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A Modified Logistic Regression Analysis On Risk Factors Of Bronchopneumonia.

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ABSTRACT
A logistic regression model was used for the analysis of risk factors for Bronchopneumonia infection. The risk factors used are demographic variables (age, sex, occupation, educational status and place of residence), home based variables (source of water, family smoking history and cooking materials), nutritional variables (nutritional status of child and breast feeding status), common childhood illness (diarrhea, malaria and immunization status of the child). From a sample of 350 patients of the Abubakar Tafawa Belewa Teaching Hospital, Bauchi , Nigeria. The results of the analysis showed that there is a high relationship of 96.65% between infection and the risk factors of bronchopneumonia. A Wald test statistic criterion demonstrated that, age of the mother, residence(rural), mother's education, breastfeeding, fully vaccinated, BCG, Diarrhea, malaria, cooking material's(firewood),water sources (well), smoking are predictor variables that made significant contributions for the analysis of bronchopneumonia. The Hosmer and Lesmeshow (H-L) test statistic of 0.457, indicates that, the model's estimates fit the data at an acceptable level of significance, thereby making the logistic regression model a good model for analyzing bronchopneumonia infection.

KEYWORDS: Logistic regression model, Bronchopneumonia and Logit models.

I. INTRODUCTION

Pneumonia has been tagged as the "forgotten killer of children" according to an article by World Health Organization (WHO) in 2015; it is one of the leading killers of children in Nigeria aside from diarrhea. Pneumonia has claimed the lives of more than 800,000 children under the age of five globally, or one child every 39 seconds, according to a new analysis by the WHO in 2018. Nigerian children make up the highest number of those who died with an estimated 162,000 deaths in 2018-443 deaths per day, or 18 children die every hour. In Nigeria, 19% of child deaths were due to pneumonia in 2018 according to a report by UNICEF, and it was the biggest killer of children under five in 2017.Pneumonia is a deadly disease and takes so many children's lives even though this is mostly preventable, and yet, this killer disease has been largely forgotten on the global and national health agendas.

The determinants of pneumonia are numerous; educational status of parents, smoking habits of any member of the household, nutritional status, age and sex of the child and widely varies across the regions of the world. Mortality due to childhood pneumonia is strongly linked to poverty-related factors such as under nutrition, lack of safe water and sanitation, indoor air pollution and inadequate access to health care. Around half of childhood pneumonia deaths are associated with air pollution. The effects of indoor air pollution kill more children globally than outdoor air pollution according to Bazie et al (2020). Several risk factors for acquiring respiratory infections in developing countries, such as poverty, low family income, low parental education level, low birth weight, malnutrition, and lack of breastfeeding, have been described.

Most global child pneumonia deaths occurred among children under the age of two, and almost 153,000 within the first month of life (WHO 2018). There is therefore a tremendous opportunity to narrow the child survival gap between the poorest and better-off children both across and within countries and to accelerate progress towards the Millennium Development Goals (MDGs) by increasing in a concerted way commitment to, attention on and funding for these leading cause of death that disproportionately affect the most vulnerable children.

Hence, the need for this study, the Logistic Regression Model built in this study will give effective guide in evidence-based medicine. That is, to achieve useful projections of the bronchopneumonia status of infants so as to isolate

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factors responsible for such. On the other hand, the study will assist medical researchers to ascertain the prevalence of bronchopneumonia status using the developed model.

1.1 Bronchopneumonia

Pneumonia is an illness, usually caused by an infection, in which the lungs become inflamed and congested, reducing oxygen exchange and leading to cough and breathlessness. It affects individuals of all ages but occurs most frequently in children and the elderly. Historically, in developed countries, deaths from pneumonia have been reduced by improvements in living conditions, air quality, and nutrition. In developing world today, many deaths from pneumonia are also preventable by immunization or access to simple, effective treatments (Anthony, 2010).

Bronchopneumonia occurs when viruses, bacteria, or fungi cause inflammation and infection in the tiny air sacs in the lungs. Someone with bronchopneumonia may have trouble breathing because their air ways are constricted.

1.2 Symptoms of bronchopneumonia

Children and adults may display symptoms differently. Coughing is the most common symptom in infants others include;
-rapid heart rate
-irritability
-decreased interest in feeding, eating or drinking
-fever
-difficulty sleeping.

Many cases of bronchopneumonia are caused by bacteria. Outside the body, the bacteria are contagious and can spread between people in close proximity through sneezes and cough. The condition is commonly contracted in a hospital setting. People who come for treatment of other illnesses often have compromised immune systems under these conditions , the body will have difficulty fighting a new infection. Pneumonia that occurs in the hospital may also be as a result of bacteria that are resistant to antibiotics.

There are several factors that can increase your risk of developing bronchopneumonia. These include:

Age: people who are 65 years of age or older, and children who are 2 years or younger have a greater risk of developing bronchopneumonia.
Environment: people who work in or visit hospitals or nursing home facilities have a higher risk for developing bronchopneumonia.
Lifestyle: smoking, poor nutrition and a history of heavy alcohol use, lack of exercise can increase your risk of bronchopneumonia.
Medical conditions: having certain medical conditions increase your risk for developing this type of pneumonia.

II. MATERIALS AND METHOD

Binary Logistic deals with the binary case, where the response variable consists of just two categorical values. Logistic regression model is mainly used to identify the relationship between two or more explanatory variables (X_i) and the dependent variable (Y). Logistic regression model has been used for prediction and determining the most influential explanatory variables on the dependent variable (Cox and Snell, 1994). The logistic regression model is the most frequently used regression model for the analysis of these data. It is important to understand that the goal of an analysis using this model is the same as that of any other regression model used in statistics; that is, to find the best fitting and interpretable model to describe the relationship between an outcome (response) variable and a set of independent (explanatory) variables.

The generalized logistic Regression model is given as:

$$Y_t = \ln\left[\frac{\pi(x_i)}{1-\pi(x_i)}\right] = \beta_0 + \beta_1 x_1 + \beta_2 x_{2+} \ldots + \beta_p x_p$$

This model explains the effects of the predictor variables on the response.
Where the response variable Y_t is binary, taking value of either 0 or 1.
$\beta_1, \beta_2, \ldots \beta_p$ representing the coefficients of the $x_{i's}$ where i ranges from 1 to 13.

The significance of the model parameter is tested individually or in groups using the walds test statistics, while the Hosmer and Lemeshow goodness of fit test statistic is used to check the appropriateness of the logistic regression model. Meanwhile, the Nagelkerke R^2 is used to determine the relationship between infection and the risk factors of pneumonia.

A modification will be done for gender.

THE MODIFIED LOGISTICS REGRESSION MODEL WILL BE G(X) $= \frac{e^{\beta_0} + e^{\beta_1 x_1} + \ldots + \propto_i}{1 + e^{\beta_0} + e^{\beta_1 x_1} + \ldots + \propto_i}$

Where $\propto_i$ stands for gender i=1,2

ASSUMPTIONS LOGISTIC REGRESSION ANALYSIS

i. The predictors are not correlated with one another, i.e. there is no multicollinearity.
ii. The independent variables do not need to be multivariate normal
iii. The dependent variable is binary.

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iv. The predicted values are probabilities and are therefore restricted to (0, 1)

DATA COLLECTION AND DATA ANALYSIS

The study would have considered all the district hospitals in the country but the Teaching Hospital in Bauchi was be sampled out purposively for the research using the primary data. The data was be taken from patients visiting the hospital with children within the range of 0-10years of age.

The following information was taken from patients visiting the Hospital; socio-demographic variables (age, sex, occupation, educational status and place of residence), home based variables (source of water, family smoking history and place of cooking), nutritional variables (nutritional status of child and breast feeding status), common childhood illness (diarrhea, malaria and immunization status). The data for the study will be analyze with the aid of statistical package for social sciences (SPSS v. 23).The test of the dependent variable (bronchopnuemonia), with the independent variables will be perform to verify whether they are statistically significant at 5% level of significance to the outcome of bronchopneumonia in children. A logistic regression model containing all the predictor variables will be fitted and a test of significance on coefficients will be performed. Based on this, logistic regression model is developed for assessing the risks factors associated with bronchopneumonia and also to make future predictions.

III. DISCUSSION OF RESULTS

Data collected by the Hematology department of the teaching Hospital, Bauchi was used for the analysis. The response variable Y is the bronchopneumonia, while the explanatory variables (risk factors) demographic variables (age, sex, occupation, educational status and place of residence), home based variables (source of water, family smoking history and cooking materials), nutritional variables (nutritional status of child and breast feeding status), common childhood illness (diarrhea, malaria and immunization status of the child).

SPSS version 23.0 was used for the analysis of the data, yielding the following results model parameters

Table 4.2 shows the Wald test of modified Logistic Regression Analysis on basic demographic, socio-demographic and environmental variable on patients

Predictor	β	Wald	DF	Sig.
Sex (∝)	0.815	6.109	1	0.0701
Age of mother (x_1)	4.103	2.014	1	0.019
Residence of mother (x_2)	-2.050	1.162	1	0.021
Non- exclusive Breastfeeding (x_3)	-3.073	5.051	1	0.000
Mother Education (x_4)	3.124	1.997	1	0.025
Mother occupation (x_5)	-2.008	3.101	1	0.814
Mother marital status (x_6)	0.015	2.109	1	0.632
Not fully Vaccinated (x_7)	-9.103	1.014	1	0.017
Non-taking of BCG (x_8)	1.050	0.162	1	0.017
Vitamin A supplementation(x_9	0.873	3.051	1	0.801
Diarrhea (x_{10})	8.124	1.290	1	0.025
Malaria (x_{11})	7.065	2.066	1	0.007
place of cooking(inside) x_{12}	8.132	5.123	1	0.527
cooking Materials(firewood) x_{13}	6.341	1.932	1	0.033
water sources(well) x_{14}	5.923	4.112	1	0.024
smoke (yes) x_{15}	-2.027	7.110	1	0.000
Constant	20.142	0.210	1	1.032

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The result above indicate that age of mother, sex of the child, residence of the mother, non- exclusive breastfed, mother's education, not fully vaccinated, non taking of BCG, Diarrhea, malaria, cooking, Materials (firewood), water sources (well), smoke (yes) are more susceptible to having bronchopneumonia while factors like place of cooking, vitamin A supplementation, Mother's marital status and mother's occupation does not make a person susceptible to developing bronchopneumonia. This implies that to determine or predict whether a person would have bronchopneumonia, sex(female), age of mother, breastfeeding status of the child, mother's education, not fully vaccinated, non taking of BCG, Diarrhea, malaria, cooking, Materials(firewood), water sources(well), smoke (yes) could be relevant factors.

The modified logistic regression model will be

$G(x)=\frac{e^{\beta 0}+e^{\beta 1 x 1}+\ldots+\propto_i}{1+e^{\beta 0}+e^{\beta 1 x 1}+\ldots+\propto_i}$ Where $\propto_i$ stands for gender 1= male, 2= female

$$= \frac{e^{20.143+0.815sex-2.050ReMoth-3.073brfeeding+3.124me-2.008mo+0.015m\ sta-9.103Vacc+1.050bcg+0.873vA+8.124diar+7.065ma+8.132p\ cook+6.341cook\ ma+5.923wat\ sour-2.027smok+4.103}}{1+e^{20.143+0.815sex+4.103age\ moth-2.050ReMoth-3.073brfeeding+3.124me-2.008mo+0.015m\ sta-9.103Vacc+1.050bcg+0.873vA+8.124diar+7.065ma+8.132p\ cook+6.341cook\ ma+5.923wat\ sour+4.327smok+4.103}}$$

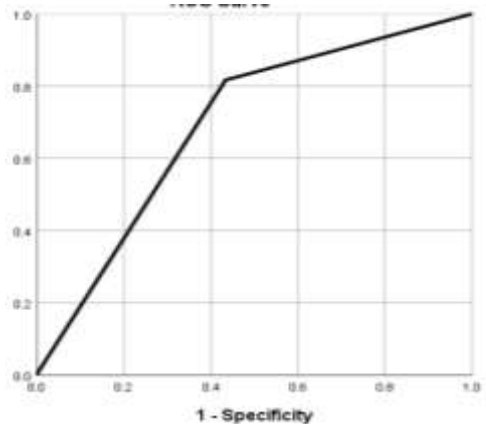
The model above indicates all the risk factors of developing bronchopneumonia with sex(female), age of mother's, gender, residence of the mother, breastfeeding status of the child, mother's education, not fully vaccinated, non-taking of BCG, Diarrhea, malaria, cooking, Materials(firewood), water sources(well), smoke (yes) are susceptible to develop bronchopneumonia. We also observed that the modified logistic regression for each of the variables were statistically significant.

The Nagelkerke R square = 0.966, indicating a strong relationship of 96.6% between infection and the risk factors of pneumonia.

For the goodness-of-fit, the Hosmer and Lesmeshow coefficient is 0.457, which is greater than 0.05; hence we conclude at 5% level of significance that the model fits the data.

Conclusively, our analysis indicates that the logistic regression model is a good model for the analysis of risk factors of bronchopneumonia infection

The Modified Logistic Regression from ROC Curve



CONCLUSION

In this study, risk factors of having bronchopneumonia using logistic regression model were studied. The risk factors used are age of mother, breastfeeding status of the child, mother's education, not fully vaccinated, non taking of BCG, Diarrhea, malaria, cooking, Materials(firewood), water sources(well), smoke (yes), sex, place of cooking, vitamin A supplementation, Mother's marital status, mother's occupation and residence of mother. The chi-square test was used to test for the association between bronchopneumonia and all the predictor variables. The test showed that age of mother, breastfeeding status of the child mother's education, not fully vaccinated, non taking of BCG, sex, Diarrhea, malaria, cooking, Materials(firewood), water sources(well), smoke (yes) are statistically significant. To assess the fitness of the model the maximum likelihood test was used to show the factors of having bronchopneumonia. The model fitted showed that getting bronchopneumonia does not depend significantly on the sex of a person.

REFERENCES

[1]. AAP. Undated. Pneumonia. American Academy of Pediatrics. Accessed on 27th September, 2018

[2]. Aaron K. (2018) via https://www.medicalnewstoday.com/articles/3231 67.php Accessed on 25th January, 2019

[3]. Anderson, AA (2008). Tracking Broncho-pulmonary dysplasia (BPD) using the logistic regression model. International Journal of Statistics 65, 5966.

[4]. Anthony, J., Brooks, W. A., Malik J. S., Douglas, H. and Kim, M. E. (2010):

Pneumonia research to reduce childhood mortality in the developing world. The Journal of Clinical Investigations. 2, 120-128

[5]. Bazie G.W.,seid, N &Admassu, B(2020). Determinants of community acquired pneumonia among 2 to 59 months of age children in Northeast Ethopia:a case-control study.Pneumonia 12, 14(2020).

[6]. Beki, OD (2012). The Use of Discriminant Model and Logistic Regression for Tracking the Incidence of Broncho-Pulmonary Dysplasia among Infants. An unpublished Dissertation Submitted to Usman Danfodio University, Sokoto Nigeria.

[7]. Benjamin j. Moses and Daniel M. Musher (2021). Candida species in community-acquired

[8]. pneumonia in patients with chronic aspiration

[9]. Cabrera, AF (1994). Logistic regression analysis in higher education: An applied perspective. Higher Education: Handbook of Theory and Research. 10: 225–56. Cornfield, A (2010). Binary logistic model for predicting Myocardial infarction. Amer. J. Pub. Health 81,15-21.

[10]. Carlos, A. B., Christieny, C. M., Moreira, E. L. M,, Jose, R. R and Guilherme, M. S. (2007). Binary logistic model for predicting Broncho- Pulmonary Dysplasia (BPD).

[11]. Cornfield, A. (2010). Binary logistic model for predicting Myocardia infection. American Journal of Public Health, 81, 15-21.

[12]. Denise E. et al (2021) carriage of upper respiratory tract pathogens in rural communities of Sarawak.

[13]. Danbaba, A., Audu, M., and Mahmud, A. M. (2013). Investigation of risk factors of low birth weight using multivariate logistic regression analysis: Journal of Humanities, Science andTechnology. A publication of Niger State Polytechnic. 3, 59-77

[14]. Emin et al (2014). The relationship between diabetic Nephropathy and Visceral Adipose tissue

[15]. Global Action Plan for Prevention and Control of Pneumonia (2009). World Health Organization/The United Nations Children's Fund (UNICEF).

[16]. Hosmer, DW; Lemeshow, S (2000). Applied Logistic Regression. (2nd ed.) Wiley and Sons, inc. New York. Janelle, M; Rachel, N (2017). Bronchopneumonia: Symptoms, Risk Factors, and Treatment.

[17]. Monir et al (2015). Reduce Order Modelling of Power systems Models using Interpolatory pro-jectionsTechnique,International journal of Modelling and Optimization 5(3),pp.228-233,2015..

[18]. Onyiriuka, A. N. (2010). Incidence of Low Birth Weight Infants in Twin Gestations. Niger J. Clin. Pract; 13, 365 – 370.

[19]. Pyng, L., Remco, M., Stephen, L., Adi, F., Katrien, G., Annette, M., Jean, L.,….,Tom, G. (2010). Din Cancer Rearch.NIH Publication Access. 58, 1713-1718.

[20]. Rees, G., Brook, Z., Doyle, W., and Costeloe, K. (2005). The Nutritional Status of Women in the First Trimester of Pregnancy attending an inner-city Antenatal Department in the UK. Journal of Royal Society for the Promotion of Health; 125(5), 232 – 238.

[21]. Sunil Kumar Kasundriya, MamtaDhaneria, Aditya Mathur and Ashish Pathak (2020)* Incidence and Risk Factors for Severe Pneumonia in Children Hospitalized with Pneumonia in Ujjain..

[22]. Suzanne, M., David, A., Kathleen, H. and John, L. (1997). Outcome of Extremely Low Birth Weight Infants Requiring Rescue High Frequency Ventilation Pediatric Research. 41, 212-212.

[23]. Thomas, W. (2007). Prevention and Treatment of BronihopulmonaryDysplasin: Current Status and Future Prospects. Journal of Perinatology.3, 26-32

[24]. UNICEF (2021) Maternal child Epidemiology Estimation accessed on https://data.unicef.org/topic/child-health/pneumonia.

[25]. Uthman, O. A. (2008): Effect of Low Birth Weight on Infant Mortality. The Internet Journal of Epidemiology.6, 1-5.Vajpayee (2005).classification of HIV-seropositive Antiretroviral Treatment.

[26]. Vimalkumar, VK; Moses, RC; Padmanaban, S (2011). Binary logistic model for detecting prevalence and risk factor of Nephropathy in type 2 diabetic patients. Int. j. Collabor. Res. Internal Med. Pub. Health. 3 (8): 598-615. View

[27]. World Health Organisation (WHO, 2019) what is pneumonia? Available on www.who.int accessed on june 7, 2021