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Modeling of the determinants of Low-birth weight among children in Uganda

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Abstract

Birthweight is the first weight of the baby obtained after birth. For live childbirths, birthweight should preferably be measured within the first hour of life, before substantial post-natal weight loss has occurred. Low birth weight renders children exposed to infectious disease morbidity and mortality during both infancy and childhood. The objective of the study was to apply the modified binary logistic model to determine the factors associated with low birth weight among children in Uganda. The data used for this study was the Uganda Demographic and Health Survey (UDHS- 2016), the UDH survey selected 20615 households where 15522 women were successfully interviewed with known child birth weight out of which 5498 observations were considered after data cleaning. The results of the study revealed that the association between the age of the mother and low birth was statistically significant with a p-value of 0.044. The study also found that the risk of low birth weight babies was low for married women as compared to non-married women with a p-value of 0.003. Antenatal visit during pregnancy decreases the chances of having an infant with low birth weight. The association between low birth weight and the employed was statistically significant with a p-value of 0.007 and the likelihood of low birth weight infants for the rich was low as compared to the poor. The study concluded that the association between age, antenatal visits during pregnancy, occupation, wealth status of the mother and low birth weight were statistically significant.

Keywords: Low birth weight, Odds ratio, Statistics, Binary logistic, Pregnancy.

1.0 .Introduction

Low birth weight is one of the factors that affect baby mortality, on top of being a more significant determinant of neonatal-infant mortality and child morbidity. Hence low birth weight has for long been an issue of clinical and epidemiological investigations and a concern for public health intervention (Girma et al., 2019a). Low Birth Weight is a multi-layered health

significant public problem and it is one of the signs of maternal and child health problems (Ghimire et al., 2019). Internationally, more than 20 million infants are born with Low Birth Weight yearly with an incidence of 15 to 20% where 95.6% occur in developing countries (Girma et al., 2019b).

Over 40% of low birth weights in developing countries are found in India and more than half of those in Asia (Girma et al., 2019b). In 2010 over 10% of babies born were premature and more than 1 million babies died as a result of prematurity. The level of Low Birth Weight in developing countries is more than double that of the developed world, very high cost of special care and intensive care units (Ghimire et al.,2019).

Birthweight is the first weight of the baby obtained after birth. For live childbirths, birthweight should preferably be measured within the first hour of life, before substantial post-natal weight loss has occurred. Low birth weight is defined as a birth weight of less than 2,500 grams (up to and including 2,499 grams). Low birth weight is one of the major determinants of perinatal survival, infant morbidity and mortality as well as the risk of developmental disabilities and illnesses in future lives (Resolution WHA65.6, 2012). However, determinants of low birth weight among children include social factors, economic factors and the past obstetric history of the mother (WHO, 2019). Low birth weight leads to many problems among children such as low oxygen levels at birth, inability to maintain body temperature, difficulty in feeding and gaining weight, breathing problems such as infant respiratory disease syndrome and sudden infant deaths (Hachisaala,2020). World Health Organization (WHO,2019) estimates that about 30 million low-birth-weight babies are born annually (23.4% of all births) and they often face short- and long-term health consequences, While the global prevalence of low birth weight has slightly declined, the rate in many developing countries is still quite high (30%). Weight at birth is a good indicator of the newborn's chances for survival, growth, long-term health and psychosocial development. Low birth weight babies are significantly at risk of death, contributing to high perinatal morbidity and mortality in developing countries (Marimuthu et al., 2018; Greer et al. 2020).

In 2019, 20.5 million babies, an estimated 14.6 percent of all babies born globally that year suffered from low birth weight. These babies were more likely not to survive during their initial month of life and those who survived faced lifetime consequences plus a higher risk of stunted growth (Wardlaw et al, 2020). The prevalence of low birth weight in Sub-Saharan Africa ranges between 13 and 15%, with a slight difference across the entire region and in East Africa the prevalence of low birth weight is 13.5% (Bekalo et al., 2021). According to a study conducted in some rural parts of Uganda by Bater et al., 2020, Low birth weight is one of the critical issues in Uganda that causes short-term and long-term health consequences among babies and tends to have higher mortality and morbidity. The research revealed that the prevalence of low birth weights is quite high. Also, according to the study by Nantege et al. (2022) in slum areas in Entebbe Municipality, Wakiso District (Uganda), findings reflected that birth weight was significantly associated with diarrhoea among infants under 5 years where infants with normal birth weight had less chance of contracting diarrhea. Low birth weight is one of the major determinants of perinatal survival, infant morbidity and mortality as well as the risk of developmental disabilities and illnesses in future lives (WHO, 2019).

Therefore, it is against this background that this study applied Modified binary logistic models with the dependent variable having two distinct categories (low and not low birth weight) to investigate the determinants of low birth weight among children in Uganda. This research's novelty lies in the fact that the research employed the Uganda Demographic and Health Survey (UDHS-2016) which captures all the provinces in Uganda to accommodate a greater scope unlike the other research works done in Uganda.

2.0 Materials and Method

This study employed an expost-facto research design because the researcher used secondary data collected by the Uganda Bureau of statistics. The study used the Uganda Demographic and Health Survey (UDHS, 2016) secondary data sourced from the Uganda Bureau of Statistics. During the UDHS (2016), Uganda was divided administratively into 112 districts, which were grouped for this survey into 4 regions. The sample for the 2016 UDHS was designed to provide estimates of key indicators for the country as a whole, for urban and rural areas separately, and for each of the 4 regions.

The dependent variable was the low birth weight of the child in Uganda. The low birth weight was measured in kilograms and infants weighing less than 2500 grams (2.5 Kilograms) were low birth weight (Egbon et al. 2022). The independent variables included social factors (age, education level, ethnicity, religion place of residence, marital status), obstetric factors (mode of delivery, place of delivery, birth history, Antenatal care visits during pregnancy, complications during labour), and Economic factors (wealth index, occupation).

2.1 Data Analysis

The analysis was done at different levels which include; Univariate analysis, Variable Selection, modified binary logistic modeling at a multivariate level and model diagnostic. The analysis was done using STATA version 14. This stage involved running a summary of statistics (mean, variance, standard deviation, etc.) for the count/continuous variables and frequencies/percentages for the categorical variables. The variables were selected using stepwise estimation, the backward selection approach and the variables with p-Value < 0.7 were selected in the model. A modified binary logistic model with all variables which qualified at the variable's selection level was done. A dichotomous dependent variable represented newborns with birth weight less than 2500 grams (low birth weight) and was coded with 1 while newborn babies with birth weight equal to or greater than 2500 grams (Not low birth weight) were coded with 0. The logit log function was considered for this research.

Logistic (Logit) model

The logit model was used to model the odds of success of an event as a function of the independent variable.

The Logit model (logistic model) is given below;

$$Logit(I) = log\left(\frac{P}{1-P}\right) = Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \quad (1)$$

Implying, P is the probability of occurrence of an event, and I is the odds of an event occurring. Z is the linear combination of independent variables with coefficients. The above equation can be solved further to arrive at the following function which can be used to determine the probability of the occurrence of the events.

$$P = \sigma(Z) = \frac{1}{(1+e^{(-z)})} \qquad (2)$$

As the value of Z approaches -infinity, the value of σ(Z) or P approaches 0. And, as the value of Z approaches +infinity, the value of σ(Z) or P approaches 1 (Babalola 2012; Adeleke et al., 2012).

2.2.4 Model Diagnostics
After running the modified binary logistic model, a goodness of fit test based on the Hosmer and Lemeshow (HL) test was conducted (Alaimo et al., 2020).
The Hosmer and Lemeshow (HL) test is given below:

$$\sum_{n=1}^{n} \frac{(O_j - C)^2}{E_j\left(1-\frac{E_j}{n_j}\right)} \backsim \chi^2 \qquad (3)$$

Where O_j is the number of observed cases in the jth group, E_j is the number of expected cases, n_j *is* the number of observations, χ^2 *is the chi sqaured* and $\sum$ is the Summation notation.

3.0 Results

This section presents the analysis at the univariate level, Variable selection, multivariate level and model diagnostics.
The findings revealed that the average index to birth history of the mother in Uganda was 1 child. The average age of the mother in the study was 27 years with a standard deviation of 6.603 years with a maximum age of 49 and a minimum of 15 years. The average number of antenatal visits was 4 with a standard deviation of 1.416 visits, the maximum number of antenatal visits was 20 and 0 was the minimum. The total number of observations was 5498 after thorough cleaning of the data set and the removal of missing values. The findings from table 4.2 revealed that out of 5498 observations, 500 had newborn babies with low birth with a percentage of 9.09 and 4998 had no low birthweight babies.
Concerning social factors, findings indicated that mothers who never had any formal education were 610 with a percentage of 11.09 out of 5,498, mothers who attended primary education were 3,144 with a percentage of 57.18, and mothers who attended secondary education were 1,308 with a percentage of 23.79, those who attended higher education were 436 with a percentage of 7.93. Generally, mothers who attended primary education had a bigger percentage of over 57.18%. It is well presented below.

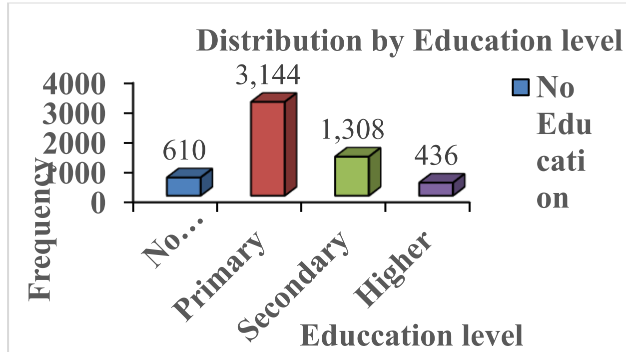

Figure 1: Distribution by Education level
With regard to ethnicity, Acholi mothers were 391 with a percentage of 7.11, Alur mothers were 170 with percentage of 3.09, Aringa mothers were 102 with percentage of 1.86, Baamba mothers were 6 with percentage of 0.11, Babwisi mothers were 19 with percentage of 0.35, Bafumbira mothers were 97 with percentage of 1.76, Baganda mothers were 729 with percentage of 13.26, Bagisu mothers were 258 with percentage of 4.69, Bagungu mothers were 7 with percentage of 0.13, Bagwere mothers were 77 with percentage of 1.4, 1 Bahehe mother with percentage of 0.02, Bahororo mothers were 5 with percentage of 0.09, Bakenyi mothers were 5 with percentage of 0.09, Bakiga mothers were 313 with percentage of 5.69, Bakonzo mothers were with percentage of 2.87, Banyankore mothers were 433 with percentage of 7.88, Banyara mothers were 3 percentage of 0.05, Banyaruguru mothers were 6 with percentage of 0.11, Banyarwanda mothers were 110 with percentage of 2, Banyole mothers were 83 with percentage of 1.51, Banyoro mothers were 161 with percentage of 2.93, Baruli mothers were 21 with percentage of 0.38, Barundi mothers were 8 0.15, Basamia mothers were 77 percentage of 1.4, Basoga mothers were 341 with percentage of 6.2, 1 Basongora mother with percentage of 0.02, Batagwenda mothers were 8 with percentage of 0.15, Batoro mothers were 159 with percentage of 2.89, Batuku mothers were 5 with percentage of 0.09, 1 Chope mother with percentage of 0.02, Dodoth mothers were 45 with percentage of 0.82, Ethur mothers were 35 with percentage of 0.64, 1 Ik (Teuso) mother with percentage of 0.02, Iteso mothers were 512 with percentage of 9.31, Jie mothers were 70 with percentage of 1.27, Jonam mothers were 27 with percentage of 0.49, Jopadhola mothers were 88 with percentage of 1.6, Kakwa mothers were 26 with percentage of 0.47, Karimojong mothers were 134 with percentage of 2.44, Kebu (Okebu) mothers were 4 with percentage of 0.07, Kuku mothers were 2 with percentage of 0.04 ,Kumam mothers were 40 with percentage of 0.73, Lango mothers were 336 with percentage of 6.11, 1 Lendu with percentage of 0.02, Lugbara mothers were 170 with percentage of 3.09, Madi mothers were 74 with percentage of 1.35, Napore mothers were 5 with percentage of 0.09, Nubi mothers were 4 with percentage of 0.07, Pokot mothers were 32 with percentage of 0.58, Sabiny mothers were 32 with percentage of 0.58, So (Tepeth) 102 with percentage of 0.05. The findings indicated that Baganda mothers had a bigger

percentage (13.26) of respondents as compared to all others ethnicity in Uganda. In place of residence, mothers from rural areas were 4,199(76.37%) while those from urban areas were 1,299(23.63%).

With regards to current marital status, respondents who were never in union, married, living with a partner, widowed, divorced and separated were 372 (6.77%), 2,259 (41.09%), 2,307 (41.96%), 51 (0.93%), 22 (0.4%), 487 (8.86%) respectively. Findings indicated that the married and the ones just living together but not officially married dominated the study with a percentage of 41.09 and 41.96 respectively as shown below.

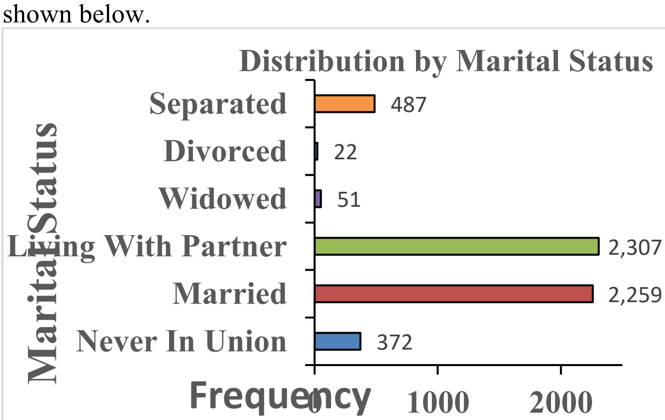

Figure 2: Distribution by Marital Status

On smoking, results reflected that nonsmokers were 5463 while the smokers were 35 only.

Obstetric Factors

With regards to obstetric factors, mothers who delivered by cesarean were 468 out of 5498 and 5030 had undergone normal delivery as shown above. On the place of delivery, respondents who delivered at a government health Centre were 2,846 (51.76%), government hospital 1,408 (25.61%), home 257 (4.67%), Other Home 69 (1.26%), Private Hospital 856 (15.57%) as shown above. Doctors who assisted the respondent after giving birth were 717 (13.04%) and Nurses or Midwives who assisted the respondents after giving birth were 4711 making a percentage of 85.69.

Economic Factors

Concerning economic factors, the wealth index was portioned into five categories, the poorest, poorer, middle class, richer and richest with the number of percentages of 1361(24.75%), 1075(19.55%), 946 (17.21%),962(17.5%) and 1154 (20.99%) respectively. On respondents' occupation, the ones not working were 934 (16.99%), employed were 480 (8.73%) and self-employed was 4,084 (74.28%).

Variable selection and Modified Binary logistic Modeling at Multivariate Level

The variables were selected using step-wise estimation and a backward selection approach was run where variables with p-value < 0.7 were included in the model as it is indicated below.

Table 1: Modified Logit model output

Child weight	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Social factors						
Age	0.984	0.008	-2.010	0.044	0.969	1.000
Marital Status						
Not married	Ref					
Married	0.569	0.107	-3.010	0.003	0.394	0.821
Living with partner	0.866	0.153	-0.820	0.414	0.613	1.223
Widowed	1.020	0.483	0.040	0.967	0.403	2.578
Divorced	0.338	0.351	-1.040	0.297	0.044	2.597
Separated	0.722	0.164	-1.430	0.152	0.462	1.127
Education						
No Education	Ref					
Primary	1.039	0.166	0.240	0.813	0.759	1.420
Secondary	0.983	0.191	-0.090	0.930	0.672	1.438
Higher	1.442	0.392	1.350	0.178	0.847	2.456
Religion						
No religion	Ref					
Christians	0.209	0.179	-1.820	0.068	0.039	1.123
Muslims	0.220	0.190	-1.750	0.080	0.040	1.201
Others	0.158	0.159	-1.830	0.067	0.022	1.137
Obstetric factors						

Antenatal	0.856	0.033	-4.040	0.000	0.793	0.923
Mode Of Delivery						
Caesarean Delivery						
No	Ref					
yes	1.089	0.192	0.480	0.630	0.770	1.539
Economic factors						
Occupation						
Not employed	Reference					
Employed	0.494	0.129	-2.700	0.007	0.296	0.824
Self-employed	0.883	0.110	-1.000	0.318	0.692	1.127
Wealth						
Poorest	Ref					
poorer	0.907	0.123	-0.720	0.474	0.695	1.185
middle	0.826	0.121	-1.300	0.193	0.619	1.101
richer	0.655	0.105	-2.650	0.008	0.478	0.896
richest	0.602	0.105	-2.920		0.428	0.846
_Cons	2.433	2.196	0.990	0.324	0.415	14.267

The findings from table 1 above exposed the following concerning social factors:

An increase in the age of a woman reduces the likelihood of delivering low birth weight babies with the odds ratio of 0.984 and p-value of 0.044 which is statistically significant. This implied that age had a negative relationship with low birth weight, as age increases the chances of having low birth weight also decreases. This also means that each additional increase of one year in age is associated with a 1.594 % decrease in the odds of the mother having a baby with low birth weight.

The risk of low-birth-weight babies for married women was 0.568 times low that of non-married women and this was statistically significant with a p-value of 0.003. This also means that a married woman experiences a reduction of 43.119% in the odds of having a child with low birth weight compared to a non-married woman. Living with a partner (odds ratio=0.865): the chances of low-birth-weight babies for a woman living with a partner are 0.865 times low that of a woman who is not married. This means that a woman living with a partner experiences a reduction of 13.408% in the odds of having a child with low birth weight compared to a non-married woman. However, the association between low birth weight and women living with a partner was not statistically significant with a p-value of 0.414.

The risk of low-birth-weight babies for a widowed woman was 1.0195 times high that of a non-married woman, however, the association between widowed women and low-birth-weight babies was not statistically significant with a p-value of 0.967. This means that a widowed women experiences an increase of 1.951 % in the odds of having a child with low birth weight compared to a non-married woman. Divorced (odds ratio =0.337): the risk of low-birth-weight babies for divorced women were 0.337 times low that of non-married women, and the association between low birth weight and divorced women was not statistically significant with a p-value of 0.297.

This means that a divorced woman experiences a reduction of 66.226% in the odds of having a child with low birth weight compared to a non-married woman. Separated (odds ratio=0.721): the risk of low-birth-weight babies for separated women was low compared to non-married women, however, the association between low birth weight and separated women was not statistically significant with a p-value of 0.152. This means that a separated woman experiences a reduction of 27.820 % in the odds of having a child with low birth weight compared to a non-married woman.

The association between the respondent's level of education and low birth weight was not statistically significant with a p-value of 0.813, 0.93, 0.178 for primary level, secondary level and higher level respectively. The association between the respondent's religion and low birth weight was not statistically significant with a p-value of 0.068, and 0.080 for Christians and Muslims respectively.

For obstetric factors, Antenatal (odds ratio=0.855) which implies that a unit increase in an antenatal visit during pregnancy decreases the chances of having an infant with low birth weight, with a p-value of 0.000, the association between low birth weight and the antenatal visit was statistically significant. This means that each additional increase in antenatal visit during pregnancy is associated with 14.447% decrease of the odds of the mother having a baby with low birth weight. Caesarean Delivery (odds ratio=1.088), the chances of low birth weight for caesarean delivery are high as compared to normal delivery, however the association between low birth weight and caesarean delivery was not statistically significant with a p-value of 0.63. This means that a woman with Caesarean delivery experiences an increase of 8.876% in the odds of having a child with low birth weight compared to a woman with normal delivery.

For Economic factors, Occupation; Employed (odds ratio=0.494) which means that the chances of low-birth weight infants for employed women were low as compared to unemployed women. The association between low birth weight and the employed was statistically significant with a p-value of

0.007. This means that an employed woman experiences a decrease of 50.584% in the odds of having a child with low birth weight compared to a un employed woman.

Wealth, Richest (odds ratio=0.602): the chances of low birth-weight infants for the rich were low as compared to the poor with odds ratio of 0.602 for the richest. The association between low birth weight and the rich was statistically significant with a p-value of 0.008, and 0.004 for the richer and richest respectively. This means that a rich woman experiences a reduction of about 39% in the odds of having a child with low birth weight compared to a poor woman.

For the model diagnostic test, the Hosmer and Lemeshow test implies that the estimated model adequately fits the data with a p-value of 0.4648.

4.0 Discussion

The results of the study revealed that the association between the age of the mother and low birth was statistically significant with a p-value of 0.044 and odds ratio of 0.984. This meant that an increase in the age of a woman reduces the likelihood of delivering low birth weight babies. This was relatively connected to a study by Toru (2019) in Ethiopia on low birth weight where age was statistically significant and low birth weight was most frequently associated with youngsters who gave birth when their bodies have not yet fully matured. In Uganda, teenage pregnancy, and lack of knowledge about any risk factors for Low Birth Weight are some of the major factors influencing low birth weight (Nantege et al., 2020). The descriptive statistics of the study revealed that the average age of the mother in the study was 27 years with a standard deviation of 6.6032 years with a maximum age of 49 and a minimum of 15 years.

Teenage mothers have high nutrient requirements for their growth and therefore pregnancy at this age is an added burden since the fetus competes for nutrients leading to low-birth weight and mothers who are educated are more likely to survive healthier lifestyles, including better health-seeking behaviour (Letamo, 2019). A higher proportion of rural mothers deliver low- birth weight than urban residents. In urban areas, health services are more accessible and of better quality as compared to rural areas. Young adolescents aged 10-15 years, single mothers, and those with a low level of education are also more at an increased risk of delivering low birth weight babies. The study also found that the risk of low birth weight babies was low for married women as compared to non-married women with odds ratio of 0.5688 and p-value of 0.003. This was similar to the findings in a study by Bater et al. (2020), where the likelihood of low birth weight among married women was low as compared to non-married women and non-cohabiting women.

The study revealed that the chances of low birthweights infant for a woman living with a partner are 0.8659 times low that of a woman who is not married. However, the association between low birth weight and women living with a partner was not statistically significant with a p-value of 0.414. The study also revealed that a unit increase in an antenatal visit during pregnancy decreases the chances of having an infant with low birth weight, similar to a study on antenatal care for positive pregnancy by the World Health Organization (2019) that commended that woman who attended antenatal visits had few chances of delivering low birth weight infants. Furthermore, Bater et al., (2020) revealed that antenatal visit provides chances for risk identification, health education and prevention of related pregnancy outcomes such as low birth weight among newborn. The descriptive statistics revealed that the average number of antenatal visits was 4 and the maximum was 20 visits.

Also, the study revealed that the chances of low-birth-weight infants for employed women were low as compared to unemployed women. The association between low birth weight and the employed was statistically significant with a p-value of 0.007 and the likelihood of low-birth-weight infants for the rich was low as compared to the poor. According to the Ethiopian Demographic Health Survey, the problem of low birth weight in Ethiopia improved significantly, 11% in 2011 and 13% in 2016. It might be attributed to unsatisfactory improvements in the quality of health care services, including delivery at health facilities, antenatal care coverage, postnatal services, and vaccination. Maintaining good nutrition and healthy weight gain, especially at the beginning of conception, controlling pre-existing medical and obstetric illnesses, increasing intake of folic acid found in fruits, whole grains, and vegetables, good periconceptional care and antenatal care follow-ups, and improving the living standards of the general population were the tips to lower the risks of low birth weight disseminated (Zenebe et al., 2021). The Study revealed that the chances of low-birth-weight infants for the rich were low as compared to the poor with odds ratio of 0.6546, and 0.6015 for the richer and richest respectively. The association between low birth weight and the rich was statistically significant with p -the value of 0.008, 0.004 for the richer and richest respectively. The findings of this study are similar to the findings of the study by Bekalo et al., (2021) in Ethiopia which was intended to model the low birth weight with marginalized linear mixed models where the odds for the likelihood of obtaining low birth weight infants for rich mothers was 0.7188 times lower compared to poor mothers, and this reflected that the probability of low birth weight was lower by 28% for mothers from a rich family as compared to the mothers from poor families.

The p-value above 0.05 (not statistically significant) implied that the estimated model adequately fits the data. (p-value= 0.4648). The findings of this study are similar to the findings of the study by (Siyoum et al., 2019) in Ethiopia which was carried out to assess the factors associated with low birth weight where they established that Hosmer and lemeshow test adequately fitted the model used. The findings revealed that out of 5498 observations, 500 had newborn babies with low birth weight with a prevalence of 9.09%. The findings of this study are similar to the findings of the study by (Alemu et al., 2019) which was carried out to obtain the prevalence and associated factors among new borns at hospitals in Kambata, Ethiopia.

5. Conclusion

The study concluded that an increase in the age of a woman reduces the likelihood of delivering low birth weight babies and the association between age and low birth weight was statistically significant. The study also concluded that th of low birth weight babies was low for married women as compared to non-married women and the association between age and low birth weight was statistically significant. This also meant that a married woman experienced a reduction i odds of having a child with low birth weight compared to a non-married woman. Each additional increase in antenatal visit during pregnancy was associated with decrease of the odds of the mother having a baby with low birth weight. The stu well indicated that the association between occupation (employed women), wealth status were statistically significant.

References

[1] Girma, S., Fikadu, T., Agdew, E., Haftu, D., Gedamu, G., Dewana, Z., & Getachew, B. (2019). Factors associated with low birthweight among newborns delivered at public health facilities of Nekemte town, West Ethiopia: a case control study. BMC pregnancy and childbirth, 19(1), 1-6.

[2]Ghimire R, Phalke DB, Phalke VD, Banjade B, Singh AK (2019). Determinants of low birth-weight: a case control study in Pravara rural hospital in western Maharashtra. India IJSR. (2019) (7):2277–8179.

[3]Ghimire, R., Phalke, D. B., Phalke, V. D., Banjade, B., & Singh, A. K. (2019). Determinants of low birth weight: A case control study in Pravara Rural hospital in Western Maharashtra, India. Int J Sci Res, 3, 243-5.

[4]Resolution WHA65.6(2012). Comprehensive implementation plan on maternal, infant and young child nutrition. In: Sixty-fifth World Health Assembly Geneva, 21–26 May 2012. Resolutions and decisions, annexes. Geneva:World Health Organization; 2012:12–1

[5]Hachisaala, M. (2020). Determinants of low birth weight in Zambia: evidence from the 2007 and 2013/14 Zambia demographic and health surveys (zdhs) (Doctoral dissertation, The University of Zambia).

[6]World Health Organization. (2019). UNICEF-WHO low birthweight estimates: levels and trends 2000-2015 (No. WHO/NMH/NHD/19.21). World Health Organization.

[7]Egbon O.A., Bogoni M.A., Babalola B.T., Louzada F. (2022). Under age five survival times in Nigeria: a Bayesian spatial modelling approach. BMC Public Health. 22(1):2207: 1-17 https://doi.org/10.1186/s12889-022-14660-1.

[8]Marimuthu, Y., Sarkar, S., Sakthivel, M., Yuvaraj, K., Bharathnag, N., & Sarveswaran, G. (2018). Association of social factors with low birth weight: a narrative review. Int J Commun Med Public Health, 5(8), 3171.

[9]Greer, C., Adamson, P., Harris, S., Horwood, J., Troughton, R., & Darlow, B. (2020). Very low birth weight is associated with reduced right ventricular function detected by strain imaging in early adulthood–findings from a prospective matched cohort study. European Heart Journal, 41(Supplement_2), ehaa946-0109.

[10]Wardlaw, T., Blanc, A., Zupan, J., & Ahman, E. (2020). Low Birthweight: Country, Regional and Global Estimates. New York: The United Nations Children's Fund and World Health Organization.

[11]Bekalo, D. B., Nigussie, Z. M., Yimer, B. B., & Anteneh, Z. A. (2021). Modeling Determinants of Low Birth Weight for Under Five-Children in Ethiopia. Annals of Data Science, 8(3), 475-496.

[12]Bater, J., Lauer, J. M., Ghosh, S., Webb, P., Agaba, E., Bashaasha, B., ... & Duggan, C. P. (2020). Predictors of low birth weight and preterm birth in rural Uganda: findings from a birth cohort study. PloS one, 15(7), e0235626.

[13]Nantege, R., Kajoba, D., Ddamulira, C., Ndoboli, F., & Ndungutse, D. (2022). Prevalence and Factors Associated With Diarrheal Diseases Among Children Below Five Years in Selected Slum Settlements in Entebbe Municipality, Wakiso District, Uganda

[14]Babalola, B. T. (2012). Application of Ordinal Logistic Regression to Pregnancy Outcome. Lambert Publisher, Germany.

[15]Adeleke, R. A., Babalola, B. T., Ogunsakin, R. E., & Adarabioyo, M. I. (2012). Application of ordinal logistic to pregnancy outcomes. Journal of Natural Sciences Research, 2(4).

[16]Toru, T & Anmut, W (2019). Assessment of low birth weight and associated factors among neonates in Butajira General Hospital, South Ethiopia, cross sectional study, 2019. Letamo GMMG (2019). Factors Influencing Low Birth Weight and Prematurity in Botswana. J Biosoc Sci. 2001; 33:391–403. [PubMed: 11446401]

[17]Zenebe, A., Tegegne, K. T., Bifato, B., & Assefa, A. A. (2021). Association between iron and folic acid supplementation and birth weight in Ethiopia: systemic review and meta-analysis. *Bulletin of the National Research Centre*, *45*, 1-10.

[18]Siyoum, M., & Melese, T. (2019). Factors associated with low birth weight among babies born at Hawassa University Comprehensive Specialized Hospital, Hawassa, Ethiopia. Italian journal of pediatrics, 45, 1-7.

[19]Alemu, A., Abageda, M., Assefa, B., & Melaku, G. (2019). Low birth weight: prevalence and associated factors among newborns at hospitals in Kambata-Tembaro zone, southern Ethiopia 2018. The Pan African Medical Journal, 34.