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Research Article

Modelling Cancer Risk Factors for Vital Topographies in the South Western States of Nigeria

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Keywords

- Cancer
- Oncology
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Abstract

This study models some risk factors for some topographies of cancer in South West of Nigeria (Osun, Ondo, Ogun, Ekiti, Oyo and Lagos states). Data on various topographies of cancer are collected by transcription from cancer registry and patients' case note of different hospitals (teaching hospitals and medical centres) across the six states. Binary logistic regression is used for modelling and probability of a patient suffering for a typical cancer is obtained with all the significant risk factors identifies in each model. Due to insignificant of frequency observed for Prostate, Rectum, and Pancreas, only models for Breast, Cervix, Colon, and Ovarian cancers are examined. Age, Marital Status, Age at first Menstruation, Use of Birth Control Pill, Consumption of High Fat Diet, Alcohol, Obesity and having multiple sexual partners are all significant factors for breast cancer. Age at first Menstruation and Consumption of High Fat Diet are the most significant factors at 5% level. Significant risk factors for cervical cancer based on the result of analyses are: Religion, Job, and Age at first Menstruation while Age, Marital Status, and Educational Status are significant factors for colon cancer. For ovarian cancer, significant risk factors are Educational Status, Residence (Urban or Rural), and Age at first menstruation, and Obesity.

INTRODUCTION

Report [1] revealed that about 14.1 million new cancer cases excluding skin cancer occur a year with about 8.8 million deaths which is approximately 15.7% of human deaths [2]. Cancer has been predicted [3] to be an important cause of morbidity and mortality in the next few decades, especially in low and middle-income countries (mostly in Africa). It belongs to a group of diseases that involve abnormal cell growth with the possibility of spreading to different location in the body [4]. It forms a set of neoplasm's (tumor) which is a group of cells with unregulated growth and often form a mass or lump, but may be distributed diffusely [5,6]. These tumors show various hallmark of cancers which are required to produce a malignant tumor. These include:

- Cell growth and division absent the proper signals
- Continuous growth and division even given contrary signals
- Limitless number of cell divisions
- Promoting blood vessel construction
- Avoidance of programmed cell death
- Invasion of tissue and formation of metastases [7]

In report by [8], Nigeria in the last few years is witnessing a tsunami in cancer incidence with about 102,000 new cases per annum along with the mortality rates of about 75,000 deaths per annum. This is largely due to associated problems with cancer care in the country and the general neglect of the country's health care system. In descending order of frequency [9] showed the following cancers: breast, cervical, prostate, liver, and colorectal are prominent in Nigeria while [8] reported that prostate and liver cancers are most common in males while breast and cervical cancer are the most frequent ones in females. There are over 50 million women whose ages are 15 years and above in Nigeria with record showing over 14,000 of them diagnosed with cervical cancer on yearly basis and over 8,000 recorded deaths [10].

PROBLEM OF CANCER IN NIGERIA

Little is still being done in area of diagnosis and treatment of cancer in Nigeria. This is largely due to lack of well-equipped personnel (oncologists); finances and modern equipment [11]. There is still no known any national policy on cancer in the country apart from various non-governmental organizations usually run by wives of political office holders. Among several other factors militating against cancer in Nigeria are poverty, poor health management, ignorance, and illiteracy [8,12,13].

While assessing the knowledge, attitudes, and practices of women concerning breast cancer in Jos and environs [14] reported that about half of 395 respondents do not have knowledge of signs and symptoms of breast cancer with majority of them having no idea of initiating self-breast examination.

In Nigeria, survival rate of cancer is next to nothing and cancer diagnosis is taken as death sentence. Data on cancer survival is mostly nonexistence and most of diagnosed patients prefer seeking spiritual assistance when they run out of cash for prescribed treatment. Most of the oncology departments of various teaching hospitals lack up-to-date record on cancer register. Those that use Can Reg (A cancer registry software provided by WHO) usually have several unknown cases in various records. Patients are usually found of reneging from treatment, making it difficult to have complete record on their treatment progression.

Another major problem militating against cancer in Nigeria is cancer registration. There is no National Cancer Registration till date in Nigeria though early attempt in 1990's-early 2000's were unsuccessful. Since infectious diseases pose immediate and more disturbing challenges, cancer is not yet a priority of the Health Ministry in the country [15]. Cancer control and monitoring receives next to nothing in budgetary allocation at all levels of Government. There is also no coordinated cancer registration in various states of the federation. Lack of adequate resource also limits access of patients to health facilities. Another challenge facing cancer registration in the country is inadequate trained personnel like epidemiologists, oncologists, and health record officials.

THE STUDY AREA

Nigeria has a total surface area of 923,768 km^2. The study area is South-Western region of Nigeria (Figure 1). South-western Nigeria consists of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti states. The area lies between longitude $2^{\circ}31^{1}$ and $6^{\circ}00^{1}$ East and Latitude $6^{\circ}21^{1}$ and $8^{\circ}37^{1}$N with a total land area of 77,818 km^2. The study area is bounded in the East by Edo and Delta states, in the North by Kwara and Kogi states, in the West by the Republic of Benin and in the south by the Gulf of Guinea.

RESEARCH DATA

Data used in this study were collected from cancer registry and patients' case note of different hospitals (teaching hospitals and medical centres) across the six states of the South-West of Nigeria. Risk factors examined are Age, Sex (66 males and 510 females), Marital Status, Educational Status, Residence, Religion, Nature of Job, Age at first of menstruation, Use of Birth Control Pills, Consumption of high fat diet, Alcohol, Physical Exercise, Obesity before diagnosis, Smoking, Number of Sexual Partner, Sexual Activities. Cancer topographies examined are limited to Breast, Cervix, Prostrate, Colon, Rectal, Ovarian, and Pancreatic. The age of the respondents are categorised as less than 35 years, 35–39, 40–44, 45–49, and 50 and above. Marital Status are categorised as Single, Married, Divorced, Separated and Widow. Respondents' residences are grouped as Rural and Urban.

METHODOLOGY

Most common method to analyse binary response data is the Logistic regression. It is used to model relationships between the response variable and several explanatory variables, which may be discrete or continuous. This is used for the situation where the response (Y) can only take one of two possible values usually alive/dead, or present/absent in practice. Logistic regression is useful in situations where the interest is to predict the presence or absence of a characteristic or outcome based on values of a set of predictor variables. This situation also arises frequently in medical trials, where at the end of the trial period, the patient has either recovered or has not. It is convenient to denote the two levels by 0 and 1 and to refer to the categories as a "failure" or a "success". Statistical software used is STATA version 12 and SPSS IBM version 22. STATA especially was employed in the analysis due its enormous ability to accept external epidemiological plug ins to carry out some important calculations and creation of vital tables of results from statistical tool used, and SPSS for ease of coding. In order to ease the various computations necessary before obtaining the result, the response variables were made to have categories of two levels (dichotomous), hence the use of logistic regression to model the data.

Logistic regression model

To fit a binary logistic regression model, a set of regression coefficients that predict the probability of the outcome of interest are estimated. The same logistic model can be written in different ways. The version that shows what function of the probabilities results in a linear combination of parameters is

$$In\left(\frac{prob(event)}{1-prob(event)}\right)=\beta_0+\beta_1X_1+\beta_2X_2+\ldots+\beta_KX_K\ldots. \quad (1)$$

The log is the log of the odds that an event occurs. The odds that an event occurs are the ratio of the number of people who experience the event to the number of people who do not. This is obtained when the probability that the event occurs is divided by the probability that the event does not occur.

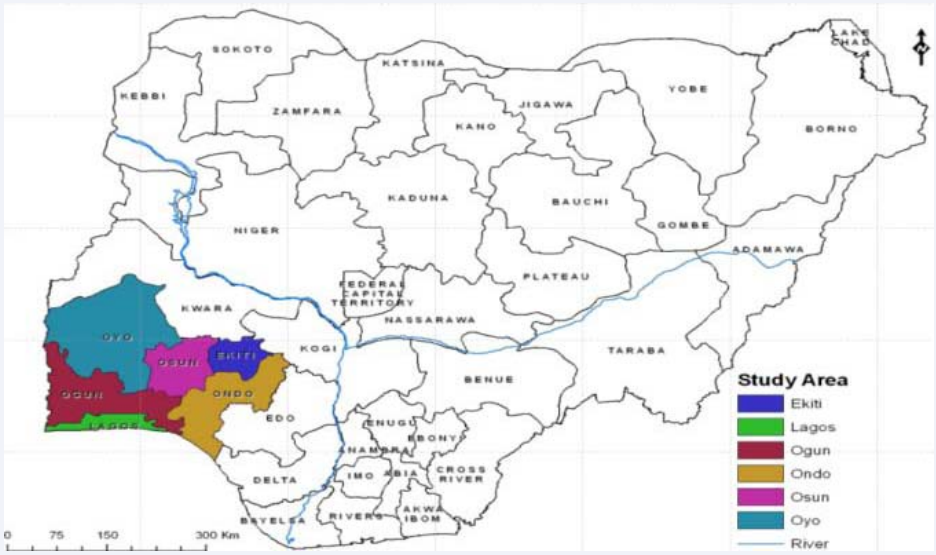

Figure 1 Map of Nigeria showing the study areas.

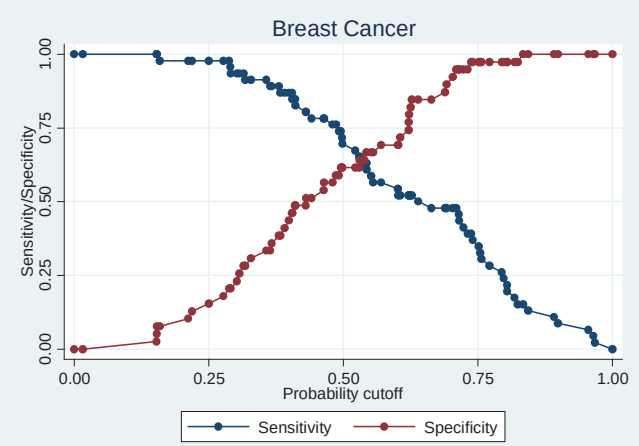

Figure 2 Sensitivity and specificity by predicted probability.

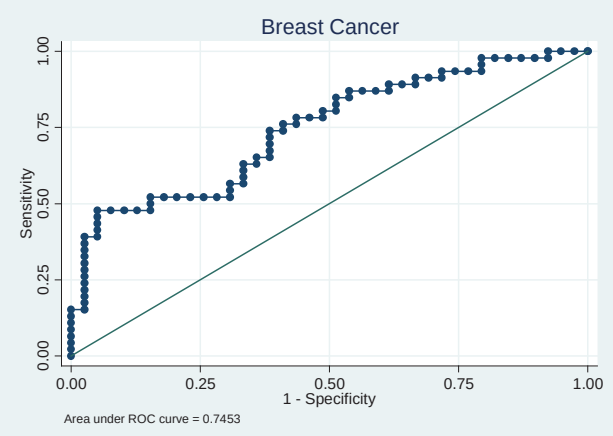

Figure 3 ROC curve for the best model.

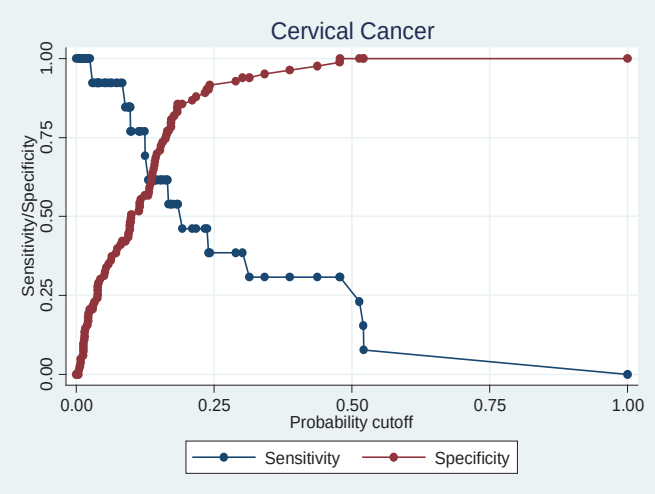

Figure 4 Sensitivity and specificity by predicted probability.

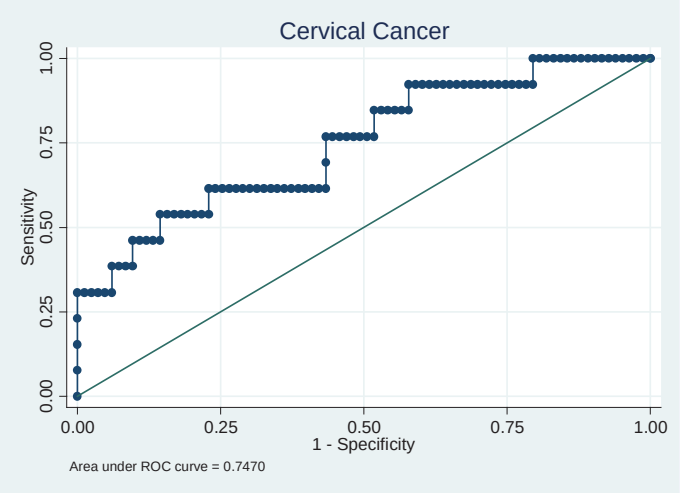

Figure 5 ROC curve for the best model.

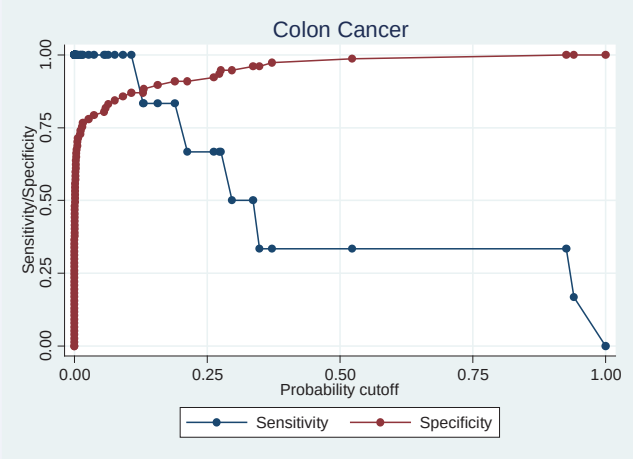

Figure 6 Sensitivity and specificity by predicted probability.

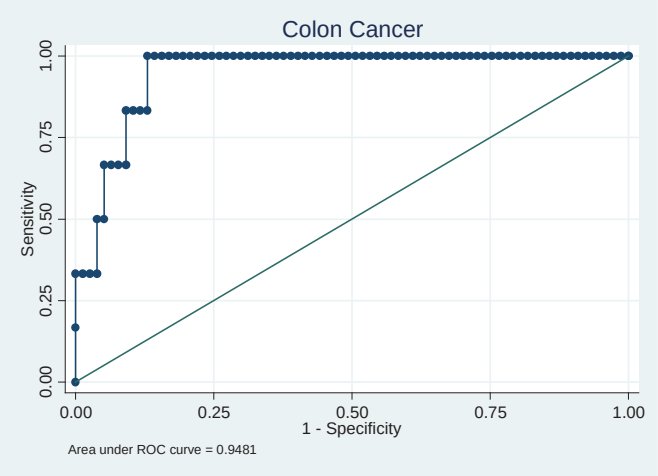

Figure 7 ROC curve for the best model.

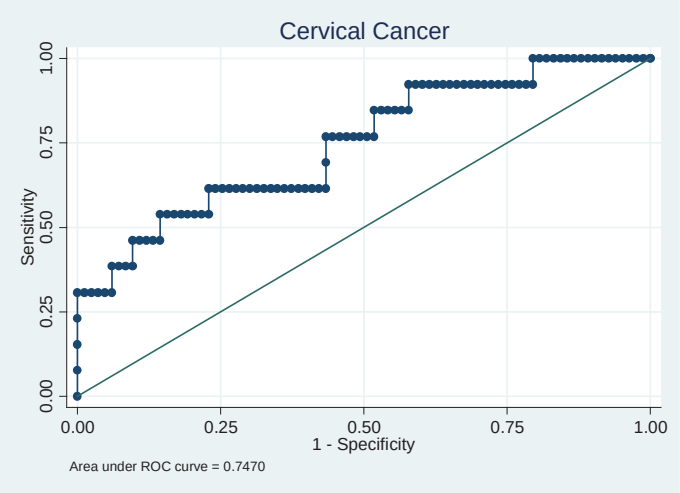

Figure 8 Sensitivity and specificity by predicted probability.

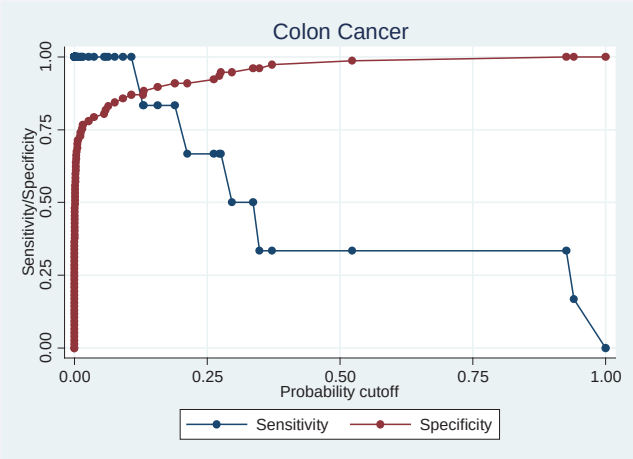

Figure 9 ROC curve for the best model.

The general linear logistic regression model is defined as:

$$\log\left(\frac{\pi_i}{1-\pi_i}\right) = \log it(\pi_i) = \beta_{i0} + \beta_{i1}x_{i1} + \ldots + \beta_{ip}x_{ip} \ldots \quad (2)$$

Where x_{i1}, x_{i2}, x_{ip} are continuous measurements corresponding covariates and/or dummy variables corresponding to factor levels and $\beta_{i0} + \beta_{i1}x_{i1} + \ldots + \beta_{ip}x_{ip}$ are the parameters.

$$\pi_i = \frac{e^{\left(\beta_{i0} + \beta_{i1}x_{i1} + \ldots + \beta_{ip}x_{ip}\right)}}{1+e^{\left(\beta_{i0} + \beta_{i1}x_{i1} + \ldots + \beta_{ip}x_{ip}\right)}} = \frac{1}{1+e^{-\left(\beta_{i0} + \beta_{i1}x_{i1} + \ldots + \beta_{ip}x_{ip}\right)}} \ldots \quad (3)$$

π_i is the probability the i[th] case experiences the event of interest.

x_{ip} is the j[th] predictor for the i[th] case

P is the number of predictors

RESULTS

In this research, logistic regression is used to model various characterised risk factors for cancer topography. The intent is to know how significant these factors are on various forms of cancer. All observed factors are modelled for each form of cancer.

Due to insignificant of frequency observed for Prostate, Rectum, and Pancreas, only models for Breast, Cervix, Colon, and Ovarian cancers are examined.

The classification table for cross tabulations of Table 1 shows the values of the sensitivity and specificity of 67.39% and 71.54% respectively, and the percentage of correct classification is 64.71%. The area under the ROC curve is 0.7453 (74.53%) which is a strong predictive power.

From the Table 2, Age, Marital Status, Age at first Menstruation, Use of Birth Control Pill, Consumption of High Fat Diet, Alcohol, Obesity and having multiple sexual partners are all significant factors for breast cancer. The odds ratio is the ratio-change in the odds of the event of interest for a one-unit change in the predictor. For example, in the Table 2, the odds for Consumption of high fat is 2.410, which means that the odds of default for a person who consumes high fat diet to have breast cancer is 2.410 times the odds of default for a person who does not consume such diet, all other things being equal. Based on the result obtained in Table 2 above, the probability that a patient will be diagnosed of Breast Cancer is expressed as:

$$p = \frac{1}{1+e^{-\left(\begin{array}{l}-43.059 + 0.316Age + 21.759Sex - 0.346Marital_{status} - 0.184Edu_{stat} + 0.182\,\mathrm{Re}\,sid - 0.127\,\mathrm{Re}\,ligion + 0.096Job \\ -0.953Menses + 0.601Pills + 0.879High_{fat} + 0.969Alcohol + 0.004Exercise - 1.320Obesity - 0.755Sex_{partner} + 0.262Sex\_Active\end{array}\right)}}$$

The figures show the specificity and sensitivity (Figure 2) of the classification table that produced Table 2 and the ROC curve for the cut-off point (Figure 3). It reveals that the greater percentage of those correctly classified (sensitivity and specificity) is above the cut-off 0.5.

Classification table for the cross tabulation of Table 3 shows the values of the sensitivity and specificity of 23.08% and 100.00% respectively while there is 89.58% of correct classification. The ROC curve is 0.7470 (74.70%) which is a strong predictive power. Significant risk factors for cervical cancer based on the result of Table 3 above are: Religion, Job, and Age at first Menstruation. It can also be observed from the Table 4 above that for example, the odds for Number of sexual partners and cervical cancer is 1.606, this implies that the odds of default for a person who has more than 1 sexual partners to have cervical cancer is 1.606 times the odds of default for a person who has only one person, all other things being equal. The probability that a patient will be diagnosed of Cervical Cancer can is obtained as:

$$p = \frac{1}{1+e^{-\left(\begin{array}{l}-0.669 + 0.032Age + 0.596Sex - 0.021Marital_{status} - 0.098Edu_{stat} + 0.011\,\mathrm{Re}\,sid + 0.855\,\mathrm{Re}\,legion - 0.185Job \\ +0.631Menses + 0.014Pills - 2.097High_{fat} - 1.074Alcohol - 0.290Exercise \pm 1.326Obesity + 0.474Sex_{partner} + 0.103Sex\_Active\end{array}\right)}}$$

The figures show the specificity and sensitivity (Figure 4) of the classification table that produced Table 3 and the ROC curve for the cut-off point (Figure 5). It reveals that the greater percentage of those correctly classified (sensitivity and specificity) is above the

Table 1: Frequency distribution for various topographies of cancer examined.

Topography	Frequency	Percent
Breast	276	47.9
Cervix	78	13.5
Prostrate	18	3.1
Colon	36	6.3
Rectal	24	4.2
Ovarian	60	10.4
Pancreatic	24	4.2
others	60	10.4
Total	576	100.0

Table 2: Breast cancer as a response variable.

Risk Factors	Coefficient	S.E.	Sig.	Odds Ratio
Age	0.316	0.105	0.003	1.371
Sex	21.759	4689.288	0.996	2.817E9
Marital Status	-0.346	0.102	0.001	0.708
Educational Status	-0.184	0.112	0.100	0.832
Residence	0.182	0.215	0.398	1.199
Religion	-0.127	0.234	0.588	.881
Job	0.096	0.069	0.161	1.101
Age at first Menstruation	-0.953	0.203	0.000	0.385
Use of Birth Control Pill	0.601	0.230	0.009	1.823
Consumption of High Fat Diet	0.879	0.247	0.000	2.410
Alcohol	0.969	0.316	0.002	2.635
Physical Exercise	0.004	0.234	0.986	1.004
Obesity	-1.320	0.273	0.000	0.267
No of sexual partners	-0.755	0.279	0.007	0.470
Sexual activities	0.262	0.178	0.142	1.299
Constant	-43.059	9378.576	0.996	0.000
BIC = 691.1085 Prob> chi2=0.0000 Pseudo R^2 =0.1506 -2 Log likelihood = 597.592				

Table 3: Cervical cancer as a response variable.

Risk Factors	Coefficient	S.E.	Sig.	Odds Ratio
Age	0.032	0.135	0.814	1.032
Sex	0.596	0.582	0.306	1.814
Marital Status	-0.021	0.144	0.885	0.979
Educational Status	-0.098	0.155	0.530	0.907
Residence	0.011	0.291	0.970	1.011
Religion	0.855	0.266	0.001	2.352
Job	-0.185	0.100	0.065	0.831
Age at first Menstruation	0.631	0.268	0.019	1.879
Use of Birth Control Pill	0.014	0.324	0.966	1.014
Consumption of High Fat Diet	-2.097	0.508	0.000	0.123
Alcohol	-1.074	0.317	0.001	0.342
Physical Exercise	-0.290	0.320	0.366	0.748
Obesity	0.326	0.361	0.367	1.385
No of sexual partners	0.474	0.275	0.085	1.606
Sexual activities	0.103	0.245	0.675	1.108
Constant	-0.669	2.693	0.804	0.512
BIC = 489.9904 Prob> chi2 = 0.0000 Pseudo R^2 = 0.1500 -2 Log likelihood = 388.2927				

Table 4: Colon cancer as a response variable.

Risk Factors	Coefficient	S.E.	Sig.	Odds Ratio
Age	-2.132	1.064	0.045	0.119
Sex	-3.309	3.470	0.340	0.037
Marital Status	3.075	1.096	0.005	21.657
Educational Status	-1.409	0.785	0.073	0.244
Residence	-3.024	1.969	0.125	0.049
Religion	-0.143	1.393	0.918	0.867
Job	0.023	0.402	0.955	1.023
Age at first Menstruation	-1.179	1.060	0.266	0.307
Use of Birth Control Pill	4.586	2.652	0.084	98.093
Consumption of High Fat Diet	-0.776	1.405	0.581	0.460
Alcohol	20.999	4487.065	0.996	1.318E9
Physical Exercise	1.905	1.466	0.194	6.720
Obesity	0.725	1.783	0.684	2.065
No of sexual partners	-2.010	2.616	0.442	0.134
Sexual activities	0.900	1.037	0.386	2.460
Constant	-59.916	13461.197	0.996	0.000
BIC = 216.1168 Prob> chi2 = 0.0000 Pseudo R^2 = 0.5243 -2 Log likelihood = 122.9578				

Table 5: Ovarian cancer as a response variable.

Risk Factors	Coefficient	S.E.	Sig.	Odds Ratio
Age	0.550	0.549	0.316	1.734
Marital Status	0.350	0.431	0.417	1.419
Educational Status	1.614	0.536	0.003	5.022
Residence	2.580	1.092	0.018	13.203
Religion	-2.398	1.446	0.097	0.091
Job	0.186	0.310	0.547	1.205
Age at first Menstruation	5.528	1.443	0.000	251.660
Use of Birth Control Pill	-0.715	0.846	0.398	0.489
Consumption of High Fat Diet	-0.459	0.890	0.606	0.632
Alcohol	18.666	4957.302	0.997	1.278E8
Physical Exercise	-0.640	1.002	0.523	0.527
Obesity	7.238	2.602	0.005	1391.883
No of sexual partners	0.309	1.015	0.761	1.362
Sexual activities	1.332	0.766	0.082	3.787
Constant	-132.174	19467.214	0.995	0.000
BIC = 263.6217Prob> chi2 = 0.0000 Pseudo R^2 = 0.5019 -2 Log likelihood = 177.7238				

cut-off 0.5.

For the classification of data for Table 4, the values of the sensitivity and specificity of 33.33% and 98.70% respectively, and there is 93.98% of correct classification with the ROC curve is 0.9481 (94.81%) which is a strong predictive power.

Table 4 gives significant risk factors for colon cancer as: Age, Marital Status, and Educational Status. The table also revealed for example that, the odds for a married person is 21.657, this implies that the odds of default for a person who is married to have cervical cancer is 21.657 times the odds of default for a person who is not, all other things being equal. The probability that a patient will be diagnosed of Colon Cancer is:

$$p = \frac{1}{1+e^{-\left(\begin{array}{l} -59.916 - 2.132Age - 3.309Sex + 3.075Marital_{status} - 1.409Edu_{stat} - 3.024\,\mathrm{Re}\,sid - .143\,\mathrm{Re}\,ligion + 0.023Job \\ -1.179Menses + 4.586Pills - 0.776High_{fat} + 20.999Alcohol + 1.905Exercise + 0.725Obesity - 2.010Sex_{partner} \\ +0.900Sex\_Active \end{array}\right)}}$$

Figure 6 shows that greater percentage of those correctly classified (sensitivity and specificity) is above the cut-off 0.5 while the ROC curve Figure 7 shows that all observed points are above the cut-off point.

Classification table for the reports obtained in Table 5 shows the values of the sensitivity and specificity of 70.00% and 98.51%

respectively with 94.81% of correct classification and a strong predictive power (ROC) of 92.69%. Table 5 shows that significant risk factors for ovarian cancer: Educational Status, Residence (Urban or Rural), and Age at first menstruation, and Obesity. The table also revealed for example that, the odds for someone who starts menstruation earlier in life is 251.660, this implies that the odds of default for a person who starts menstruating early is 251.660 times the odds of default for a person who does not, all other things being equal. The probability that a patient will be diagnosed of Ovarian Cancer can be is obtained as:

$$p = \frac{1}{1+e^{-\left(\begin{array}{l} -132.174 + 0.550Age + 0.350Marital_{status} + 1.614Edu_{stat} + 20580\,\mathrm{Re}\,sid - 2.398\,\mathrm{Re}\,ligion \\ +0.186Job + 5.525Menses - 0.715Pills - 0.459High_{fat} + 18.666Alcohol \\ -0.640Exercise + 7.238Obesity + 0.309Sex\_Partner + 1.332Sex\_Active \end{array}\right)}}$$

Figure 8 shows that greater percentage of those correctly classified (sensitivity and specificity) is above the cut-off 0.5 while the ROC curve Figure 9 shows that all observed points are above the cut-off point.

DISCUSSION

The results from the various analyses carried out show that the risk factors determining the topographies of cancer on human differ. Since most of the cases handled are breast, cervix, colon, and ovarian cancers, it behaves the researchers to model the ones most reported in order to give room for concise prediction of probability of having a case or not having it. Almost all the factors considered are significant for breast cancer, though the odd ratios give more information on the significant factors. The specificity, sensitivity and predictability of the tests are presented in Figures 2-9, show various reliability of all the tables of cancers' topography. Also the ROC curve was used for determination of the cut-off point and the largest area occupied.

CONCLUSION

From various analysis carried out, obtained results indicate that Age, Marital Status, Age at first Menstruation, Use of Birth Control Pill, Consumption of High Fat Diet, Alcohol, Obesity and having multiple sexual partners are all significant factors for breast cancer. Most of these factors have earlier been identified by [16]. Other reported risk factors for breast cancer by [17,18] include westernized diet, low fibre intake, family history of breast cancer and presence of benign breast disease. For cervical cancer significant risk factors are: Age at first Menstruation and Consumption of High Fat Diet while Religion, Job, and Age at first Menstruation are significant factors for cervical cancer. For colon cancer, Age, Marital Status, and Educational Status are significant risk factors and Educational Status, Residence (Urban or Rural), Age at first menstruation, and Obesity are significant for ovarian cancer.

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