

A 35-year standardized prediction estimates for gynecological lesions in oil and gas exploration and production city in the Niger Delta

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ABSTRACT

Background: The impact of constant emission of hydrocarbons and contaminated water level through oil spillage in the oil and gas exploration and production areas of Niger Delta on women's health cannot be underestimated. We developed a 35-year standardized prediction estimates for gynecological lesions using data obtained from an integrated specialist hospital serving the residence of the oil and gas exploration and production City of Port Harcourt and the surrounding areas of Niger Delta, Nigeria.

Methods: The study participants comprised of 697 females who received medical care at the Braithwaite Memorial Specialist Hospital (BMSH), Port Harcourt, Rivers State, Nigeria, between 2010 and 2014. Predictive modeling of the diseases was performed using JMP statistical discovery™ software, version 12.0 (SAS Institute, Cary, NC, USA).

Results: The distribution of the gynecological lesions ($n = 697$) differed significantly ($P < 0.001$) by year of diagnosis, developmental stage, age category, and types of lesion. The mean age of study participants was 39.1 ± 12.8 years, and most of the lesions (61.8%) occurred among females who were 30- to 49-year old. Leiomyoma recorded the highest 5-year standardized prevalence rate of 0.508, and with no intervention, it is estimated that the number of cases diagnosed will rise from 235 in 2015 to 1883 by the year 2050. This was followed by ovarian cyst with a prevalence rate of 0.124 and projected increase from 57 in 2015 to 461 by the year 2050. Similarly, the product of conception is also estimated to increase from 34 to 277 by the year 2050.

Conclusion: The over 700% increased prediction of gynecological lesions by 2050 calls for urgent attention by both governmental and private agencies to fund awareness campaigns and screenings for women, especially for those residing in the oil- and gas-producing areas of Niger Delta.

Key words: Gynecological lesions; Niger Delta; Nigeria; prediction estimates.

Introduction

With the rapid growth in population, prediction models and forecasts have become more important in our localities.^[1] Over the next 50 years, gynecological lesions are projected to change due to population growth, which is one of the largest contributors to the increasing total

number of gynecological cases.^[2,3] The world population as at 2015 was 7.3 billion and Nigeria population was

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put at 183.5 million; this number is expected to increase to 9.7 billion and 440 million in the world and Nigeria, respectively, by 2050.^[4-6]

The recent alarm on rising global incidence of lesions by the World Health Organization (WHO) should worry African countries, including Nigeria. Cancer killed 7.6 million persons in 2008 worldwide, and there is indication that the figure could double to 13 million by 2030.^[7] Cancer accounts for 13% of all deaths registered globally and 70% of that figure occurred in middle- and low-income countries.^[8] It is on record that about 10,000 cancer deaths occurs annually in Nigeria,^[9] whereas 250,000 new cases are recorded yearly with two-third of the deaths and new cancer cases recorded being as a result of shortage of functional cancer control programs in Nigeria.^[9]

Since gynecological lesions frequently occur in relatively younger women, its toll in reducing life span is considerable. There have been concerns worldwide and especially in the developing countries because of the significant contribution of these conditions on morbidity and mortality.^[10,11] Data on gynecological lesions in some developing countries show a preponderance of cancer of the cervix.^[12,13] Cervical carcinoma in developing countries accounts for 80% of the estimated 231,000 deaths that occurred from it annually.^[14-17] The incidence and prevalence of other female genital lesions vary from one geographical region to another.^[18] The wide global variation in incidence indicates that the impact of the various gynecological lesions would be much reduced by application of current knowledge of populations with high-incidence and death rates in any planned intervention efforts.

In the Niger Delta of Nigeria, where oil exploration and extraction take place, oil spills have extensively contaminated the landscape, polluted the soil and water with toxins, and are believed to have severe health effects on the inhabitants of the area. Although there have been series of studies to access the impacts on the environment,^[19-21] little is known about the possible health effects on the people living near the contamination, especially women, most of who derive their livelihood from farming and fishing. However, there has been evidence in Nigeria and Kuwait that the burning of hydrocarbons has led to cancer, especially of the lungs.^[22] This finding, however, remains inconclusive as the claims are not sufficiently supported. In order to get to the root of the health problems in the Niger Delta region of Nigeria, it is important to identify the common types of gynecological lesion and their prevalence rates from a major specialist hospital that provides comprehensive healthcare services to inhabitants of the metropolitan city of Port Harcourt

and the surrounding oil-producing rural areas. Models help make the most of limited data in the face of the challenges. Although modeling has become an important ally in our attempts to project future occurrence of diseases and can have a significant impact on our distribution of resources for purposes of control and prevention, much of this approach have not been effectively exploited in Nigeria and other developing countries. Knowledge of this information could form the basis for a comprehensive research study that may help identify the risk factors associated with the health of the inhabitants of the area and lay ground work for the implementation of disease control and prevention measures. This pilot study was aimed at determining the epidemiology of gynecological lesions among residents of an oil city in the Niger Delta region, and to use the data obtained to develop standardized prediction estimates for the diseases in 35-year time (2015–2050).

The objectives of this study were to determine the prevalence of gynecological lesions in Braithwaite Memorial Specialist Hospital (BMSH), Port Harcourt, Rivers State, Nigeria, and to use the information obtained to develop standardized prediction estimates for these lesions in 35-year time (2015–2050).

Methods

Study area and data source

Braithwaite Memorial Specialist Hospital (BMSH) was established in 1925. It is a government-owned hospital, named after a British doctor Eldred Curwen Braithwaite. It is in the old Government Reserved Area (Old GRA) in Port Harcourt, Rivers State, Nigeria. The hospital initially served as a medical facility for senior civil servants, later became a General Hospital and presently is a major Specialist Health Hospital with the mandate to deliver comprehensive healthcare services to the metropolitan city of Port Harcourt and the surrounding oil-producing rural areas of Rivers State and the Niger Delta region of Nigeria.

Rivers State is one of the six states that make up the South-South geopolitical zone of Nigeria. Rivers State lies at latitude 4°45' north and longitude 6°50' east and covers an area of 10,432.3 km². As of 2010, the state had a population of 5,198,716 million with a density of 468 people/km² and represented 3.7% of Nigeria's total population. Port Harcourt is the capital of Rivers State and one of Nigeria's leading industrial centers. The City lies at latitude 4°47'21" north and longitude 6°59'55" east, with a population of 1,382,592 million.

The natives of Rivers State are mainly farmers and fishermen, and they speak >23 main languages. The State

is known as the *treasure base of Nigeria* due to its abundant oil and gas resources. Oil explorations in Rivers State began in 1956, and since then, there has been a paradigm shift in the occupation and life style of the natives resulting from reckless environmental pollution and industrialization. There is very little data quantifying the oil's impact on the health of people whose property, crops and livestock, drinking water, and air are polluted by oil, waste products from exploration and extraction, and extensive waste gas flaring.

Data collection

Six hundred and ninety-seven ($n = 697$) gynecological lesion data were obtained from the archives of Histopathology Laboratory of BMSH. The data represent the number of females who received medical care including histopathological evaluation at the BMSH from 2010 to 2014 [Figure 1].

Diagnosis of gynecological lesions

The data used for this study were based on lesions identified through histopathology screening by qualified pathologists and analyzed using the methods of Onyije *et al.*^[23] The major lesions identified include the following: adenocarcinoma, adenoma, adenomyosis, cervical polyp, chronic endometritis, cervical intraepithelial neoplasia, condyloma acuminatum, endometrial hyperplasia, endometrial polyp, leiomyoma, ovarian cyst, products of conception, and squamous cell carcinoma. Other minor lesions identified and classified under "others" in our study include the following: basal cell epithelioma, Brenner tumor, cervical cyst, chronic endocervicitis, chronic vulvitis, endometrial carcinoma, epidermal cyst, fibroma, hemangioma, ovaritis, batholin's cyst, vulval warts, vulvitis and yolk sac tumor (hepatoid variant). These lesions occurred very rarely and therefore were grouped for statistical convenience.

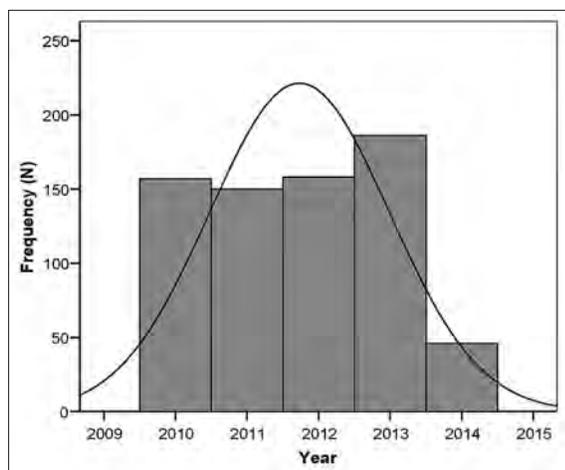


Figure 1: Distribution of number of gynecological lesions by year of diagnosis

Statistical analysis

Preliminary analyses involved the descriptive statistics and frequency runs for the dependents and independent variables. Subsequently, to determine the relationships between the number of gynecological lesions occurring over the years, multiple linear regression analysis was conducted using the Fit Model and represented by the following prediction equation: $\hat{y}_i = \beta_0 + \beta_1[\text{year}]_i + \beta_2 [\text{Match...Lesion}]_i + \varepsilon_i$, where \hat{y}_i is the predicted or expected value of the dependent (response) variable for the i^{th} observation; β_0 is the intercept parameter, which correspond to the value of the response variable when the predictor is 0; β_1 represents the change in the response variable given one-unit change in the predictor variable, year; β_2 represents the change in the response variable given one-unit change in the second predictor variable, i^{th} match lesion diagnosed; and ε_i is an error term representing deviation of the line defined by $\beta_0 + \beta_1[\text{year}] + \beta_2 [\text{Match... Lesions}]$. Data management, statistical analysis, and predictive modeling were performed using JMP statistical discovery™ software, version 12.0 (SAS Institute, Cary, NC, USA).

Ethical approval

Ethical approval was granted by the ethics committee of BMSH through the Hospitals Management Board of Rivers State, Nigeria.

Results

Characteristics of sample population

The characteristics of the sample population used in the current study have been presented in detail elsewhere.^[24,25] In summary, a total of 697 gynecological lesions were diagnosed in the sample population with the majority ($n = 689, 98.9\%$) occurring at the adults' stage. The mean age of the participants studied was 39.1 ± 12.8 years and most of the gynecological lesions (61.8%) were identified among females who were aged between 30 and 49 years. In general, the distribution of the lesions differed significantly ($P < 0.001$) by year of diagnosis, developmental stage, age category, and types of lesion. Gynecological lesions occurrence in the study population were similar between 2010 and 2012 and ranged from 150 (21.5%) to 158 (22.7%). The highest prevalence was in 2013, where 186 (26.7%) cases were reported, and the least number of cases were recorded in 2014 ($n = 46, 6.6\%$).

Prediction equation model

The prediction equation model based on our study data with the corresponding match coefficient estimate for each gynecological lesion is presented on Table 1. The goodness of fit for the model as determined by the adjusted coefficient

of determination (R^2) was 0.781 with root mean square error of 10.529 and mean response value of 11.617.

Standardized rates and predicted estimates for diagnosed lesions, 2015–2050

The detailed summary of the gynecological lesions diagnosed among the subjects and the predicted estimates by type of lesions diagnosed over the 35-year period is presented in Table 2. The most prevalent lesion recorded over a 5-year

period was leiomyoma (56%) with standardized mean rate of 0.508. This was followed by ovarian cyst, product of conception, and endometrial hyperplasia, which recorded standardized rates of 0.124, 0.075, and 0.044, respectively, over the 5-year period. The least diagnosed lesion was adenoma with standardized mean rate of 0.004. Based on the prevalence rates, it was estimated that incidence of leiomyoma among the patients' population will increase from 235 in 2015 to 706 cases by the year 2025, and by the year 2050, an estimated 1,883 females will be diagnosed with the disease. Similarly, ovarian cyst, which represented the second most common lesion, is projected to rise from an average estimate of 58 in 2015 to 173 by the year 2025, and by year 2050, 461 women will be diagnosed with this lesion. Product of conception, which was ranked third in prevalence rates, is expected to increase from 35 diagnosed cases to ~104 cases by the 2025, and subsequently, increased to 278 by the year 2050. In general, proportional increases are expected over the 35-year period on all other gynecological lesions identified in the sample population based on the standardized prevalence rates.

Table 1: Prediction equation expression and coefficient estimates for gynecological lesions

Equation: $\hat{Y}_i = 2679.765 + (-1.327) * \text{Year} + \text{Match} [\text{Lesion}]^{\text{§}}$	
Gynecological lesion	Match coefficient estimate
Lesion [adenocarcinoma]	-7.560
Lesion [adenoma]	-9.020
Lesion [adenomyosis]	-5.160
Lesion [cervical polyp]	-8.687
Lesion [chronic cervicitis]	-0.560
Lesion [chronic endometritis]	-7.851
Lesion [CIN]	-7.245
Lesion [condyloma acuminatum]	-7.693
Lesion [endometrial hyperplasia]	-3.024
Lesion [endometrial polyp]	-6.524
Lesion [leiomyoma]	68.640
Lesion [others]	-5.024
Lesion [ovarian cyst]	4.640
Lesion [product of conception]	1.840
Lesion [squamous cell carcinoma]	-6.774

CIN, Cervical intraepithelial neoplasia Model information: R-square=0.8370; adjusted R-square=0.781; root mean square error=10.529, mean of response=11.617.

[§]Predicted estimates can be determined by substituting year and the match coefficient estimate of gynecological lesion of interest

Discussion

Gynecological lesions are public health problem, worldwide affecting all categories of females. It is a common cause of death in developed countries and among the leading causes of death in developing countries. Our study identified the top five gynecological lesions common among females attending BMSH in order of hierarchy as leiomyoma, ovarian cyst, product of conception, chronic cervicitis, and

Table 2: Summary of prediction model: standardized and predicted estimates of gynecological lesions

Lesion	Number of lesion	Percentage (%)	Standardized*			Predicted estimates (Numbers) by Year**						
			Mean	SD	Rates	2020	2025	2030	2035	2040	2045	2050
Adenocarcinoma	9	1.3	9.195	0.138	0.020	18.390	27.586	36.781	45.976	55.171	64.366	73.562
Adenoma	5	0.7	1.943	0.385	0.004	3.885	5.828	7.770	9.713	11.655	13.598	15.540
Adenomyosis	21	3.0	13.981	0.300	0.030	27.961	41.942	55.922	69.903	83.884	97.864	111.845
Cervical polyp	6	0.9	4.337	0.546	0.009	8.674	13.010	17.347	21.684	26.021	30.358	34.694
Chronic cervicitis	44	6.3	27.610	0.103	0.060	55.220	82.830	110.440	138.050	165.659	193.269	220.879
Chronic endometritis	7	1.0	6.509	0.318	0.014	13.018	19.527	26.036	32.546	39.055	45.564	52.073
CIN	9	1.3	9.880	0.280	0.021	19.760	29.640	39.520	49.400	59.280	69.160	79.040
Condyloma acuminatum	5	0.7	6.193	0.436	0.013	12.385	18.578	24.770	30.963	37.156	43.348	49.541
Endometrial hyperplasia	28	4.0	20.345	0.585	0.044	40.690	61.035	81.380	101.726	122.071	142.416	162.761
endometrial polyp	14	2.0	12.797	0.644	0.028	25.594	38.390	51.187	63.984	76.781	89.578	102.374
Leiomyoma	390	56.0	235.401	0.438	0.508	470.803	706.204	941.605	1177.007	1412.408	1647.809	1883.210
Others	20	2.9	14.112	0.151	0.030	28.224	42.336	56.448	70.560	84.672	98.784	112.896
Ovarian cyst	70	10.0	57.640	0.638	0.124	115.279	172.919	230.558	288.198	345.838	403.477	461.117
Product of conception	56	8.0	34.729	0.518	0.075	69.458	104.188	138.917	173.646	208.375	243.104	277.834
Squamous cell carcinoma	13	1.9	8.968	0.522	0.019	17.936	26.904	35.872	44.840	53.807	62.775	71.743
Total	697	100	463.639	6.003	1.000	927.277	1390.916	1854.554	2318.193	2781.832	3245.470	3709.109

SD, Standard deviation of Mean; CIN, Cervical intraepithelial neoplasia. *Standardized rates are based on prediction equation [Table 1] using observed data from 2010 to 2014 at maximum desirability score of 0.099296. Baseline for predicted estimates=2015. **Note that the estimates are based on standardized mean rates, and thus, represent the hospital's sample population (which is limited by the number of available medical charts abstracted by the researchers) and not the general population

endometrial hyperplasia. These lesions are predicted to increase in the population to the range of 797%–815% in 35-year time. There has been little or no information on the prediction estimates of gynecological lesions in Nigerian tertiary hospitals. Therefore, our study is the first attempt at filling this knowledge gap, and we are hopeful that the data obtained will provide the needed basic information to engender interest among researchers and governmental agencies in addressing this important public health problem.

WHO reported that about 24.6 million people live with cancer worldwide.^[26] Parkin *et al.*^[8] reported that in indigenous Africans, 650,000 people of the estimated 965 million were diagnosed of cancer annually, and a lifetime risk of dying from cancer in African women was reported to be two times higher than in developed countries.^[27] In the United States, it was reported that leiomyoma-related hospitalized cases will rise from 37,134 in 2010 to 49,154 in 2050 with an increase of 22% in black women and 8% in white women.^[28] This is inconceivably lower when compared with the 801% increase (235–1,883 by 2050) reported in our current study for leiomyoma lesion, although the present research focused on one tertiary hospital.

Studies have shown that high incidence of leiomyoma occurs within the age of 35 years^[27,28] and early menarche has also been identified as a factor.^[29,30-32] According to Baird and Dunson,^[33] Parazzini,^[34] and Wise *et al.*,^[35] parity and pregnancy are contributory factors to the rise in cases of leiomyoma. Other factors include caffeine intake^[36] and estrogen.^[37] Estrogen influences the growth of leiomyoma and decreased estrogen regresses its growth.^[37] Flake *et al.*^[38] reported high concentrations of estrogen receptor (at 6q25.1 and 14q) in leiomyomata than in other lesions.^[37] Estrogen dominance is a complex situation caused by excess exposure to environmental xenoestrogens (made up of hydrocarbons), which may arise from oil and gas exploration.^[37] Ngokere *et al.*^[39] has earlier reported increased estradiol and decreased progesterone in rabbits administered with Escravos crude oil. The use of synthetic estrogens, such as the birth control pill and hormone replacement therapy, anovulation which is common among women older than 35 years; unresolved emotional issues; poor diet; and negative lifestyle factors, such as smoking and alcohol, are also contributing factors.^[40]

Similarly, ovarian cyst which were predicted in this study to increase from 58 to 461 by 2050 is higher than the projection for Ireland as a country, where it was reported that ovarian cyst will increase from 407 cases in 2015 to 662 by 2040.^[41] Retained products of conception, which is the third highest predicted lesion in our study are associated with

complication from labor and delivery. The retained tissue can cause prolonged postpartum hemorrhage and endometritis. The usual treatment is curettage, which results in further complications in 7% of patients, including uterine perforation, cervical laceration, and subsequent synechia formation.^[42] Retained products of conception are suspected when routine examination of the placenta at delivery reveals an incomplete placenta or when a patient has signs of endometritis or prolonged vaginal bleeding in the postpartum period.^[43]

Studies have shown that relationship exists between people living in close proximity to oil- and gas-contaminated areas and pregnancy complications, partly due to polluted sources of water by chemicals from the exploration and production of oil and gas.^[44,45] Hurtig and Sebastian^[44] reported in their study in Ecuador that miscarriages were found to be much more prominent in oil-contaminated areas with a risk of 2.34 times higher spontaneous abortion in communities situated near oil-contaminated environments. More than 60% of communities in Rivers State suffer the same fate as the case reported in Ecuador. Umunnakwe^[46] reported hydrocarbon leakages into grand water wells of two oil-producing communities (Obite and Egita) in Ogba, Rivers State, Nigeria. Similar report of extensive oil contamination of rivers, creeks, and ground water in Ogoni land in Rivers State was also given by Olof and Jonas.^[47] These reports tend to highlight the possible link of oil-contaminated environments with the prevalence of these lesions identified in our study. However, further research is needed to uncover the existence of such a relationship.

Study limitations

There are some limitations in our current study that may highlight opportunities for future method enhancement. The study was based on data collected from only one tertiary hospital, and thus, may not be representative of the actual prevalence of the various gynecological lesions in the general population. Also, several independent factors of interest including participants' occupation and race/ethnicity were not captured in the original data making it impossible to associate these factors with the distribution and predictive patterns. Consequently, while the predictive estimates obtained are the first of its kind in Nigeria, it is important to interpret the predicted prevalence rates of the diseases with caution as any effective intervention and control program may significantly alter these estimates in future.

Conclusion

Leiomyoma, ovarian cyst, and product of conception are the most prevalent gynecological lesions among patients receiving medical care at the BMSH and they have been

predicted to increase alongside other lesions in the next 35 years. However, application of effective intervention and control measures such as alteration of life style (sexual behavior), vaccination against human papillomavirus (HPV), cytological screening, early clinical detection, and treatment and improved therapy could help reduce incidence and mortality rates associated with these diseases. In addition, healthcare physicians specializing in cancer care for women need to be alert to every opportunity to improve cancer screening and prevention among the growing and aging female populations in Nigeria, and other less-developed countries. More researches are needed to uncover the impact of oil and gas exploration, extraction, and environmental pollution on health outcomes in the oil-producing areas of Nigeria, and elsewhere around the world.

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Conflicts of interest

There are no conflicts of interest.

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