INTERNATIONAL JOURNAL OF LATEST TECHNOLOGY IN ENGINEERING, MANAGEMENT & APPLIED SCIENCE (IJLTEMAS)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

Modelling the Effects of Age and Gender on Patients with Hepatitis B

OLAJIDE Oluwamayowa Opeyimika[1], OLAYEMI Michael Sunday[2], OLUWAFEMI James Oluwaseyi[3], & AJAYI Omolola Felicia[4]

[1, 2,4]Department of Statistics, Kogi State Polytechnic, Lokoja, Nigeria
[3] Department of Science, Kogi State Polytechnic, Lokoja, Nigeria

Abstract

Background. Hepatitis B is a potentially fatal cause of liver disease worldwide. Nigeria is currently recognized as having one of the highest rates of infection in all of Africa. This study aimed at modelling the effect of gender and age on the presence of hepatic B patients at Unilorin Teaching Hospital, Ilorin, Kwara State, Nigeria.

Methods. The study was conducted over a three-year period (2019-2021) which translates to a total of 4,364 patients who underwent testing at the hospital's laboratory during that time. The data were fitted to both Probit and Logit models, and we choose the optimal model for the study using the Akaike Information Criterion (AIC) and Log Likelihood (LOG LIK).

Results. The results show that 24.38% of the population tested positive to hepatitis B, whereas 75.63% tested negative. Patients between the ages of 20 and 30 had the highest frequency of 1162, while there were no patients in the age range of 100 to 110. Women under the age of 20 had a higher rate of HBsAg positivity (20%) compared to those over 20 (8.7%), or=2.54 (95% CI 1.31 to 4.90).

Conclusion. We concluded that gender and age are statistically significant (i.e., not all level means are equal) to testing positive to hepatitis B in Nigeria. Since Pr (>|z|) for gender and age = 2e-16 *** and it was discovered that the Probit model fits the data better than the Logit model.

Keywords: Probit regression model, Logit Regression model, Hepatitis, Selection Criteria

I. Introduction

Infection with hepatitis B is a significant global health issue. The hepatitis B virus, which is frequently spread through bodily fluids like blood, semen, and vaginal secretions, can harm the liver. Most adults who get infected with hepatitis B virus were able to recover from the infection when treated. Patients may have acute symptoms or be found to have an asymptomatic condition following a hepatitis B virus screening. Nigeria is a branch of Sub-Saharan Africa, which is currently recognized as having one of the highest rates of hepatitis B virus infection in all of Africa. This study aims to model how gender and age may affect the presence of hepatitis B patients at Unilorin Teaching Hospital.

The significance of this research is in relation to the global hepatitis targets outlined in the Sustainable Development Agenda which involve eliminating hepatitis B in Nigeria by 2030 through examining the relationship between age, sex, and patient's outcome for those tested for hepatitis B. In order to understand the likely effect of age and gender on the prevalence rate of Hepatitis B in Nigeria.

II. Review of Literature

According to estimates, chronic HBV infection affects 3.6% of the world's population. Although viral hepatitis poses a serious threat to public health worldwide, it has not previously received high priority. The World Health Organization (WHO) approved the Global health sector strategy on viral hepatitis in 2016, setting the target of 90% of affected people receiving a diagnosis by 2030 in order to eradicate viral hepatitis as a public health issue. Similar to this, the 67th World Health Assembly of the WHO on the prevention and control of viral hepatitis recently reiterated the significance of tracking national and international progress in viral hepatitis prevention, diagnosis, and treatment. An estimates of 6.2% of the population in Africa has chronic HBV infection, which affects 60 million people.

Children have the highest incidence of new infections, and prenatal pathways account for the majority of transmission. In the pre-vaccine era (1980s to early 2000s), the prevalence of chronic HBV infection among children under five years of age was 5%; in 2019. Since 1995, the WHO Extended Programme for Immunization (EPI), which includes improved strategies for the prevention of mother-to-child transmission has been gradually implementing the HBV vaccine across Africa. According to Schweitzer et al. and Ott et al., the total population prevalence of HBV infection remains high in various settings in SSA (> 8%) despite more than two decades of vaccine introduction, which has been crucial for reducing infections in children (2017). Early epidemiological

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

studies revealed that estimates of HBV prevalence in SSA varied widely between nations and within population categories. Methodological discrepancies highlighted by Jacobs et al. (1997) and Belo (2000) frequently account for these variations.

According to Kramvis (2007), Nigeria is one of the continent's nations with a hyper-endemic rate of HBV infection (> 8%).Due to a lack of funding, political will, and awareness of the problem, about nine out of ten Nigerians who have chronic HBV are ignorant of their infection status and are absent from data on global public health. As a result, according to De Martel's (2020) observations, Nigeria has one of the highest rates of HBV-attributable cancer in West Africa, with an estimated age-standardised incidence rate of 2.6 to 5.1 cases per 100,000 person per year. Howell (2014) noted that HCC is a very aggressive cancer with few therapeutic choices, frequently absent in resource-constrained settings. In Nigeria, viral hepatitis B cannot be completely eradicated due to a lack of accessible diagnostics, such as specialized immunoassays and nucleic acid tests, and the out-of-pocket costs for underprivileged communities, making HBV a serious threat to public health. Additionally, clinical and epidemiological studies on HBV infection are being conducted in Nigeria, but they have not been successful in obtaining the necessary financing and investment. There are no recent systematic reviews that cover the entire nation of Nigeria and report the prevalence of HBV. In 2013, Musa (2015) conducted the first systematic review and meta-analysis of HBV in Nigeria, which comprised 61% of studies first published before 2010. Additionally, Schweitzer et al. (2015)'s systematic review which estimated the prevalence of chronic HBV infection globally had a narrower focus because it did not detail the data sources used in each nation and did not place special emphasis on at-risk subgroups or particular populations for whom interventions should be most targeted. These restrictions point to a research void that calls for a current, thorough inquiry. They conducted a systematic review to determine the prevalence of HBV in the Nigerian community in order to address this. To develop specialized control and prevention strategies for HBV infections, updated national and subnational statistics are also required.

Age at which the host contracts the disease may be a determining factor in the rate at which the sickness will spread, hence Oluwole et al. (2019) evaluated the effect of age and gender on the transmission of any infectious disease. Their study's objective was to use data gathered from Lagos State, Nigeria, to predict the major impact of age and gender on the spread of the hepatitis B virus. The Nigeria Institute of Medical Research provided the ten years of data used in the study, which covered the years 2006 to 2015. (NIMR). Software written in the R programming language was used to implement a log-linear modelling strategy. The best model was chosen using the Akaike Information Criterion (AIC) method of model selection. The conclusion of the research indicated that age and gender both significantly influence the spread of hepatitis B infection. This implies that the age at which a person tests positive for the hepatitis B virus will have an impact on the disease's spread. Model AY: GY (age & year: gender & year), which was chosen as the best model out of the four generated models, was discovered to be the best model.

Pontius Bay et al. (2011) found out that 96.2% of 397 pregnant women between the ages of 13 and 43 were either married or living with a partner. 47 (11.8%) tested positive for HBsAg; of these, 7 (14.9%) were HBeAg positive. Additionally, it was discovered that women under the age of 20 had a higher rate of HBsAg positivity (20%) compared to those over 20 (8.7%), or=2.54 (95% CI 1.31 to 4.90).

III. Methodology

Nigeria has a population density of 226 persons per km2, making it one of the most populous nations in Africa. It is situated in West Africa on the Gulf of Guinea, between Benin and Cameroon, and has the biggest population in Africa, with almost 206 million people living there. 36 states and the Federal Capital Territory make up the federation of Nigeria, which is divided into six geopolitical zones. The case study is located in Ilorin, Kwara State, Nigeria. Kwara state is situated in North-central Nigeria. It is bounded by Benin to the west and by Niger to the north, Kogi to the east, and Ekiti, Osun, and Oyo to the south whereas, the University of Ilorin Teaching Hospital is a member of the nation's second generation of teaching hospitals which is situated at Ilorin, the State capital of Kwara State.

This research study employed both quantitative and qualitative data. The study was conducted over a three-year period, between 2019 and 2021, we tracked a total number of 4,364 patients who underwent hepatitis B testing at the hospital's laboratory during that time. The test results included information about each patient's age and sex, among other things.

Y is a binary variable. The outcome Y takes one of the two values

$$y = \begin{cases} 1 & with\ probability\ p \\ 0 & with\ probability\ 1-p \end{cases}$$

We modelled p as a function of the regressors X while there is no loss of generality in setting the outcome values to 1 and 0. The probability density function for the observed outcome Y is $p^y(1-y)^{1-y}$ with E(y) = p while the Var(y) = p(1-p).

The general regression model is given as:

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon \equiv X'\beta + \varepsilon \quad (1)$$

While the Probit model

$$P(Y = 1/X_1, X_2, \ldots X_k) = \Phi(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k) \quad (2)$$

The probability Density Function (PDF) of logistic distribution is given as:

$$fX(x) = \frac{e^{X'\beta}}{1 + e^{X'\beta}}, \quad where - \infty < x < \infty \quad (3)$$

The probability Density Function (PDF) of probit model is given as:

$$\Phi(X'\beta) = \int_{-\infty}^{X'\beta} \emptyset(z)dz \quad (4)$$

The models above were fitted using the data collected within the period under review using R software package.

IV. Data Analysis, Results and Discussion

Table 1 Gender Distribution

	FEMALE	MALE
Gender	**2050**	**2314**

Table 1 shows the gender distribution of patients tested for hepatitis B, we have 2314 males and 2030 females while figure 1 below presents the bar chart for the distribution.

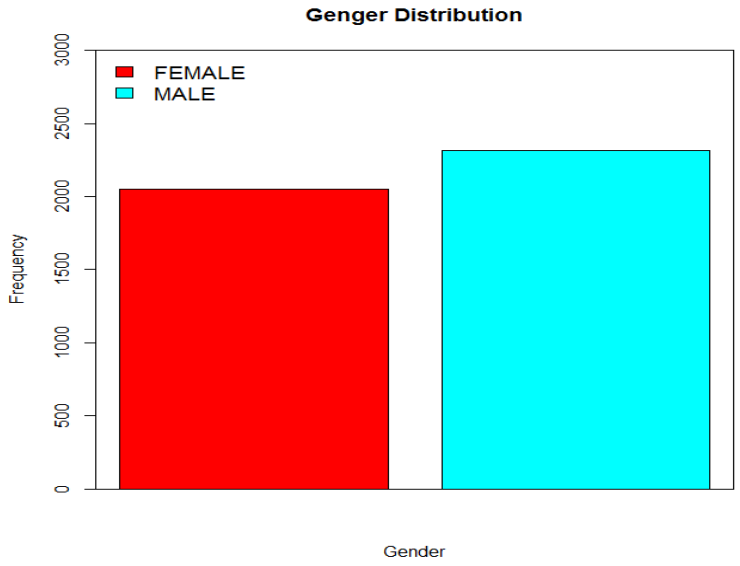

Table 2: Outcome Distribution

	Positive	Negative
Outcome	**1064**	**3300**

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

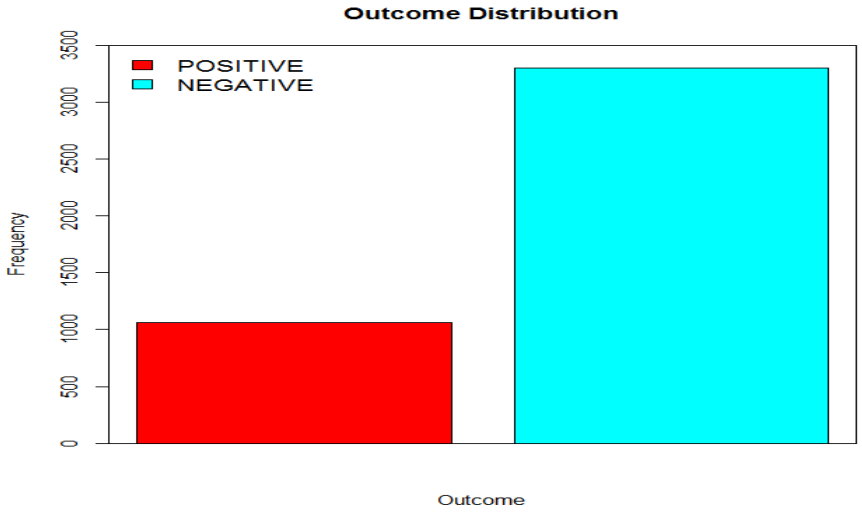

Figure 2

Table 2 above presented the outcome of the hepatitis B test. 24.38% of the tested population had positive results, whereas 75.63% had negative results. Figure 2 gave a pictorial illustration of the outcome

Table 3

Outcome/Sex	**FEMALE**	**MALE**
Negative	**1728**	**1572**
Positive	**322**	**742**

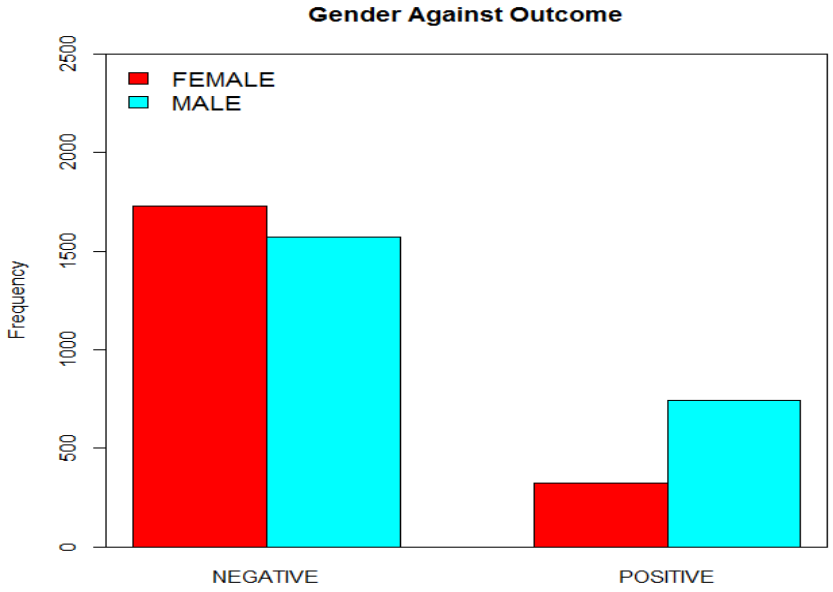

Figure. 3

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

Table 3 shows that 1728 and 1572 female and male patients tested negative to hepatitis B respectively, while, 322 females and 724 males tested positive for hepatitis B respectively. Figure 3 presented the multiple bar chart to the data.

Table 4: Age Distribution

S/N	CLASS INTERVAL	FREQUENCY
1	(0,10]	198
2	(10,20]	372
3	(20,30]	1162
4	(30,40]	1033
5	(40,50]	583
6	(50,60]	474
7	(60,70]	321
8	(70,80]	159
9	(80,90]	51
10	(90,100]	10
11	(100,110]	0
12	(110,120]	1

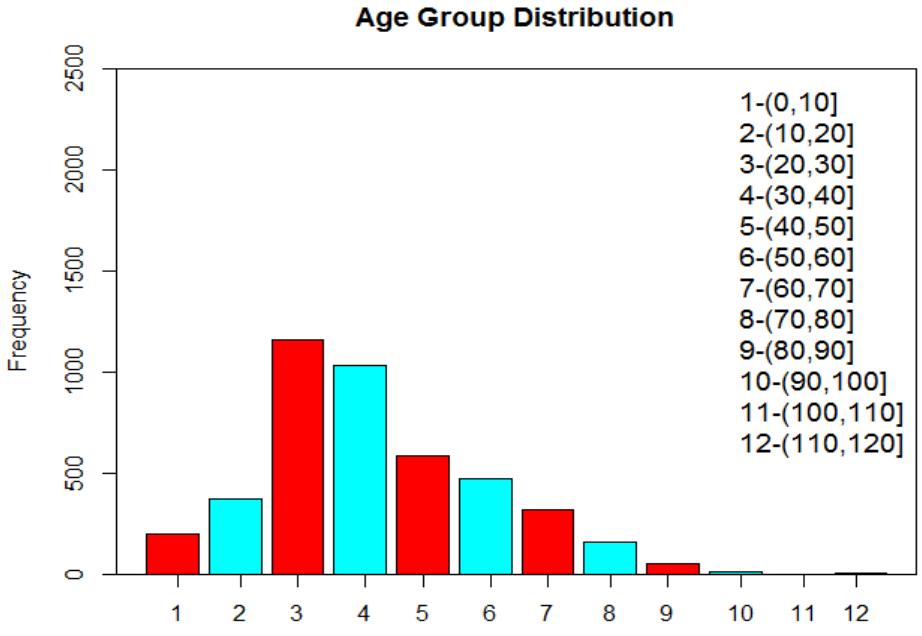

Figure 4: graphical representation of the Age distribution.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

Table 4 above shows the age and frequency of patients tested for hepatitis B. Patients between the ages of 20 and 30 had the highest frequency of 1162, while there were no patients in the age range of 100 to 110. The bar chart is presented in Figure 4 above.

Table 5: Logit Regression Model

Logit Model

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.0586	-0.6270	-0.5399	-0.4025	2.5117

Coefficients:

	Estimate	Std. Error	z value	Pr (>| z |)	Odd Ratio	95% C.I
(Intercept)	-1.036568	0.102194	-10.143	<2e-16 ***	0.3547	-1.2377187, -0.8370147
Gender	0.768222	0.083067	9.248	<2e-16 ***	2.1559	0.60548784, 0.9312116
AGE	-0.017728	0.001882	-9.421	<2e-16 ***	0.9824	-0.02145181, -0.0140732

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 3953.9 on 4363 degrees of freedom

Residual deviance: 3781.6 on 4361 degrees of freedom

AIC: 3787.6

Number of Fisher Scoring iterations: 4

Table 6: Probit Regression Model

Probit Model

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.0352	-0.6317	-0.5436	-0.3936	2.5821

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.631555	0.057085	-11.063	<2e-16 ***
Gender	0.426327	0.046749	9.119	<2e-16 ***
AGE	-0.010015	0.001025	-9.773	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 3953.9 on 4363 degrees of freedom

Residual deviance: 3780.3 on 4361 degrees of freedom

AIC: 3786.3

Number of Fisher Scoring iterations: 5

Table 7: Publication quality of the model

Sources	L/Estimates	P/Estimates	L/SE	P/SE	L/z score	P/ z score
Intercept	-1.036568	-0.631555	0.102194	0.057085	-10.143	-11.063
SEXMALE	0.768222	0.426327	0.083067	0.046749	9.248	9.119
AGE	-0.017728	-0.010015	0.001882	0.001025	-9.421	-9.773

The precision of the coefficient estimate is explained by the standard error column; it was discovered that gender and age standard errors are low for both logit and Probit model which indicates the accuracy of our estimates.

The Z- value that is sufficiently far from zero for sex (male) and age demonstrated that the coefficient estimate and the standard error ratio is statistically significant for both probit and logit estimates.

Table 8: Model Selection

Methods	Logit	Probit
LogLik	-1890.80	-1890.14
AIC	3787.586	3786.287

Table 9: Odds Ratio

	Logit Estimates	Probit Estimates	Logit Odds ratio	Probit Odds ratio
(Intercept)	-1.037	-0.632	0.3547	0.5318
SEX(MALE)	0.7682	0.4263	2.1559	1.5316
AGE	-0.018	-0.010	0.9824	0.9900

V. Discussion of Findings

The coefficients are presented in the log-odds form in the estimate column of logit regression model table, the estimate increases in gender by one unit while the expected change in the log-odds is 0.768222, signifying that hepatitis B is more likely to occur as gender increases. When age increases by one unit, the expected change in the log-odds is -0.017728, suggesting that hepatitis B is less likely to occur as age increases.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

The logit and probit estimates, the logit and probit standard error, and the Logit and Probit Z score from the publication quality model table, smaller standard error values were obtained for all coefficients in probit regression which revealed probit regression is more sensitive than logit regression showing the significant effects of the data set used, and also, the probit regression model outperforms the logit regression model in Log Likelihood and Akaike Information Criterion (AIC) because the probit regression model generates lower values for LogLik and AIC.

Furthermore, since the odd ratio for age is 0.9, it follows that the likelihood of having hepatitis B decreases by one with an increase in age. Additionally, the gender odd ratios of 2.1559 (for Logit) and 1.5315 (for Probit) show that male patients are two times more likely to have hepatitis B than the female patients.

VI. Conclusion

Hepatitis B is a potentially fatal cause of liver disease worldwide. Nigeria is currently recognized as having one of the highest rates of infection in all of Africa. The study was conducted over a three-year period (2019-2021), which translates to a total of 4,364 patients who underwent testing at the hospital's laboratory during that time. The data were fitted to both Probit and Logit models, and we choose the optimal model for the study using the Akaike Information Criterion (AIC) and Log Likelihood (LOG LIK).

The results showed that 24.38% of the population had positive results. We concluded that gender and age is statistically significant to the occurrence of Hepatitis B in Nigeria. Since Pr (>|z|) for gender and age = 2e-16 ***. It was discovered that the Probit model fits the data better than the Logit.

VII. Recommendations

The following recommendations are made based on the findings of this paper:

i. To reach the Sustainable Goal of eradicating hepatitis B by 2030, health professionals and the government of Nigeria should increase their awareness and education about how to prevent contracting the disease.
ii. The media (television, radio, newspapers, and social media) should sensitize the public about the need for precautions to be taken to avoid infection, the spread of the virus, and potential treatment requirements if tested positive for hepatitis B.

Acknowledgment

We want to specially appreciate the management of Kogi State Polytechnic, Lokoja and TETFUND Nigeria for given us the opportunity to make impact to the world research.

References

1. Andale (2015) Statistics how to, www.statisticshowto.com/akaike's information, statistic how to Sept 17, 2015.
2. Belo AC. Prevalence of hepatitis B virus markers in surgeons in Lagos, Nigeria. East Afr Med J. 2000;77(5):283–5.
3. Burnham, K. P., and D. R. Anderson. (2002). Model Selection and Multimodel Inference: a practical information-theoretic approach, 2nd edition. Springer Verlag, New York.
4. David W. Hosmer, Stanley Lemeshow (2000) Applied Logistic Regression, Second Edition, John Wiley & SON inc. New York.
5. De Martel C, Georges D, Bray F, Ferlay J, Clifford GM. Global burden of cancer attributable to infections in 2018: a worldwide incidence analysis. Lancet Glob Health. 2020;8(2):e180–90.
6. Federal Ministry of Health. National AIDS/STIS control program. 2016. https://www.hepb.org/assets/Uploads/Nigeria-Hepatitis-Guidelines-TX-guidelines.pdf. Accessed 29 Sept 2021.
7. Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2010 (GBD 2010) results by cause 1990–2010. Institute for Health Metrics and Evaluation (IHME). http://ghdx.healthdata.org/record/ihme-data/gbd-2010-results-cause-1990-2010. Accessed 5 Feb 2021.
8. Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2010 (GBD 2010) results by cause 1990–2010. Institute for Health Metrics and Evaluation (IHME). http://ghdx.healthdata.org/record/ihme-data/gbd-2010-results-cause-1990-2010. Accessed 5 Feb 2021.
9. Global Burden of Disease Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2013;385(9963):117–71.
10. Global Burden of Disease Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2013;385(9963):117–71.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue I, January 2023

11. Howell J, Lemoine M, Thursz M. Prevention of materno-foetal transmission of hepatitis B in sub-Saharan Africa: the evidence, current practice and future challenges. J Viral Hepatitis. 2014;21(6):381–96.
12. Indolfi G, Easterbrook P, Dusheiko G, Siberry G, Chang MH, Thorne C, et al. Hepatitis B virus infection in children and adolescents. Lancet Gastroenterol Hepatol. 2019;4(6):466–76.
13. International Agency for Research on Cancer. Cancers attributable to infections: age standardized rates (in Africa) per 100 000 individuals in 2018 attributable to infections (Hepatitis B virus), by country. https://gco.iarc.fr/causes/infections/tools-map?mode=1&sex=0&continent=1&agent=2&cancer=0&key=asr&scale=threshold. Accessed 29 Sept 2021.
14. Jacobs B, Mayaud P, Changalucha J, Todd J, Ka-Gina G, Grosskurth H, et al. Sexual transmission of hepatitis B in Mwanza, Tanzania. Sex Transm Dis. 1997;24(3):121–6.
15. Kramvis A, Kew MC. Epidemiology of hepatitis B virus in Africa, its genotypes and clinical associations of genotypes. Hepatol Res. 2007;37(s1):S9–19.
16. Musa BM, Bussell S, Borodo MM, Samaila AA, Femi OL. Prevalence of hepatitis B virus infection in Nigeria, 2000–2013: a systematic review and meta-analysis. Niger J Clin Pract. 2015;18(2):163–72
17. Ott JJ, Horn J, Krause G, Mikolajczyk RT. Time trends of chronic HBV infection over prior decades—a global analysis. J Hepatol. 2017;66(1):48–54.
18. Schweitzer A, Horn J, Mikolajczyk RT, Krause G, Ott JJ. Estimations of worldwide prevalence of chronic hepatitis B virus infection: a systematic review of data published between 1965 and 2013. The Lancet. 2015;386(10003):1546–55.
19. Scott. A Czepiel. Maximum Likelihood Estimation of Logistic Regression models. Theory and Implementation.
20. The Journey to hepatitis elimination in Nigeria. In: Hepatitis Foundation: media centre. 2020. https://www.hepb.org/blog/journey-hepatitis-elimination-nigeria/. Accessed 29 Sept 2021.
21. Vasisht A. k (2004), Logit and Probit Analysis, IASRI, Library Avenue, New Delhi – 110072 amitvasisht@lasri.res.in
22. World Health Organisation. Global health sector strategy on viral hepatitis, 2016–2021.
23. 2016. https://apps.who.int/iris/bitstream/handle/10665/246177/WHO-HIV-2016.06eng.pdf?sequence=1. Accessed 27 Jan 2021
24. World Health Organisation. Hepatitis B fact sheet. 2019. https://www.who.int/newsroom/factsheets/detail/hepatitis-b. Accessed 21 Mar 2021.
25. World Health Organisation. Hepatitis B key facts. 2021. https://www.who.int/newsroom/factsheets/detail/hepatitis-b. Accessed 29 Sept 2021.
26. World Health Organisation. Hepatitis. Sixty-seventh world health assembly. Agenda item 12.3. May 24, 2014. http://apps.who.int/gb/ebwha/pdf_files/wha67/a67_r6-en.pdf?ua=1. Accessed 18 Jan 2021.
27. World Health Organization (July 2016), fact sheet, www.who.int.org.
28. World Hepatitis Alliance. Find the missing millions: barriers to diagnosis global report. 2018.