Spatial and socio-demographic disparities of cancer morbidity in Nigeria: Patterns and factors

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Abstract

An analysis of cancer pattern among states in Nigeria was undertaken with a view to identify spatial variations and the associated factors which could aid in the allocation of health resources and intervention planning. Retrospective cancer data from 1987 to 1996 were retrieved from five national cancer registries in Nigeria which included the cancer patients' age, gender, cancer site and residential area. In addition, socio-demographic, environmental and pathogenic data used as explanatory variables were collected from secondary sources. Results showed that all cancer sites according to WHO classification were reported in Nigeria. The five leading cancer groups within the study period were breast, cervical, leukaemia/lymphoma, gastro-intestine and bone cancer (19–8%). At each of the cancer registries (zones), cancer occurrence varied in composition and magnitude. Cancer incidence varied significantly (P <0.05) among states; 70–125 in Oyo and Osun, and 15–40 in Enugu, Lagos, Ondo, Kwara, Ogun, Anambra, Imo and Abia state. There was positive correlation between cancer pattern and indices of urbanization, industrialisation and biomass energy utilisation in each state (R = 0.79–0.56) explaining between 31% to 63% (R^2 =0.31–0.63) of the observed variation in specific cancer pattern. Further, inequality in the development level of the states influenced the cancer pattern. Socio-medical resources allocation for cancer control should thus take cognizance of the regional heterogeneous cancer profile in the country for optimum results.

Keywords: cancer, cancer factors, cancer profile, morbidity, spatial variation of cancer, socio-medical resource allocation

Introduction

The current global status of cancer indicates that the developing countries carry higher burden of the disease. Beside higher incidence and mortality of cancer in these countries, health care resources which are grossly inadequate to manage the cases of extant infectious diseases are further stressed by cancer upsurge. In 2007, over 12 million new cases of cancer were estimated worldwide of which 6.7 million were expected in the developing countries (American Cancer Society, 2007). According to recent cancer projections, more than 155 million cases and 11 million deaths will be found in the developing countries by 2050 (WHO 2008; Ferlay et al. 2008). Moreover, there are indications of a gradual reduction in cases of infectious diseases in the developing countries while degenerative diseases are emerging as the main cause of death (Wilkinson, 1996).

The spatial distribution of cancer cases have showed remarkable differences between developed and developing countries in cancer magnitude and profile (Ferlay et al. 2004), and the causative and associative factors (Narain et al. 2002; Lavachy, 2004; Durosinmi, 2006; Powell, 2007). Common cancers in the developing countries included lung, stomach, breast, liver, colorectal and cervix. Although cancer cases are usually under-reported in sub-Saharan Africa, Okobia (2003) observed regional and temporal variations in the incidence of liver, breast and prostate cancer. For instance, West Africa came second behind East Africa in the occurrence of liver cancer (Globocan, 2002). According to Okobia (2003), Adebamowo (2007) and Awodele et al. (2011) the leading cancers in Nigeria are breast, prostate, cervical and liver.

From available reports based on specific hospital records, common cancer among men are prostate, liver and lymphomas while breast and cervical carcinomas are prevalent among females (Adebamowo 2007; Awodele et al. 2011). There has been regional and temporal dynamics in the morbidity of breast and colorectal carcinomas in Nigeria (Adebamowo & Adekunle 1999; Adewuyi, 2010; Irabor et al. 2011), hence the need for continuous analysis of cancer pattern. Inter-regional comparison of cancer occurrence within Nigeria has been limited since most reports are based on information from individual cancer registry. Therefore, cancer analysis that is predicated on data from several registries across the country as conducted in the current study is desirable.

Although the risk factors of cancers are copious, the role of environmental and behavioural factors is quite significant (WHO 2007; Ogundiran et al. 2010). Common risk factors of cancer initiation and amplification are high dietary fat intake, tobacco smoking, exposure to pollutants, poor micro-nutrients and fibre in diets, over-weight, viral, bacteria and parasites infections and poor access to adequate health care among populations (Dreiher et al. 2005; Kazan-Allen 2005; Willet et al. 1990; WHO 1996; Frimpong-Boateng, 2010; Silverman et al. 2010; Pisani, 2011).

For the design of aetiologic and epidemiologic investigations at community level, information on spatial variations in cancer distribution among population groups is indispensable (Pastides, 2001). To date, most cancer studies on Nigeria showed the specific interest of biomedical scientists while socio-spatial analyses are quite scarce. McIntyre (2005) and Bonita and Mathers (2003) had observed earlier that spatio-ecologic analysts have always focussed on infectious ailments while their contribution to cancer research has been minimal in sub-Saharan Africa. The present study adopted an ecologic perspective to analyse the socio-spatial pattern of 10 leading cancer groups among the states in Nigeria. In addition to mapping cancer morbidity, it conducted an associative analysis that provides hints on risk factors of cancers within regional context.

The study area

Nigeria has a total surface area of 923,768 km^2 lying between latitude $4^o1^'$–$13^o9^'$ north of the equator and longitude $2^o2^'$–$14^o30^'$ east of the Greenwich Meridian. In 1991, the country was divided into 30 administrative units called state and a federal capital territory (Abuja). Currently, there are 37 administrative units including the capital territory. For the purpose of using manageable spatial units, the earlier states division was adopted as the framework for this study (Figure 1).

Materials and methods

Cancer data used in this study were collected from five cancer registries in Nigeria from 1987 to 1996. The registries are situated at the University Teaching Hospitals located in Ibadan, Ilorin, Ile-Ife, Enugu and Zaria. Registries mentioned above were those assessed as "active" by the National Secretariat of the cancer registries during the period of study. The doctoral research proposal from which this study was extracted was submitted to each of the hospitals named above for ethical consideration; data collection commenced after permission was granted. The specific information collected from the record of cancer patients included age, sex, cancer site and the town of residence. While the registries at Ibadan, Enugu, and Ilorin had data for 1987, Ile-Ife and Zaria began data collection in 1989.

The various cancer sites diagnosed at the hospitals were classified into 15 groups (excluding ill-defined sites) similar to Verhasselt and Timmans (1987) grouping. The resultant cancer groups are oral cancer (T140-149), gastro-intestine (T150-154), liver (T155), internal organ (T156-158, T163-164), glands (T193-196), respiratory system (T160-162), bone (T170-171), skin (T172-173), breast (T174-175), cervical (T179-184), prostate (T185-187), urinary system (T188-189), eye (T190), brain/nervous system (T191-192) and leukaemia/lymphoma (T200-208).

With respect to the associative analysis of cancer pattern, data employed as explanatory variables were collected from relevant agencies. The choice of explanatory variables in this analysis was based on specific risk factors that have been identified by previous studies; level of education (Galobardes et al. 2006; De Kok et al. 2008), diet, smoking, occupation, housing and index of deprivation (Menvielle

et al. 2010; Galea et al. 2004), aging and life expectancy of the population, adaptation to western lifestyle (Okobia 2003; Merletti et al. 2010; Ferlay, et al. 2010), reproductive factor (Ogundiran et al. 2010), industrial pollution (Dreiher, 2005), exposure to biomass smoke (Goldberg et al. 1999) and schistosomiasis infection (Kanavos, 2006; Frimpong-Boateng, 2010). The variables that were collected on state basis as proximate factors of some risk factors mentioned above included male and female population, population density, percent urbanisation, life expectancy in 1991 (NPC 1996 report), 1991 literacy level (UNDP 1996 report), number of industries (MAN 1991 report), percent utilisation of wood-fuel (NBS, 2009) and 1991 schistosomiasis cases (FOS 1994 reports).
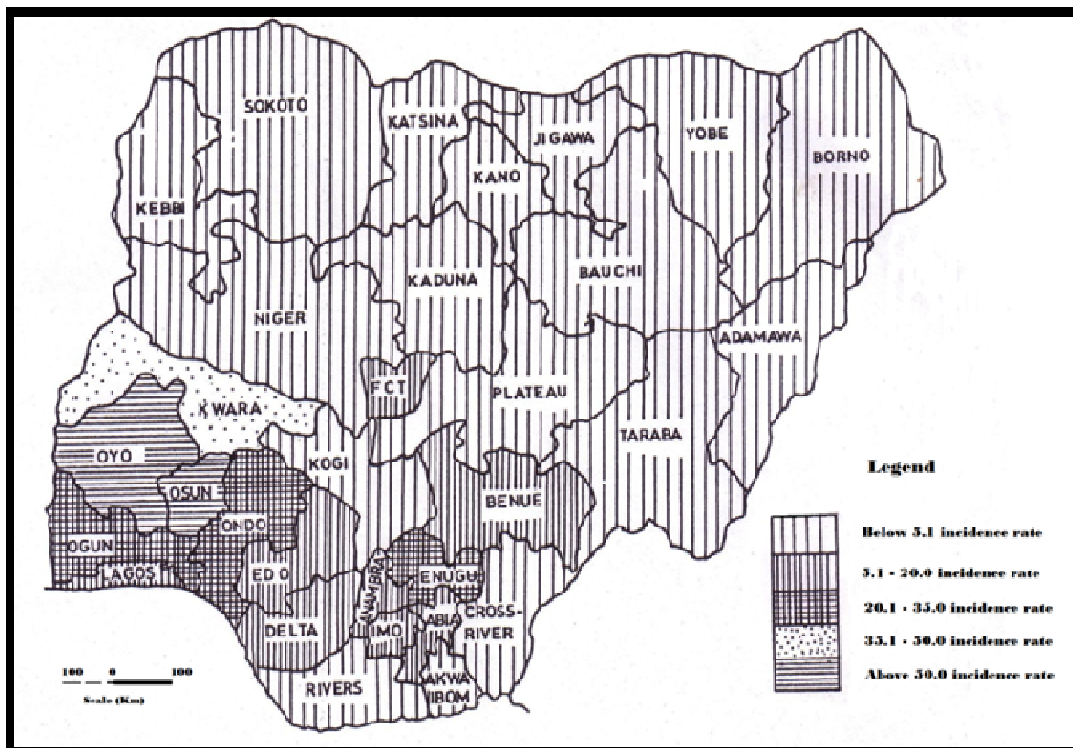

Figure 1. *Incidence of overall cancers among states in Nigeria (1987–1996)*

Data analysis

Reported cancer cases were collated and summarised using frequency and percentage. Cancer incidence in each state (CIR_{rj}) was computed as using the equation $CIRrj = \frac{N_{ij}}{P_{ij}} + k$; where N_{ij} stands for cancer cases reported by population i in state j, P_{ij} is the population i at risk in state j, k is a constant (100,000).

Correlation statistics was employed to analyse the association between cancer cases (Y) in each state and the socio-demographic, pathogenic and environmental variables (X). In the analysis, the *r* value shows the coefficient of association between the dependent and the explanatory variables. To account for the explanatory strength of the selected variables, regression statistics was employed. The regression model is of the form: $Y = a + b1X1 + b2X2 + b3X3 \dots bnXn$; where *a* stands for intercept of model slope and b_1–b_3, the quotient of the explanatory variables, Y represent cancer cases per state and X, the explanatory variables. A colinearity diagnostic test showed that number of industries and population density per state were colinear. Hence, the later was excluded from the final regression analysis. All the analyses were conducted in Statistical Package for the Social Sciences (SPSS version 20) and the significant level of results was P ≤0.05.

Results

The overall cancer profile in Table 1 shows the leading positing of breast cancer followed by cervical cancer (19%, 17%) while oral, respiratory and skin cancers were the least. Other cancer groups recorded between 5.0% and 9.0% each. At each registry, the proportion of cancer varied from the overall profile except at Ibadan. The proportion of leukaemia/lymphoma (0.1%) were remarkably lower at Ile-Ife registry while bone and prostate cancers (>10% each) were notably higher compared to the proportions in the overall profile. Again, while cases of cervical cancer were quite low at Ilorin registry, the occurrence of liver cancer was higher (>20%) than the proportion in the overall profile. At Enugu registry, the reported cases of leukaemia/lymphoma were quite low (<5%) while bone cancer (>21%) was outstandingly higher than the proportion in the overall profile. Liver cancer accounted for 30% of reported cancer cases at Zaria, which is similar to the proportion at Ilorin but different from the share of liver cancer in the overall profile.

Table 1. Distribution of Cancer cases among the registries (1987–1996)

Cancer group	Cancer registry					Total
	Ibadan	Ile-Ife	Ilorin	Enugu	Zaria	
Breast	1793 (17.3)	351 (18.9)	94 (16.2)	581 (24.0)	5 (4.9)	2824
Cervical	2110 (21.3)	208 (11.2)	5 (0.9)	282 (11.6)	1 (1.0)	2606
Leukaemia/ lymphoma	1001 (9.6)	2 (0.1)	166 (28.5)	113 (4.7)	-	1282
Gastro-intestine	788 (7.6)	209 (11.2)	57 (9.8)	159 (6.6)	15 (14.7)	1228
Bone	532 (5.1)	191 (10.2)	23 (4.0)	398 (16.4)	8 (7.8)	1152
Prostate	600 (5.8)	194 (10.4)	37 (6.4)	157 (6.5)	7 (6.9)	995
Liver	571 (5.5)	142 (7.6)	125 (21.5)	133 (5.5)	31 (30.4)	1002
Oral	601 (5.8)	63 (3.4)	2 (0.3)	84 (3.5)	4 (3.9)	754
Respiratory	529 (5.1)	18 (1.0)	25 (4.3)	79 (3.3)	2 (2.0)	653
Skin	403 (3.9)	73 (3.9)	-	137 (5.7)	4 (3.9)	617
Others	1449 (13.0)	411 (22.1)	47 (8.1)	298 (12.2)	25 (24.5)	2230
Total	10377	1862	581	2421	102	15343

The highest occurrence of overall cancer was recorded among ages 46–60 (30%) followed closely by 31–45 years (Table 2). While cervical, gastro-intestine, liver, respiratory and skin cancers (29%–35%) portrayed age distribution similar to that of overall cancer; other cancer groups differ. For instance, the highest cases of leukaemia/lymphoma and bone cancer (23%, 30%) were reported among age group 0–15 in contrast to prostate cancer that was highest among ages 61–75. Only breast cancer was highest (37%) among age group 31–45 within the study period.

Table 2. Age characteristic of the selected cancer groups in Nigeria

Cancer group	Age-group (years)						Total
	0–15	16–30	31–45	46–60	61–75	76+	
Breast	123 (4.4)	324 (11.5)	1034 (36.6)	954 (33.8)	340 (12.0)	49 (1.7)	2824
Cervical	160 (6.1)	349 (13.4)	778 (29.8)	862 (33.1)	403 (15.5)	54 (2.1)	2606
Leukaemia/ lymphoma	390 (30.4)	230 (17.9)	257 (20.1)	253 (19.7)	129 (10.1)	23 (1.8)	1282
Gastro-intestine	50 (4.1)	137 (10.7)	305 (23.8)	430 (33.5)	252 (19.6)	54 (4.3)	1228
Bone	268 (23.3)	247 (21.4)	247 (21.4)	244 (21.2)	126 (10.9)	20 (1.8)	1152
Prostate	40 (4.1)	49 (4.9)	81 (8.1)	271 (27.2)	421 (42.3)	133 (13.4)	995

Cancer group	Age-group (years)						Total
	0–15	16–30	31–45	46–60	61–75	76+	
Liver	47 (4.7)	121 (12.1)	323 (32.2)	341 (34.0)	149 (14.9)	21 (2.1)	1002
Oral	75 (9.9)	132 (17.5)	172 (22.8)	222 (29.4)	130 (17.2)	23 (3.2)	754
Respiratory	53 (8.1)	71 (10.9)	151 (23.1)	229 (35.1)	126 (19.3)	23 (3.5)	653
Skin	41 (6.6)	91 (14.7)	149 (24.1)	188 (30.5)	117 (18.9)	31 (5.2)	617
Others	450 (20.2)	284 (13.1)	486 (22.3)	599 (27.5)	340 (15.6)	71 (3.3)	2230
Total	1697	2035	3983	4593	2533	502	15343

Apart from breast, cervical and prostate cancers that are largely gender specific, males reported higher proportions of other cancer groups (38%–49%) from 1987–1996 (Figure 2). Variations from this female dominance of the overall cancer occurrence were observed at Ilorin and Zaria registries with higher proportions among males (52%, 70%).
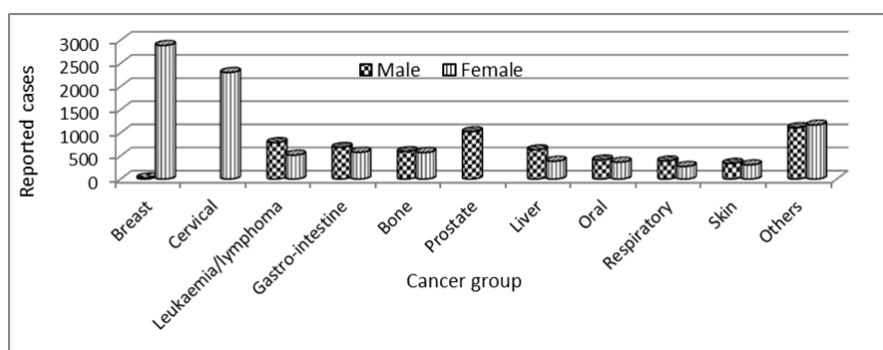

Figure 2. *Gender distribution of reported cancer cases*

The overall cancer occurrence (Figure 3) was higher in urban (81%) settlements than rural. Unlike the picture portrayed by all registries, cancer cases at Zaria and Enugu were significantly high in rural settlements (46%, 50%). At Ilorin registry, cancer groups that showed relatively high occurrence in rural settlements included prostate (1:1.8) and respiratory (1:2) cancers. Oral cancer cases at Enugu registry were higher in rural settlements; leukaemia/lymphoma had equal proportion of occurrence in rural and urban areas. The urban-rural ratios of prostate, respiratory, breast and gastro-intestine cancers ranged from 1:1.1 to 1:1.2.
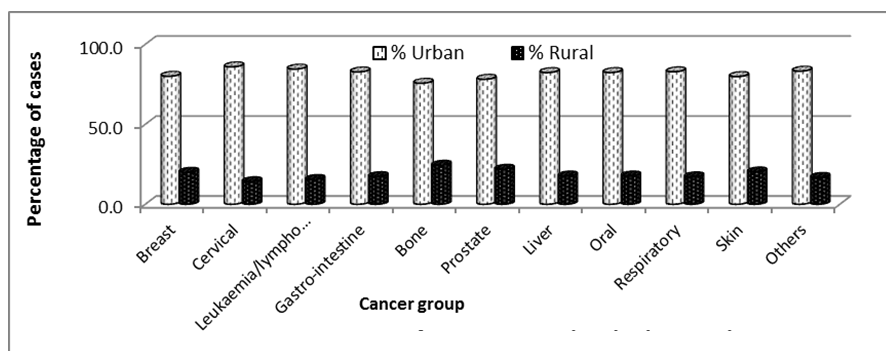

Figure 3. *Occurrence of cancers in rural and urban settlements*

Using 12335 cancer cases with identifiable state addresses, Oyo state had the highest occurrence followed by Osun, Lagos and Ondo states (835–1545 cases) in the western part of the country. In the eastern part, Enugu had the highest number of cases followed by Anambra, Imo and Abia states (352–406 cases). States in the southern part that reported more than 100 cases included Edo, Delta and

Rivers (136–247 cases). From the middle belt to the northern part of the country, Kwara, Benue and Kaduna states recorded well over 100 cases within the study period.

Relatively high occurrence of breast and cervical cancers were observed among western states. Specifically, there were high cases of leukaemia/lymphoma (Oyo, Lagos and Ogun states), gastro-intestine and prostate cancers (Osun and Ondo states), and bone cancer (Osun state). Breast cancer topped the cases of cancers in the eastern states followed by bone cancer except in Imo state. In addition, the occurrence of skin cancer was outstanding in the eastern part. The leading cancer groups in the southern part were gastro-intestine, liver and leukaemia/lymphoma. Moreover, the proportion of cervical cancer was higher than breast cancer among southern states, except in Rivers. With the exception of Kwara state, other states in the middle belt had higher cases of cervical cancer than breast cancer. Furthermore, leukaemia/lymphoma led other cancers in Kwara state with a magnitude that doubled the occurrence of any other group. In the northern part, cervical cancer had the highest proportion except in Kaduna state and a few other with equal proportion of cervical and breast cancers.

Table 3. Occurrence of 10 leading cancer groups among states in Nigeria (1987–1996)

State	Breast	Cervical	Leukaemia/lymphoma	Gastro-intestine	Bone	Prostate	Liver	Oral	Respiratory	Skin	Other	Total
Abia	96	48	18	27	49	15	17	12	13	22	35	352
Adamawa	2	0	2	1	3	0	1	1	1	1	6	18
Akwa-Ibom	2	0	0	2	2	0	1	2	2	0	0	11
Anambra	76	36	32	33	70	24	26	22	20	20	47	406
Bauchi	1	1	1	5	1	3	3	2	2	2	6	27
Benue	18	19	9	9	10	5	8	5	2	11	21	117
Borno	4	15	12	9	9	4	4	6	3	7	12	85
Cross River	6	10	6	5	5	2	1	3	0	5	6	49
Delta	14	19	20	28	15	10	22	6	13	12	38	197
Edo	16	28	59	12	8	20	20	6	11	5	64	249
Enugu	256	129	50	54	162	88	56	37	34	42	122	1032
FCT	10	6	3	1	2	0	0	0	3	2	7	34
Imo	106	49	19	27	41	33	19	7	9	14	42	366
Jigawa	0	0	0	2	0	6	1	0	0	0	0	9
Kaduna	26	21	10	7	7	8	18	5	3	7	23	135
Kano	10	11	10	9	6	4	11	4	5	6	17	93
Katsina	4	5	4	1	3	2	6	1	1	3	3	33
Kebbi	3	2	0	0	0	0	1	1	0	0	1	8
Kogi	10	10	11	2	6	1	3	2	4	0	6	55
Kwara	85	22	144	51	31	52	114	10	36	5	60	610
Lagos	232	246	78	34	40	10	33	31	26	25	103	858
Niger	10	5	5	6	3	2	6	2	1	2	3	45
Ogun	101	120	68	38	33	17	15	33	16	34	100	575
Ondo	169	141	21	71	64	71	39	37	23	36	163	835
Osun	274	231	47	179	116	135	119	68	49	56	271	1545
Oyo	774	841	411	354	204	247	274	264	228	146	596	4339
Plateau	4	12	6	4	1	1	1	4	2	1	8	44
Rivers	42	27	6	8	10	1	11	6	10	2	13	136
Sokoto	5	5	3	7	4	0	5	5	7	2	8	51
Taraba	2	2	1	0	1	2	0	2	1	0	5	16
Yobe	1	0	0	0	1	0	2	0	0	0	1	5
Total	2361	2061	1056	986	907	763	837	584	525	468	1787	12335

Overall cancer incidence (Figure 1) appeared concentrated in Oyo, Osun (70–125 cases per 100,000 people), Kwara (35–50 cases per 100,000 people), Enugu, Ondo and Ogun states (20–35 cases per 100,000 people). Other states, including the federal capital territory (Abuja) had incidence

rates below 20 cases per 100,000 people. The pattern of crude incidence is akin to the occurrence of cancers among the states.

As presented in the associative analysis (Table 3), only percentage using wood-fuel, percentage of urbanisation, percentage of population more than 64 years and rate of family planning adoption in each state showed significant association (P< 0.05) with the distribution of cancer groups. While the percentage using wood-fuel showed negative correlation with all cancer groups, the other three variables were positively correlated. The coefficient of correlation between the cancer groups and percentage using wood-fuel ranged from (R) -0.41–-0.56; the least association was with prostate cancer while breast cancer had the highest.

The highest positive association of percentage of urbanisation was with breast cancer (R=0.64) while prostate cancer showed the least (R=0.51). With respect to correlation between rate of family planning adoption in each state and cancer pattern, gastro-intestine, bone and skin cancers ranged from (R) 0.37–0.51. Positive association between percentage of population above 64 years and breast, gastro-intestine, bone, prostate, skin and overall cancers showed values ranging from (R) 0.35–0.40.

As indicated by the determination coefficients in Table 4, only percentage of urbanisation, number of industries and percentage using wood-fuel significantly explained the variation in cancer pattern among the states. Percentage of urbanisation accounted for the highest proportion of variation in each cancer pattern (R^2=0.26–0.41). Forty-one percent, 37% and 31% of variation in breast, cervical and leukaemia/lymphoma patterns were explained by percent of urbanisation. Number of industries per state explained 13%–27% (R^2= 0.13–0.27) of the variation in the pattern of seven cancer groups excluding breast, cervical and leukaemia/lymphoma. Between 7.3% and 9.3% of variations in the pattern of gastro-intestine, prostate, liver and skin cancers were explained by the percentage using wood-fuel in each state.

Table 4. Associative analysis of cancer pattern and socio-environmental variables

Cancer group	Male population	Female population	Life expectancy	% of literacy	Population density	% of urbanisation	No. of industries	Cases of Schistoso	Hiv/Aids Prev	% family Planning	% using woodfuel	% 65+
Breast	-.05	.17	.04	.22	.25	.64**	.28	-.19	-.16	.34	-.56**	.37*
Cervical	-.02	.19	.04	.16	.22	.61**	.29	-.16	-.16	.26	-.54**	.32
Leukaemia/lymphoma	-.05	.07	-.02	.15	.10	.56**	.21	-.17	-.16	.21	-.48**	.27
Gastro-intestine	-.06	.08	.01	.14	.06	.54**	.09	-.18	-.14	.37*	-.44*	.39*
Bone	-.09	.11	-.03	.24	.19	**.59**	.16	-.22	-.09	**.51**	**-.47**	**.39***
Prostate	-.07	.05	-.02	.15	.02	**.51**	.03	-.18	-.14	**.42***	**-.41***	**.38***
Liver	-.07	.05	-.01	.13	.05	**.55**	.11	-.18	-.16	.34	**-.45***	.33
Oral	-.03	.13	-.01	.10	.07	**.52**	.14	-.14	-.12	.24	**-.43***	.29
Respiratory	-.04	.10	.01	.12	.06	**.52**	.14	-.15	-.13	.23	**-.43***	.27
Skin	-.06	.15	-.01	.19	.14	**.59**	.18	-.19	-.12	**.39***	**-.49**	**.40***
Overall	-.05	.13	.01	.17	.14	**.60**	.20	-.18	-.15	.34	**-.51**	**.36***

Regression model		R	R^2 %	Sig. level
$Y_{breast} = a+bX_{\%urban}$	1	0.64	41.0	0.001
$Y_{cervical} = a+bX_{\%urban}$	2	0.61	37.0	0.001
$Y_{leuka/lym} = a+bX_{\%urban}$	3	0.56	31.0	0.008
$Y_{gastro-int} = a+bX_{\%urban}+bX_{indust.no}-bX_{fuelwood}$	4	0.76	57.9	0.003
$Y_{bone} = a+bX_{\%urban}+bX_{indust.no}$	5	0.73	52.8	0.004
$Y_{prostate} = a+bX_{\%urban}+bX_{indust.no}-bX_{fuelwood}$	6	0.79	62.7	0.001
$Y_{liver} = a+bX_{\%urban}+bX_{indust.no}-bX_{fuelwood}$	7	0.77	58.8	0.002
$Y_{oral} = a+bX_{\%urban}+bX_{indust.no}$	8	0.63	40.0	0.013
$Y_{respiratory} = a+bX_{\%urban}-bX_{fuelwood}$	9	0.64	40.1	0.009
$Y_{skin} = a+bX_{\%urban}+bX_{indust.no}-bX_{fuelwood}$	10	0.75	55.8	0.01
$Y_{overall} = a+bX_{\%urban}+bX_{indust.no}-bX_{fuelwood}$	11	0.75	56.4	0.01

Discussion

The observed leading position of breast, cervical, leukaemia/lymphoma and gastro-intestine cancer in Nigeria between 1987 and 1996 was equally reported by Okobia (2003), Adebamowo and Adekunle (1999), Ogunbiyi and Shittu (1997) and Irabor (2011). These cancer groups are linked to the divergent factors of westernisation of lifestyle and exposure to bacteria/viral infections (Faggiano et al. 1997; Ferlay et al. 2010).

Females carried higher burden of overall cancers within the study period. In agreement with this finding, Jemal and others (2011) reported higher cancer cases among women in West Africa and East Africa. Exception to this was noted in the record of cancer occurrence at Ilorin and Zaria zones.

Apart from cancers of the reproductive systems, males reported more cases of the remaining cancer groups from 1987–1996. While leukaemia/lymphoma and bone cancers were depicted as childhood cancers, prostate cancer was most prevalent among elderly men. In a study conducted by Pastides (2008) in the US, leukaemia cases were most common among children. Osegbe (1997) and Ogunbiyi and Shittu (1999) in separate studies showed the mean ages of prostate cancer patients were 68 and 71 years.

Urban dominance of cancer occurrence in this study concurs with the submissions of Cramb et al. (2011), NCRI (2011) and Raiz et al. (2011) from studies conducted outside Africa. Although it is difficult to dismiss urban bias in cancer reporting due to the location of cancer registries in cities and better cancer awareness among urban residents, higher exposure to vehicular and industrial pollutants, prevalence of stress and poor dietary habit of most urban residents predispose them to higher cancer burden (Ana et al. 2010).

While breast cancer leads in most states in the west, east and southern part, cervical and leukaemia/lymphoma were significantly high in the middle belt and northern part of Nigeria. According to Faggiano et al (1997), breast, gastro-intestine, bone and skin cancers are classified as cancer of high socio-economic societies while cervical and lung cancers are typical of low socio-economic societies. By implication, cancers of high socio-economic status or westernisation were more prevalent in states located in the west, east and south of the country than those in the middle belt and north. Despite this broad view, each state portrayed a dual cancer profile with varied proportions of cancers that are associated western lifestyle and those caused by infections. This finding reflected the dual structure of most settlements and their residents in Nigeria (Onibokun, 1986; Metz, 1991; Asike, 2000).

Negative correlation between percentage using wood-fuel and the pattern of all cancers may indicate affordability of western diet and lifestyle by people ascending the energy ladder as a result of prosperity rather than exposure to emissions from biomass combustion. In addition, most people that quit wood-fuel utilisation for domestic energy supply easily replace it with kerosene. Incomplete combustion of hydrocarbon fuels in indoor environment equally exposes users to hazardous gases and particulates that are capable of predisposing them to health risks, including cancers (Plenta & Esper, 1993).

Concentration of diet rich in fat, cigarette smoking, alcohol abuse, minimal physical exercise among city residents may explain the positive association between urbanisation levels and the distribution of all cancer (WHO, 2007; Willet et al. 1990). Moreover, traffic and industrial pollution levels are generally higher in Nigeria urban settlements than rural areas which are deprived of social amenities. In line with this argument, Ana et al. (2010) attributed variation in the occurrence of respiratory cancers between cities to difference in residents' exposure to industrial pollutants.

The positive association between family planning adoption rate and pattern of gastro-intestine, bone and skin cancers which are cancers of high socio-economic status points more to westernisation levels of states rather than the bio-chemical impact of contraception on human body system (Merletti, et al. 2011). In Nigeria, most adopters of modern family planning methods are urban residents, and possible users of domestic and industrial chemicals (Fakeye, 1990), which are implicated in the causation of skin cancer.

Proportion of states population aged 65 and above which is a measure of population ageing showed positive association with pattern of prostate and breast cancers. This association implies population survival into middle and old age cohorts noted for the prevalence of breast and prostate

cancers respectively. In agreement with this finding, Ogunbiyi and Shittu (1997) and Kazan-Allen (2005) identified ageing in societies as a risk factor of prostate cancer.

    In all, percentage of urbanisation, number of industries and percentage of wood-fuel users in each state explained 31%–63% of variation in the pattern of each cancer group among states in Nigeria.

Conclusion

The Nigerian cancer profile comprised cancers associated with western lifestyle and those caused by infections. States in the western, eastern and southern parts of the country had higher proportions of cancers of socio-economically developed societies than states in the other regions. Although limited proximate data were analysed, the negative influence of urban lifestyles coupled with human exposure to pollutants and stress in Nigerian cities was nevertheless predominant. The gender perspective of this cancer analysis indicated the overwhelming proportion of breast, cervical and prostate cancers among the Nigerian population. Cancer intervention programmes should thus take cognisance of the heterogeneous cancer patterns in the country.

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References

Adebamowo CA, Adekunle OO (1999) Case control study of epidemiological risk factors for breast cancer in Nigeria. *Br J Surg*. **86**, 665-668.

Adebamowo CA, Ajayi OO (2000) Breast cancer in Nigeria. *West Afr. J Med*. **19** (3),179–191.

Adebamowo CA (2007) Cancer in Nigeria. American Society of Clinical Oncology (ASCO) News and Forum. Available from: http://www.ascocancerfoundation.org/anf/Past+ Issues/April+2007/Cancer+in+ Nigeria.

American Cancer Society (2007) *Cancer prevention & early detection facts & figures*. Atlanta, GA.

Ana REEG, Sridhar KCM, Asuzu CM (2010) Environmental risk factors and hospital-based cancers in two Nigerian cities. *Journal of Public Health and Epidemiology* **2** (8), 216-223.

Awodele O, Adeyomoye AA, Awodele DF, Fayankinnu VB, Dolapo DC (2011) Cancer distribution pattern in southwestern Nigeria. *Tanzania J. Health Res*. **13** (2), 106-108.

Cramb MS, Mengersen LK, Baade DP (2011) Identification of area-level influences on regions of high cancer incidence in Queensland, Australia: A classification tree approach. *BMC Cancer* **11**, 311

De Kok IM, van Lenthe FJ, Avendano M, Louwman M, Coebergh JW, Mackenbach JP (2008) Childhood social class and cancer incidence: Results of the globe study. *Soc Sci Med*. **66**, 1131-1139.

Dreiher J, Novack V, Barachana M, Yerushalmi R, Lugassy G, Shpilberg O (2005) Non-Hodgkin's lympohma and residential proximity to toxic industrial waste in southern Israel. *Haematologi- ca* **90**, 1709-1710.

Durosinmi MA (2008) Cancer control in an economically disadvantaged setting; Nigeria. INCTR Newsletter. [cited 19/5/2008]. Available from: www.inctr.org/publications/2004_v05-n01_s02.shtml.

Faggiano F, Partanen T, Kogevinas M, Boffetta P (1997) Socioeconomic differences in cancer incidence and mortality. In: Kogevinas M, Pearce N, Susser M, Boffetta P (eds) *Social inequalities and cancer, Vol. 138*, pp. 65 – 176. IARC Scientific Publications, IARC, Lyon.

Fakeye O (1990) Contraception with dermal levonorgestrel implants as an alternative to surgical contraception at Ilorin, Nigeria. *Int. J. of Cynecology & Obstetrics* **35** (4), 331–336.

Ferlay J, Shin HR, Bray F, Forman D, Mathers C, Parkin DM (2008) Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008. *Int J Cancer* (2010), [Epub ahead of print], doi: 10.1002/ijc.25516.

Ferlay J, Bray F, Pisani P, Parkin DM (2004) GLOBOCAN 2002: Cancer incidence, mortality and prevalence worldwide. *IARC Cancer Base 5 Version 2.0*. IARC Press, Lyon.

Frimpong-Boateng K (2010) Infectious disease and cancer in Africa – A medical and demographical reality. **A** Keynote Lecture presented at the "Global Health and Molecular Medicine: Our Common Future", Hannover. Available from: http://www.ourcommonfuture.de.

Galea S, Nandi A, Vlahov D (2004) The social epidemiology of substance use. *Epidemiol Rev.* **26**, 36-52.

Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey Smith G (2006) Indicators of socio-economic position (part 1). *J Epidemiol Commun Health* **60**, 7-12.

Globocan (2008) Country fast statis-Nigeria. [cited 23/5/2011]. Available from: http://globocan.iarc.fr/factsheets/populations/ factsheet.asp?uno= 566.

Goldberg M, Siemiatyck J, DeWar R, Desy M, Riberdy H (1999) Risk of developing cancer relative to living near a municipal solid waste landfill site in Montreal, Quebec, Canada. *Arch Environ Health* **54**, 291-296.

Irabor OD (2011) Colorectal Carcinoma: Why is there a lower incidence in Nigerians when compared to Caucasians? *Journal of Cancer Epidemiology.* doi:10.1155/2011/675154.

Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D (2011) Global cancer statistics. *A Cancer Journal for Clinicians* **61** (2), 69–90.

Kanavos P (2006) The rising burden of cancer in the developing world. *Annals of Oncology* **17** (Supplement 8), viii15–viii23.

Kazan-Allen L (2005) Asbestos and mesothelioma: Worldwide trends. *Lung Cancer* **49** (Suppl 1), S3-8.

McIntyre P (2007) HPV vaccine: Will women have to wait another 20 years? *Cancer World* December 2006 - January 2007, 50-53.

Menvielle G, Boshuizen H, Kunst AE, Vineis P, Dalton SO, Bergmann MM (2010) Occupational exposures contribute to educational inequalities in lung cancer incidence among men: Evidence from the EPIC prospective cohort study. *Int J Cancer* **126**, 1928-1935.

Merletti F, Galassi C, Spadea T (2011) The socioeconomic determinants of cancer. *Environmental Health* **10** (Suppl. 1), S7.

National Cancer Registry Ireland (2011) Incidence, mortality, treatment and survival. Available from: http://www.ncri.ie/ncri/index.shtml.

Ogunbiyi OJ, Shittu BO (1999) Increased incidence of prostate cancer in Nigeria. *J Natl Med Assoc.* **91**, 159-164.

Ogundiran O.T. Huo, D. Adenipekun, A. Campbell, O. Oyesegun, R. Akang, E. (2010). Case-Control Study of Body Size and Breast Cancer Risk in Nigerian Women. American Journal of Epidemiology, 172 (6): 682–690.

Okobia NM (2003) Cancer care in sub-Saharan Africa - Urgent need for population-based cancer registries. *The Ethiopian Journal of Health Development* **17**, 89–98.

Onibokun AG (1986) Two decades of Public Housing in Nigeria. NISER Publication, Ibadan.

Osegbe DN (1997) Prostate cancer in Nigerians: Facts and nonfacts. *J Urol.* **157**, 1340-1343.

Pastides H (2001) The descriptive epidemiology of cancer. In: Nasca PC, Pastides H (eds) *Fundamentals of cancer epidemiology*, Part. xvi, 368 p. Aspen Publishers, Gaithersburg, Md.

Pastides H (2008) The descriptive epidemiology of cancer. In: Nasca PC, Pastides H (eds) *Fundamentals of cancer epidemiology, 2nd edition*. Jones and Bartlett, Sudbury, MA. Available from: http://www.jblearning.com/samples/076373618X/3618X_FMTR_i-xiv.pdf.

Pisani P (2011) The cancer burden and cancer control in developing countries. *Environmental Health* **10** (Suppl. 1), S2. Available from: http://www.ehjournal.net/content/10/S1/S2.

Plenta KJ, Esper PS (1993) Risk factors for prostate cancer. *Ann. Int. Med.* **118**, 793-803.

Silverman HR, Nguyen C, Weight JC, Klein AE (2010) The human retrovirus XMRV in prostate cancer and chronic fatigue syndrome. *Nature Reviews Urology* **7**, 392-402.

Verhasselt Y, Timmermans A (1987) World maps of cancer mortally. Geografisch Instituut Publisher, Brussel.

WHO (2007) Cancer and control: Knowledge into action and control – WHO guide for effective programs. Cancer control series, Module 2, Geneva. Available from: http://www.who.int/cancer/modules/Prevention%20 Module.pdf.

WHO (1996) Infectious diseases and cancer. In: *Fighting disease fostering development*, pp.59-62. Geneva: World Health Organization Report, Geneva.

Wilkinson RG (1996) Unhealthy societies: Afflictions of inequality, Routledge, London.