptible to such infections.

Figure 14: Access to traditional Sanitation Facilities by U5M and living children's Families



Source: Author's computation based on EDHS (2016)

4.1.13 Type of Birth

Under-five Mortality appears higher in multiple rather than single births. Of total multiple births, about 25% of children passed away before they celebrated their fifth birthday while only 7% of single birth children died before their fifth birthday (Table 2). This shows the probability of Under-five Mortality is higher in multiple-birth than in single birth.

Table 2: Children by Type of Birth

Type of Birth	Single Birth	Multiple Birth	Total
Alive	797	18	815
U5M	58	6	64
Total	855	24	879
% alive from total	**93.21637**	***75***	**92.719**
% dead from total	**6.783626**	**25**	**7.281001**

Source: Author's computation based on EDHS (2016)

4.2 Econometrics Analysis

4.2.1 Variables Definition and Hypotheses

The econometric analysis was made using a Probit model where a dichotomous dependent variable takes the values of 0 and 1. "1" stands for the under-five mortality and "0" stands for alive and breathing under-five children. The Probit model works for a binary dependent variable, assuming that the probability of a positive outcome is determined by the standard normal cumulative distribution function. It can compute robust and cluster-robust standard errors and adjust results for complex survey designs.

In addition, to investigate the partial effect of each explanatory variable on the dependent variable, assuming other things remain the same, we have also estimated the marginal effect of explanatory variables on the dependent variable. (Stata Manual, version 14).

Margins are statistics calculated from predictions of a previously fitted model at fixed values of some covariates and averaging or otherwise integrating the remaining covariates. The estimates margins of responses for specified values and present the results as a table. Capabilities include estimated marginal means, least-squares means, and conditional marginal and partial effects (which may be reported as derivatives or as elasticities), average and conditional adjusted predictions, and predictive margins

The types and definitions of variables and related hypotheses are presented in Table 3.1 below. They show the relationship, positive or negative, that the explanatory variables have with the dependent variable, Under-five Mortality.

Table 3.1: Variable Code, Type and Definition of Variables, and Hypotheses

Variable code	Variable Type	Definition of Variables	Hypotheses
EDUM	Discrete	Mother's educational level (Categories: no education, primary, secondary and higher)	Negative
DOB	Continuous	Duration of breastfeeding	No breastfeeding - positive Breastfeeding – negative
PBINT	Continuous	Birth interval	Negative
MSS	Dichotomy	Marital status	Single - Positive Married – Negative
WEALTH	Discrete	Income/wealth of household	Negative
AGEHH	Continuous	Mother's age at first birth	Negative
ACCESS		Getting medical help; distance to health facility	Major problem - positive Minor problem/ no problem - negative
HHSSTOCK	Continuous	Family size by number	Positive
RES	Dichotomy	Place of residence (urban or rural)	Urban - positive Rural - negative
SEX	Dichotomy	Sex of the child	Male - positive and Female - negative
DRINK11	Dichotomy	Source of drinking water	Non-potable water - positive Potable water - negative
TOILET11	Dichotomy	Sanitation	Traditional - positive Modern - negative
CHNO22	Dichotomy	Types of birth (single/multiple)	Multiple - positive Single - negative

Source: Author's computation based on EDHS (2016)

4.2.9 Results and Discussion

As mentioned in the descriptive analysis above, the focus of econometric analysis is on key variables, either closely linked to mothers' child care characteristics or those which empower women directly or indirectly in child care. With the introduction of key and controlled variables, the model is found to be stable, as a whole. The sensitivity of model stability can be seen as follows:

H_0: $\beta_1=\beta_2=\beta_3=\ldots=\beta_n=0$
H_0: $\beta_1\neq\beta_2\neq\beta_3\neq\ldots\neq\beta_n\neq0$

The Ch2 test results shown on the Table 3.2 tends to accept the null hypo which indicates that at least one variable is statistically different from zero; that is the model is stable, having at least one coefficient different from zero.

Table 3.1: The Maximum Likelihood Estimates of the Probit Model

Variables	Coefficient	Std. Err.	Z	P>z	Marginal effect
EDUM	-0.30951	0.1762	-1.76*	0.079	-0.02599
DOB	-0.52566	0.0710	-7.41***	0.000	-0.04414
PBINT	-0.01194	0.0060	-1.98**	0.047	-0.00100
Mss	-0.8146	0.3392	-2.4**	0.016	-0.12799
WEALTH	-0.12714	0.0660	-1.93*	0.054	-0.01068
AGEHH	-0.01571	0.0228	-0.69	0.491	-0.00132
Hhsstock	0.008274	0.0394	0.21	0.834	0.00069
RES	-0.25303	0.5155	-0.49	0.624	-0.02125
SEX	-0.03571	0.1515	-0.24	0.814	-0.00300
drink11	0.339704	0.3579	0.95	0.343	0.02242
toilet11	0.349683	0.4169	0.84	0.402	0.03909
Access	0.112626	0.1559	0.72	0.47	0.00946
chno22	0.459071	0.3404	1.35	0.177	0.05590
_cons	49.55037	7.0389	7.04	0.000	
dy/dx is for discrete change of dummy variable from 0 to 1					
Number of obs= 736		**Log likelihood= -159.292**			
Wald Chi2(13) = 70.1		**Prob>Ch2=0.0000**			

***, **, & * indicates the level of significance of variables at 1%, 5% & 10% respectively
Source: Author's computation. Model output based on EDHS (2016) using Stata 14

Using the estimated results of the Probit model and the marginal effect results shown in Table 3.2, discussion and possible explanations for the five significant independent variables follow here:

i. ***Mother's Educational Level:*** Mother's educational level is statistically significant at 10 percent in affecting Under-five Mortality negatively, a result in line with our hypothesis. This implies that changing the educational status from no education to some level of education, lowers the probability of under-five mortality. This shows that in educated families, we find less under-five mortality than in uneducated families. Educated mothers are better informed about mother and child health care and also more willing to adopt new technologies, accept advice from extension services, diversify income, become visionary in educating their families, or producing marketable crops. It all contributes positively towards a healthier life for children. This result is in conformity with the findings of other studies (Ramakrishna, G. and Asseffa, D., 2002) and (Haile et all., (2005). Analysis of changes in educational status reveals that the probability of Under-five Mortality decreases by approximately 2.6 percent with every additional unit of mothers' educational level. The coefficient and marginal effect of education indicates that empowering women through education is key to addressing the Under-five Mortality in the region. The result suggests that the region should expand formal as well as informal education especially for females. Females constitute around 50 percent of the population so investing on female education will have a pivotal effect in improving the socio-economic status of half the population as well as reduce Under-five Mortality;

ii. ***Preceding Birth Interval (month):*** Preceding birth interval negatively affects Under-five Mortality in conformity with our expectation and it is found statistically significant at less than 10 percent significance level. The marginal effect of the preceding birth interval reveals that the probability of Under-five Mortality decreases approximately by 0.10 percent as the preceding birth interval increases by one unit (year). This indicates that wider birth interval will lessen the mortality rate in the study area. Thus, encouraging women to widen birth intervals through the promotion of Family Planning by the Regional Government and NGOs will have dumping effect on under-five mortality.

iii. ***Duration of Breastfeeding (Month):*** The Probit output result revealed that the duration of breastfeeding negatively influences the Under-five Mortality in agreement with our hypothesis and is statistically significant at 1 percent level.

The marginal effect of duration of breastfeeding indicates that the probability of the Under-five Mortality Rate will decrease by approximately 4.42 percent when breastfeeding increases by 1 unit (month). The coefficient and the marginal effect of breastfeeding indicate that breastfeeding brings about a more substantial reduction in Under-five Mortality than any other intervention. All stakeholders in the region are therefore advised to encourage mothers through awareness and other training programs to increase breastfeeding and reduce Under-five Mortality.

iv. ***Income/Wealth of the Household:*** The income or wealth of the household has a negative relationship with Under-five Mortality at 10 percent significance. This again agrees with our hypotheses. The marginal effect of household income reveals that the probability of occurrence of Under-five Mortality decreases by approximately 1.03 percent when the level of household income increases by 1 unit. In addition, the absolute value of the coefficients of income increases as the income category of the society changes from poorest, to poor, middle, richer and richest family groups. This indicates that programs that target to increase the income of households and bridge income disparities in favor of the poor will result in reducing Under-five Mortality substantially.

v. ***Marital Status:*** Marital Status is the final major determinants of Under-five Mortality. It is statistically significant at less than 5% probability level and has a negative relationship with Under-five Mortality in conformity with our hypothesis. The marginal effect of marital status reveals that the probability of occurrence of Under-five Mortality decreases by approximately 1.3 percent when the marital status changes from single to married. This shows that the welfare of children is relatively better in married families than in single or divorced families. The culture of Benishangul-Gumuz is in favor of keeping traditional norms where marriage is respected and the bonds that keep couples together is powerful. A woman who is unmarried and has a child is regarded as shameful by both society and her family. Treatment of the child in such circumstances is likely to be as good as in married families.

All other variables included in the model were statistically insignificant but the signs of the coefficients were in line with our hypotheses as noted in the descriptive analysis.

5. Conclusions and Recommendations

5.1 Conclusions

The Under-five Mortality Rate in Benishangul-Gumuz is relatively the highest among Ethiopia's regional states, next to the Afar region. The risk of a child dying before completing five years of age in Benishangul-Gumuz is 72.8 per 1000 live births, almost 22 percent higher than the national average. Recognizing the problem, this study has tried to identify the main determinates of Under-five Mortality in Benishangul-Gumuz region using the Ethiopian Demographic and Health Survey (2016). Using a Probit model estimation, five of 13 explanatory variables were found to a negative and statistically significant effect on the Under-five Mortality Rate in Benishangul-Gumuz Regional State: Mother's Educational Level; the length of Preceding Birth Interval; Duration of Breastfeeding; Income or Wealth of a household and the income disparities of the society; and Marital Status.

5.2 Recommendations

These five statistically significant determinants of Under-five Mortality in the Benishangul-Gumuz region are all related, directly or indirectly, to women's empowerment in education, health and income. We would, therefore, suggest the following recommendations to tackle the problem of the excessive Under-five Mortality Rate in the region:

Taking into account the impact of mother's education on Under-five Mortality, the region should expand formal as well as informal education especially for females. Females constitute around 50 percent of the population so investing on female education will have a pivotal effect in improving the socio-economic status of half the population as well as reduce Under-five Mortality;

Encourage women to widen birth intervals through the promotion of Family Planning by the Regional Government and NGOs to expand the birth intervals will minimize under-five mortality.

Duration of breastfeeding has a negative impact on under-five mortality. Thus, it is recommended that all concerned bodies, governmental and non-governmental, should encourage breastfeeding through awareness and other training programs for the advancement of child health, and emphasize the importance of extending its duration;

Government and NGOs should target policies, programs and projects to increase the income of households and aim to reduce the income disparities of the society in favor of the poor;

The Government should make efforts to maintain the culture of the region and its emphasis on favoring marriage. This may be due to the culture of the region. Single or divorced family is discouraged in the Benishangul-Gumuz region making children treatment in the single or divorced families less favorable than that of married families. Thus, it is recommended to maintain the good culture of the society as it favors married couples for better nutriment of children.

References

Abebe Argaw. (2016). "Determinants of Time-To-Under-Five Mortality in Ethiopia: A Comparison of Various Parametric Shared Frailty Models." Addis Ababa University, School of Graduate Student College of Natural and Computational Sciences Department of Statistics.

Ayichew Kebede. (2011). "Pattern and Determinates of Infant and Child Mortality Rates in Ethiopia: Some Reflections from Regional-Level Panel Data." Ethiopian Economics Association Bahir Dar Chapter, Proceedings of the Second Regional Conference of The Amhara Regional State Economic Development. Master Printing Press Plc. Addis Ababa

Constitution of the Federal Democratic Republic of Ethiopia. (1995). Federal Negarit Gazeta, No.1 21 August 1995

Dechasa Bedada. (2017). "Determinant of Under-Five Child Mortality in Ethiopia." *American Journal of Statistics and Probability* Vol. 2, No. 2, Pp. 12-18. Science Publishing Group://Www.Sciencepublishinggroup.Com/J/Ajsp

EDHS. (2016). Ethiopian DHS Final Report, Addis Ababa

EDHS. (2016). Ethiopian DHS Key Finding, Addis Ababa

Fitsum Zewdu Mulugeta. (2011). "Socioeconomic Factors Affecting Childhood Mortality in Ethiopia: An Instrumental Variable Approach". *Ethiopian Journal of Economics* Vol XX No 2.

Girma Temam. (2017). Magnitude and Determinants of Under-Five Mortality and Its *Association with Maternal Mental Distress in Gamo Gofa Zone,* Ethiopia. Addis Ababa University, School of Graduate Studies College of Health Sciences, School of Public Health

Haile Kidane, Zerihun Gudeta Alemu, and Kundhlande, G. (2005). "Causes of household food insecurity in Koredegaga Peasant Association, Oromiya zone, Ethiopia." Agrekon, Vol 44, No 4 (December 2005)

Hosmer D. W. and Lemeshew S. (1989). *Applied Probit and Logistic Regression*, A Wiley- Inter-Science Publication, New York.

Iram U. and Butt, M. S. (2008), "Socioeconomic Determinants of Child Mortality in Pakistan: Evidence from sequential Probit model." *International Journal of Social Economics,* Vol. 35.

Johansson, J. S. (2016). "Determinants of Under-5 Mortality in Uganda: An Econometric Analysis." Department of Economics - School of Business, Economics and Law, University of Gothenburg.

Karyani A. K., Kazemi Z., Shaahmadi F., Arefi Z. and Meshkani Z. (2015) "The Main Determinants of Under 5 Mortality Rate (U5mr) In OECD Countries: A Cross-Sectional Study". *International Journal of Pediatrics* 3(1.2):421-427

Kumar, P. and File, G. (2010). "Infant and Child Mortality in Ethiopia: A Statistical Analysis Approach." *Ethiopian Journal of Education and Sciences* Vol 5 No 2 (2010)

Pison, G., Monden, C., and Smits, J. (2015). "Population and Development Review: Twinning Rates in Developing Countries; Trend and Explanation" 644-645. Population and Development Review, 41 (2).

Planning and Programming Department, Federal Democratic Republic of Ethiopia Ministry of Health. (2004). Health and Health Related Indicator. Ethiopia.

Ramakrishna, G. and Asseffa Demeke. (2002). "An Empirical Analysis of Food Insecurity in Ethiopia: The Case of North Wello." Africa Development, Vol. XXVII, Nos. 1&2, 2002, pp. 127–143

Solomon Gebretsadik Bereka, Fekade Getabil Habtewold and Tewodros Desalegn Nebi. (2017). "Under-Five Mortality of Children and Its Determinants in Ethiopian Somali Regional State, *Eastern Ethiopia. Health Science Journal*, Vol 11, 2017

Stata Manual, version 14

Tariku Dejene and Eshetu Girma. (2013). "Social Determinants of Under-Five Mortality in Ethiopia: Event History Analysis using evidence from Ethiopian Demographic and Health Survey (EDHS)" Health Vol.5, 879-884 (2013).

UNICEF's Annual Report 2015

World Health Statistics. (2016). Monitoring Health for the Sustainable Development Goals. World Health Organization, Geneva. www.who.int

WHO Monitoring health for the SDGs, World Health Statistics data visualizations dashboard WHO Global Health Observatory (GHO) data. (2016). http://www9.who.int/gho/publications/world_health_statistics/2017/dashboard/en/

Zelalem Tafese Wondimagegn. (2014). "Magnitude and Determinants of Stunting Among Children in Africa: A Systematic Review," *Current Research in Nutrition and Food Science* Vol. 2(2), 88-93 (2014). Hawassa College of Health Sciences, Ethiopia