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Under- Five Mortality in the West Mamprusi District of Ghana

MubarikaAlhassan[1], MaahiTuahiru[2], Abdul-HananAbdulai[3]
[123]*Department of Statistics, Mathematics &Science, Tamale Polytechnic, P. O. Box 3 E/R, Tamale-Ghana.*

ABSTRACT: *This study applied both descriptive and logistic regression analysis to the factors associated with under five mortalities in the West Mamprusi district of Ghana. Results from the descriptive analysis revealed that male deaths occur more than female deaths with a percentage of 52(52%) for the three years whiles majority (32.24%) of the deaths were being cause by malaria. The interesting finding in this study was that, among all the factors (variables) associated with under five mortalities, only one variable (i.e. Prematurity) showed significant impact after running the analysis.*
***Keywords**:Under-five mortality, Logistic Regression, Disease, Prematurity*

I. INTRODUCTION

Under-Five Mortality also known as Child Mortality refers to the death of infants and children under age of five. The Under -Five Mortality Rate is the number of children who die by the age of five per thousand live births per year. Worldwide an estimated 10.5 million children aged 0-4 years died in 1999, a reduction of about 2.2 million or 17.5% a decade ago. A report by UNICEF; WHO; The World Bank and UN Population Division (2007), indicated that worldwide the number of children dying before the age of five reached a record low, falling below 10 million for the first time in 2006. A decline which however is not evenly distributed. There are still some regional differentials. The WHO (2006) estimates that on average about 15% of new born children in Africa are expected to die before reaching their fifth birthday. The corresponding figures for many parts of developing world are in the range of 3-8% and Europe under 2%. Sub-Saharan Africa's infant and under five (5) mortality rates are by far the highest. Situations like under development, armed conflict and the spread of HIV/AIDS have seriously undermined the efforts to improve child survival. The estimated under-fivemortality rate exceeds 200 deaths per 1000 live birth in ten countries in this region. Infant and child mortality rates also remain relatively high in South Asia.

Omar, et al (2000) gives a good summary of the global trend of infant and child mortality. There have been dramatic declines in mortality in almost all countries of the world, regardless of initial levels, socio-economic circumstances and development strategies. In advance economies the declines were already apparent at the end of the 19^{th} century. In the period leading to 1970 under-five mortality in these countries were 27 deaths per 1000 live births, this decline to 10 deaths per 1000 live births in the period 1970-1990. In the decade that followed,under-fivemortality decline to 7 deaths per 1000 live births. The decline took place during the time of steady economic growth and major improvements in nutrition, housing, and living condition. Garenne and Gakusi (2006) point out the development during the above period; the benefits during the period were improvement in water and sanitation, hygiene, child feeding practices and the development of vaccines. UNICEF (2004) identified a better, more effective and less costly medicines, technology, and interventions as the main contributor to the steady decline in mortality rates in the industrialized countries during the period 1990-2003.

In the developing countries, under-fivemortality has declined, however it is still high compared to the develop regions. In the period 1960-1970 under-fivemortality were 164 deaths per 1000 live birth and it further declined to 128 deaths per 1000 live birth during the 1970-1980 period. In the following decade a further decline to 103 deaths per 1000 live births was observed. The downward trend continued beyond the year 1990. The 2006 figures indicatedthat under-fivemortality in this region declined to 79 deaths per 1000 live births. However, East Asia and the Pacific, Latin America and the Caribbean, and Central/Eastern Europe and the Commonwealth of Independent states had achieved under-five mortality rates of bellow 30 deaths per 1000 live births. Achieving the Millennium Development Goal (MDG4) the target requires that the under-five mortality rate declines, on average, by 4.4%annually between 1990 and 2015. These regions achieved this benchmark through 2006 or came closer to it, putting them on track to achieve the MDG4 together (UNICEF, et al. 2007:7). Murray, et al. (2007) suspected that some other factors might have been shared across these regions, such as educational or environmental policies or the key driver of mortality change, accumulation of stocks of household, community and national physical and human capital. All these put together could have driven the mortality decline in these regions. UNICEF (2004) identified common conditions in countries where progress has been slow. Access to clean water was low; percentage of under-five moderately or severally underweight was high; percentage of one year olds who did not receive 3 doses of Diphtheria, Pertussis (whooping cough), and Tetanus (DPT)was high, and percentage of children under-6 month of age who are not exclusively breastfed is high.

Finally, among the developing regions mortality in Sub-Saharan Africa has remained notoriously high. UNICEF (2004) approximates that 42% of children who die before they are five live in Sub-Saharan Africa. In 1960 the under-fivemortality was 277 deaths per 1000 live births and adecade later it had decline to only 243 deaths per 1000 live births. In the period 1970-1980 the under-five mortality declined to 200 deaths per 1000 live births. The pace of decline slowed down in the following decade when under-five mortality rate declined to 187 deaths per1000 live births in 1990. During the period 1990-2000, the under-fivemortality declined further to 170 deaths per 1000 live birth. However, West and Central Africa showed a higher rate of 193 per 1000 live births in the same period while Eastern and Southern Africa reported 145 deaths per 1000 live births. The 2006 figures indicates that the under-five mortality rate was 160 deaths per 1000 live births for the region, however, in West and Central Africa it was 186 death per 1000 live births.

In Ghana currently, 50 children per 1,000 live births die before their first birthday (30 per 1,000 before the age of one month and 21 per 1,000 between one and twelve months). Overall, 80 children per 1,000 live births, or about one child out of twelve, die before reaching age five. These are dramatic decreases over the 20-year period since the 1988 GDHS. Mortality rates differ by residence. The under-five mortality rate for the 10-year period before the survey in urban areas was 75 per 1,000 live births compared to 90 per 1000 live births in rural areas (GDHS, 2008).

The infant mortality rate has reduced from 20 deaths per 1,000 live births in 2010 to 17 per 1000 live births in 2011 in the west Mamprusi district. The child mortality rate has also declined from 49 per 1,000 live births to 37 per 1,000 live births for 2010 and2011 respectively (Wale District Hospital, 2011). These figures are below the national infant mortality rate of 64 deaths per 1,000 live births and child mortality rate of 50 deaths per 1,000 (Ghana Statistical Service, 2004).

It is within this context that this paper proposes to explore the factors associated with under- five mortalities in the West Mamprusi District.

The logistic regression model was use as the main statistical methodology for analyzing the data in order to achieve the objective of this paper. The model tries to show the association between a categorical response variable and a set of independent or predictor variables.

1.2 Statement of the Problem

According to Goro (2007) the disparities within countries in infant and child mortality observed in Africa are equally experienced in Ghana. As with any averages, the national statistics has masked the disparities among the regions and among the various socioeconomic groups within the country. According to Ghana Statistical Service (2004) cited in Goro (2007), there is striking differential in infant mortality rates among the three northern regions (Upper East, Upper West and Northern). Upper East region has the lowest infant mortality rate of 33 per 1000 live births in the country, with Upper West region having the highest infant mortality rate of 105 per 1000 live births followed by Ashanti region of 80 per 1000 live births, 75 for Volta region and 69 per 1000 live births for Northern region. With regards to child mortality rate, there is sharp difference between the three northern regions on one hand and the rest of the regions on the other hand. Upper West region has the highest child mortality rate of 115 per 1000 live births in the country, followed by Northern region with 90 child deaths per 1000 live births and Upper East region having the third largest child mortality rate of 48 per 1000 live births in country. In addition, marked regional differentials in under-five mortality are also observed. The Under- five mortality rate ranges from a low of 75 per 1000 live births in the Greater Accra region to as high as 208 per 1000 live births in Upper West region followed by 116 in the Ashanti region and 154 per 1000 live births in Northern region, however Upper East region ranked second to Greater Accra region with 79 deaths per 1000 live births (GSS, 2004). It is noticed from the above that Upper West region has the highest rates for all the three levels of mortality in the country.

According to West Mamprusi district health directorate, Malaria and other diseases have claimed the lives of many under five year’s children in West Mamprusi district of Northern region of Ghana. In 2010 and 2011 the neonatal death rate was 7.8 and 3.7 per 1000 live birth respectively. Also post neonatal death was 26, 20 and 17 per 1000 live birth for 2010, 2011 and 2012 respectively (West Mamprusi district health directorate 2012 Annual Report).

In order to implement effective child survival programmers’, there is the need to identify the factors that contribute to child deaths and assess their effects. It is also important to take note of sharp mortality differentials among various communities in the same district as different intervention strategies may be required to arrest the situation. It is against this background that the study seeks to find out the factors associated with under-five mortality trends (2010-2012) in West Mamprusi District of the Northern Region.

II. MATERIALS AND METHODS

The data for analysis of this paper was based on Secondary data from the West Mamprusi District hospital. The data gathered was on under-five mortalities and the factors associated with it in the West Mamprusi district for the period 2010-2012 indicating their sex, etc.
The logistic regression model was use as the main statistical method for analyzing the data in order to achieve the objective of the paper. The model tried to show the association between a categorical response variable and a set of independent or predictor variables. The dependent variable in this research is a binary response variable (dichotomous) which is under-five mortalities. Factors in the data sampled were categorized as either death or alive.
Furthermore, the Wald test together with the deviance and Chi-square test is use as criteria to either reject or fail to reject independent variables in the model. SPSS was used to analyze the responses in order to address the central question.

2.1 Logistic Regression Model

Logistic regression is a form of regression analysis used when the response variable is a binary variable. This method is based on the logistic transformation or logic of a proportion p ;

$$p(x) = \frac{\exp^{(\beta_0+\beta_1 x)}}{1+\exp^{(\beta_0+\beta_1 x)}} \qquad (1)$$

$$1-p(x) = 1-\frac{\exp^{(\beta_0+\beta_1 x)}}{1+\exp^{(\beta_0+\beta_1 x)}}$$

$$= \frac{\left(1+\exp^{(\beta_0+\beta_1 x)}\right)-\exp^{(\beta_0+\beta_1 x)}}{1+\exp^{(\beta_0+\beta_1 x)}}$$

$$1-p(x) = \frac{1}{1+\exp^{(\beta_0+\beta_1 x)}}$$

Writing the logistic regression in terms of Odds

$$Odds = \left(\frac{p(x)}{1-p(x)}\right) \qquad (2)$$

This can be obtained as follows

$$\frac{p(x)}{1-p(x)} = \frac{\exp^{(\beta_0+\beta_1 x)}}{1+\exp^{(\beta_0+\beta_1 x)}} \div \frac{1}{1+\exp^{(\beta_0+\beta_1 x)}}$$

$$= \frac{\exp^{(\beta_0+\beta_1 x)}}{1+\exp^{(\beta_0+\beta_1 x)}} \times \frac{1+\exp^{(\beta_0+\beta_1 x)}}{1}$$

$$\frac{p(x)}{1-p(x)} = \exp^{(\beta_0+\beta_1 x)}$$

Taking logarithm of the odds gives the link function

$$g(x) = \log\left(\frac{p(x)}{1-p(x)}\right) = \beta_0+\beta_1 x \qquad (3)$$

Hence, the transformation of logistic function known as the logit transformation becomes

$$\log\left(\frac{p(x)}{1-p(x)}\right) = \beta_0+\beta_1 x$$

Where p = probability (dependent variable =1), and x is the explanatory variables.

III. DATA ANALYSIS AND RESULTS

3.1 Descriptive analysis

TABLE 1 below shows the summary statistics of diseases in relation to under-five mortalities in the district by the various years (i.e. 2010-2012).Diseases are displayed in the first column as against the Deaths/Alive in the top row by years.

Table 1 shows the number of diseases causing under-5 mortality by years

Disease	2010		2011		2012		Total	
	Death	Alive	Death	Alive	Death	Alive	Death	Alive
Malaria	19	878	17	1596	13	1914	49	4388
Anaemia	5	104	2	164	3	221	10	489
Asphyxia	2	19	1	32	3	37	6	88
Dehydration	3	28	2	78	3	82	8	188
Typhoid	3	48	1	103	4	137	8	288
Malnutrition	3	87	5	240	4	361	12	688
Others	3	103	4	164	2	186	9	453
Pneumonia	5	98	3	212	4	278	12	588
Respitory	2	96	5	197	3	196	10	489
Prematurity	5	44	1	102	1	42	7	188
Sepsis	7	236	9	529	5	819	21	1584
Total	57	1741	50	3417	45	4273	152	9431

It is clear from the above Table 1that most of the under-five deaths are caused by malaria considering the three years whiles the rest of the diseases fluctuates. As indicated in row 3 column 8, malaria has the highest number (i.e. 49 cases) of death cases

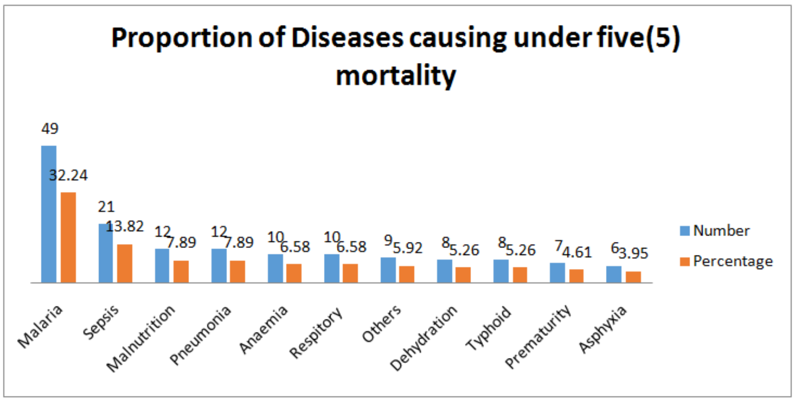

Figure 1: Proportions of Diseases Causing Under-5 Mortality

It is obvious from Figure 1 above that 32 % (49) of the deaths are caused by malaria while 4 %(6)are caused by Asphyxia.

TABLE 2 shows the number of admissions, births, and deaths and alive by gender for the three years. It has the various years shown in the first column whiles the Births, Number of admissions, male, female Deaths and Alive in the first row

Table 2: summary of the number of admissions, births, deaths and alive from 2010-2012

Year	Birth	Admission	Alive	Death	Male Death	Female Death
2010	1186	1798	1741	57	32	25
2011	1453	3467	3417	50	22	28
2012	1578	4318	4273	45	32	13
Total	4217	9583	9431	152	86	66

The TABLE 2 above suggests that, out of the 9583 admissions records for the three years, bulk(32) of the deaths were males which occurred in 2010 and 2012 while fewwere females which occurred in 2012. Also, the number of births in the health center increases accordingly from 1186 to 1578 for the three years.
TABLE 3 shows the frequency and percentage of admissions by gender in the West Mamprusi District. The numbers of Female or Male admissions are displayed column wise whiles the frequency and percentages are in row wise.

Table 3: Number of admissions by Gender

Gender	Frequency	Percent
Female	4578	47.7
Male	5005	52.3
Total Admissions	9583	100

It is obvious from Table 3 that, male admissions outweigh female admissions in the West Mamprusi District Health Center by 52% and 46% respectively.

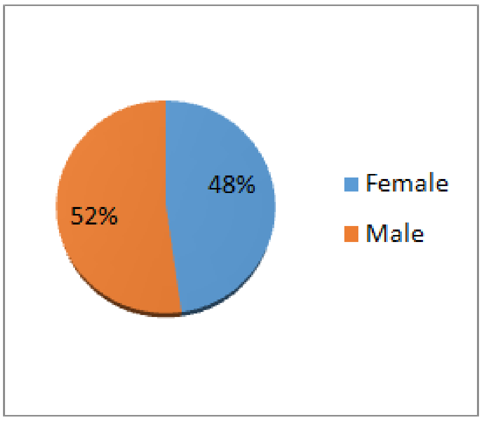

Figure 2: A pie chart showing the proportion of Admissions by Gender

From Figure 2, it can be seen clearly that out of the 9583 admissions in the Health Center for the period 2010-2012, majority are males (52%).

3.2 Data Analysis

Presented in TABLE 4 below are the results of the logit model for the factors with significant effect on under-five mortality. The coefficient, standard error,wald statistics, significant level, odds ratio and 95% confidence level for all the variables (factors) are displayed rowwise whiles the variables are in column wise. Significant factors are mainly identified by the significant levels.

Table 4: Parameter Estimation

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
sex(1)	-38.194	1937.408	.000	1	.984	.000	0.000	
Malaria(1)	38.365	1937.408	.000	1	.984	45874411684691100.000	0.000	
Anaemia(1)	36.212	1937.408	.000	1	.985	5327620828285560.000	0.000	
Asphyxia(1)	15.886	2174.979	.000	1	.994	7928885.702	0.000	
Dehydration(1)	16.063	1708.556	.000	1	.992	9466928.989	0.000	
Typhoid(1)	16.212	1528.880	.000	1	.992	10985789.491	0.000	
Malnutrition(1)	.264	.439	.362	1	.547	1.302	.551	3.078
Others(1)	-.405	.402	1.016	1	.313	.667	.303	1.466
Pneumonia(1)	-.432	.365	1.400	1	.237	.649	.317	1.328
Respitory(1)	-.436	.388	1.265	1	.261	.647	.302	1.382
Prematurity(1)	**-1.033**	**.443**	**5.436**	**1**	**.020**	**.356**	**.149**	**.848**
Constant	4.324	.220	387.470	1	.000	75.476		

It is clear from the above TABLE 4 that, Prematurity and the Constantare the only variables that shows some significant effect whiles the rest of the variables are not significant. Therefore, only one of the variables was found statistically significant at 0.05 levels. The variable prematurity is significant at 0.05 significant level; thus the variable becomes the variable used for the model.
Hence, the Logit Model Formulated is;

$$g(x) = 4.324 - 1.033 \; prematurity$$

TABLE 5 illustrates the values of -2log likelihood, Cox and Snell and Pseeudo R square values for the logistic regression model with the headings displayed in the top row follow by the values associated with them.

Table 5 Pseudo R Square of the Logit Regression Model for under –five Mortality.

-2 Log likelihood	Cox & Snell R Square	Negelkerke R Square
1273.627	.030	.197

The value of -2log likelihood is fairly large(1273.627), besides, the Cox and Snell R square value of 0.03 and NegelkerkeRsquare of 0.197 are moderate. Hence the two values are between 3 per cent and 19.7 per cent. This signifies that 3 per cent and 19.7 per cent of the variability in the dependent variable is explained by the model.
Shown in TABLE 6 below is the Hosmer and Lemeshow test for the fitted logistic regression model. The chi square, degree of freedom and significant level are displayed in the top row with their corresponding values below.

Table 6: Hosmer and Lemeshow Test of the Logit Model for Under-five Mortality.

Chi-square	Degrees of Freedom(d.f)	Significant level
.000	4	1.000

From TABLE 6 above the Hosmer and Lemeshow test has a chi-square value of 0.000 with corresponding p-value of 1.00.This p-value is greater than the level of significance (i.e. 0.05), therefore, indicating support for the model.
Presented in TABLE 7 is the results of the Omnibus test of the logit model coefficients of the factor associated with under-five mortality. The table also shows in the first row, the Chi-square values, degrees of freedom (d.f) and corresponding p-value for the three test criteria with their values displayed in columns 2, 3 and 4 respectively.

Table 7: OmnibusTest of the Logit Model for Under Five Mortality

	Chi-square	df	Sig.
Step	287.684	11	.000
Block	287.684	11	.000
Model	287.684	11	.000

Indicated from TABLE 7 above, the Chi-square value and their corresponding p-values are 287.684 and 0.00 for the entire omnibus test criterion. This p value implies that it is less than the significant level (i.e. $p<0.05$).Hence suggesting that the entire test is statistically (highly) significant at 0.05(5%) level.

3.3 Discussion

The results from the descriptive analyses and the hierarchical logistic regression analysis from 2010-2012 birth cohorts was provided and discussed.Among the demographic variables, the number of death occurrences for the three years decreases with male deaths (52.3%) being the most dominant.Furthermore, results suggest that malaria is the most dominant (32.24%) disease affecting under five mortality, followed by sepsis (13.82%) and lastly by Asphyxia (3.95%).Findings show that Prematurity has adverse significant impact on under-fivemortality. Similarly, our results suggest that malaria and prematurity adversely affects under five mortality. However only the effect of Prematurity was statistically significant. It was also realized that the cox and Snell values between 3% and 19.7%suggests that the variability in the dependent variable is explained by the set of variables in the model.However the Hosmer and Lemeshow test has its p-value of 1.000 greater than the level significant (0.05), suggesting that the model is statistically significant.

IV. CONCLUSION

In summary under-fivemortality was significantly associated with only one variable during 2010-2012 period namely; Prematurity. The observed level of significance for regression coefficients(i.e. 0.02) for this variable was less than 5% suggesting that this variable was indeed good explanatory Variable. Hence the Logit Model for Prematurity as the only significant variable was

$$g(x) = 4.324 - 1.033 \; prematurity$$

Results emerging from the pseudo R Square (i.e. Cox and Snell =0.30; Negelkerke R Square = 0.197) suggests that the factors identified as the significant factors in the model gives a moderate prediction of under-five mortality. Moreover, the chi-square value of 0.000with corresponding p-values of 1.000 from the Hosmer and Lemeshow test gives an indication that the fitted logit model is consistent with the data used in this paper.Also, the chi-square value of 287.684 with corresponding p-values of 0.00 from the omnibus test signifies that the predictors are significant.Furthermore, the table classification shows that we were 98.7% right in the classification of our causes (cases). Thus indicating that, the model presents a reasonable statistical fit.

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