

Full Length Research Paper

Environmental risk factors and hospital-based cancers in two Nigerian cities

Godson R. E. E. Ana^{1*}, Mynepalli K. C. Sridhar¹ and Michael C. Asuzu²

¹Division of Environmental Health Sciences, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria.

²Department of Community Medicine, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria.

Accepted 12 April, 2018

This ecologic study assessed disparities between environmental risk factors and cancers in two Nigerian cities. Environmental data were obtained for Port Harcourt (highly industrialized) and Ibadan (less industrialized) cities respectively. Ten-year cancer records were also obtained from the University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt and the University College Hospital (UCH), Ibadan. Data were analyzed using descriptive statistics, chi square and t-test statistics at 5% level of significance. Environmental risk factors particularly levels of polycyclic aromatic hydrocarbons in air was higher in Port Harcourt than Ibadan locality ($p < 0.05$). Both skin and lung cancers were higher in Port Harcourt area (19.0 and 3.7%, respectively) than Ibadan (10.4 and 3.2%, respectively) for the combined group ($p < 0.001$). Therefore, people living in highly industrialized communities with increased environmental risk factors are likely to have a higher probability to develop cancers. In-depth studies are required to establish empirical links between the identified environmental risk factors and the prevalence of cancers.

Key words: Environmental quality, industrialized communities, cancer.

INTRODUCTION

Cancer incidence is on the rise globally. In 2002, an estimated 11 million new cancer cases and 7 million cancer deaths were reported worldwide; and nearly 25 million persons were living with cancer (Kamangar et al., 2006). In spite of underestimation, developing countries are known to be contributing 61% of the global incidence (Clayson, 1962).

The spread of cancer varies along geographical lines and according to differences in population groups (Maduagwu et al., 1975). Cancer health disparities reflect differences in cancer incidence, mortality, and prevalence among different populations. Among the eight most common cancers, global disparities in cancer incidence, mortality, and prevalence are evident, and are likely due to complex interactions of non modifiable (that is genetic susceptibility and aging) and modifiable risk factors (that is tobacco, infectious agents, diet, and physical activity) (CHDPR, 2004).

It had been widely documented that in African countries while deaths from communicable and nutritional diseases are falling, those from cancer is rising exponentially (Wogan and Tannenbaum, 1975). Although in Nigeria, the commonest causes of death are infectious diseases, cancer is being increasingly diagnosed; and it is estimated that about 100,000 people are diagnosed with cancer annually. The crude incidence rate for malignant neoplasm in Ibadan was 33.7 and 45.1 per 100,000 for males and females respectively in the 1960's, with the highest rates of 408 and 506 per 100,000 for males and females in the post 60 to 70 year age group (Andelman and Sjuess, 1979).

Breast cancer has become the commonest malignancy in women worldwide and it is now the commonest cancer in Nigeria (Perkin et al., 1977). With an estimated 1,152,161 new cases each year, female breast cancer is the second most common cancer in the world and the most common cancer among women. It accounts for 411,093 cancer deaths per year notwithstanding well-established reproductive risk factors such as early menarche, low parity, late age at first pregnancy, late

*Corresponding author. E-mail: anagrow@yahoo.com.

menopause, and hormonal exposures (Henderson and Feigelsv von, 2000). The greatest risk factor for developing female breast cancer is aging (Lilienfeld and Johnson, 1955)

However, in men prostate cancer has overtaken hepatocellular carcinoma as the most common form of cancer. Prostate cancer is the fifth most common cancer in the world and the second most common cancer among men. During the years 1973 to 1997, prostate cancer incidence rates increased in all parts of the world. Diet has been implicated in the etiology of prostate cancer, but definitive etiologic evidence is lacking. High intake of animal fat, meat (Kolonel, 2001) and calcium (Chan et al., 2005) had been associated with an increased risk of prostate cancer.

Evidence strongly suggests that different environmental pollutants such as soot, tar and oils cause skin and lung cancers (Biomedical Lecture, 1975). With an estimated 965,446 new lung cancer cases per year among males and 386,875 cases per year among females, lung cancer is the most common cancer in the world and the leading cause of cancer related mortality, accounting for 1,179,074 cancer deaths per year. Cigarette smoking is by the far the most important risk factor for lung cancer (Ezzati and Lopez, 2001) Compared with nonsmokers, smokers have a 20-fold increased risk of developing lung cancer. (Alberg and Samet 2003) Other risk factors include occupational and indoor exposure to asbestos, radon progeny, and air pollution, as well as increasing age, genetic susceptibility, and perhaps low intake of fruits, vegetables, and micronutrients (Alberg and Samet, 2003; Wardwell and Massion, 2005; Alberg et al., 2005).

Cigarette smoke is linked to lung cancer. Nitrosamines have been recognized as environmental contaminants particularly in urban air, soil, water, sewage treatment wastes and food materials (Waterhouse et al., 1976). As a result, they may pose a hazard to human health (Abioye, 1981).

Polycyclic aromatic hydrocarbons are very common in the environment and are largely present in the atmosphere, rivers and oceans, soil and processed foods (Adembamowo and Ajayi, 2000). They originate mainly from transportation, heat and power generation, refuse burning, industrial processes and oil contamination. High temperature treatment of foods results in the formation of polycyclic aromatic hydrocarbons. They are also found in smoked meat and fish and have been found to cause cancers in experimental animals (Plenta and Esper, 1993).

Although there is a huge data base on breast and prostate cancers emanating from cancer registries in Nigeria, epidemiological data linking the prevalence of other less dominant cancers with environmental risk factors is lacking. This study compared the prevalence of cancer cases especially those of the lungs, skin and eye that could be associated with diverse environmental

toxicants in two different geographical locations in Nigeria (one with and the other without high industrial activities).

MATERIALS AND METHODS

Study design

The ecologic study design involved collection of records from tertiary health facilities viz the University College Hospital (UCH) located in Ibadan, Oyo State capital and the University of Port Harcourt Teaching Hospital (UPTH) located in Port Harcourt, Rivers State capital. The limitation in this design is that even though majority of the cases were from the region there were other cases referred from other satellite locations.

Ibadan locality

UCH is one of the major and foremost teaching hospitals in the South western part of Nigeria serving communities primarily within this region. Ibadan where the facility is located is the largest indigenous city south of the Sahara. It comprises largely the Yoruba speaking tribe and other ethnic groups. It is dominantly a civil service oriented city with pockets of industries, private businesses, and other forms of trade and peasant jobs.

Port Harcourt locality

UPTH serves Port Harcourt and its environs, especially communities located in the south- south area of the country. Port Harcourt is the most industrialized city in this region located in the Niger Delta Area, boasting of major industries such as the refinery, petrochemical and chemical fertilizer industries. The area has deltaic features, mangrove swamps and equatorial rain forest. The people in this locality are cosmopolitan and are a mixture of industrial workers, civil servants, private business concerns, different forms of vocations, fishermen and peasant farmers.

Environmental characteristics

The environmental characteristics in Port Harcourt, Rivers State were obtained from the State Environmental Action Plan (SEAP) report documented at the instance of the Federal Environmental Protection Agency (FEPA, 1998b) and studies carried out by Ana (1997, 2003). The environmental characteristics in Ibadan, Oyo State were culled from a report on the Environmental Action Plan for Oyo State, instituted by the Federal Environmental Protection Agency (FEPA, 1998b) and studies carried out by Osibanjo and Ajayi (1981).

Hospital records

Hospital records comprising patient case notes for a 10-year period (1992-2001) from UCH, Ibadan and UPTH, Port Harcourt as identified from the respective cancer registries were collected with the help of the cancer registry officials; even though departments such as surgery and chemical pathology were visited. Records were limited to only these two health facilities because they alone had well established and reputable cancer registries. These records were to illustrate the pattern of various cancers including breast, prostate, kidney, lungs, skin and eye. However, emphasis was

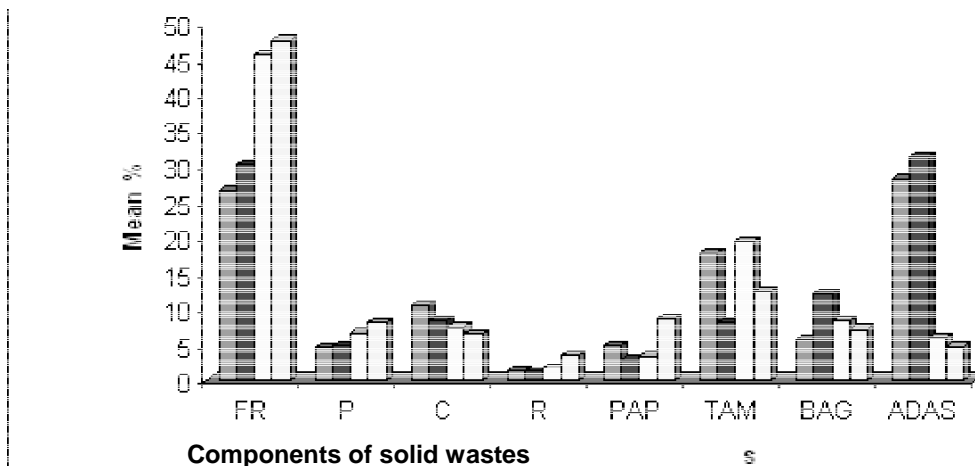


Figure 1. Composition of domestic wastes in various locations in Port Harcourt (Results expressed as mean percent on fresh weight basis). CPH: Central Port Harcourt; D: Diobu ; NL: New layout; GRA: Government Reserved area; FR: Food remnants; P: Paper; C: Cartons; R: Rags; PAP: Plastics and polythene TAG: Tin and glass; BAG: Bottle and glass; ADAS: Ash, dust and stones. Source: Federal Ministry of Housing and Environment (1983).

placed on the last three types of cancer. Records were collected from both locations using a prepared pro-forma.

Statistical analysis

Data gathered was analyzed using SPSS software package version 15. Descriptive statistics such as frequencies, percentages, mean and standard deviation was used. Also, inferential statistical analysis was done using chi-square and student t-test all at 5% level of significance.

RESULTS

Environmental characteristics of Port Harcourt area

The report indicated that water pollution is perhaps the worst problem affecting fresh (both surface and ground), brackish and marine waters in the area. In a study of 27 water sampling stations in Rivers State, 85% of the samples contained total coliforms above 40 per 100 ml. *Escherichia coli*, *Streptococcus faecalis* and *Clostridium perfringenes* were detected in over 75% of the samples and this has health implications (Sridhar, 1995).

Oil drilling, transportation and refining operations contribute to substantial release of pollutants including Polycyclic Aromatic Hydrocarbons (PAHs) (Table 2), which enter surface and ground waters and pollute such aquatic ecosystems. Ana (2003) showed that the pollution of Okrika Creek by industrial effluents affected the Creek quality and its life forms especially fishes and this may have attendant health implications. Solid wastes in the Port Harcourt area, like any other urban environment pose serious environmental and public health problems. The solid wastes contribute to rodent,

mosquito and fly breeding, spread of faeco-oral transmissions such as typhoid, cholera and gastro-enteritis, traffic related problems, flood, fire outbreaks, groundwater and surface water contamination, air pollution and also has nuisance effect. Typical solid wastes characteristics in Port Harcourt (FEPA, 1983) are shown in Figure 1.

Air pollution considered to be one of the most serious environmental problems in industrialized communities like Port Harcourt is mostly from combined sources such as gas flaring, industrial and automobile emissions, power plants, firewood, bush or refuse burning. Gas flaring from oil flow stations is also reported to cause considerable impact on vegetation, animal life and human health.

Industrial air pollution considered to be a major environmental problem was found to be on the increase in this region. The most common air pollutants are mostly smoke, oxides of carbon, nitrogen and sulphur and particulate matter. In a recent study, levels of ammonia, particulates and polycyclic aromatic hydrocarbons were recorded for communities near Port Harcourt in Rivers State (Table 1). Flaring of gas at the petroleum operating sites is of particular concern as fumes are known to contain toxic chemicals which may cause harmful health effects such as mutagenesis, teratogenesis and carcinogenesis.

Typical air pollutants levels in some locations around Port Harcourt (Ana et al., 2005) were: NH_3 $14.1 \pm 4.25 \text{ mg/m}^3$ at Onne; Total suspended particulate (TSP) in ug/m^3 123.4 ± 14.9 , 114.1 ± 11.64 , 75 ± 6.51 , 260 ± 47.7 and 232.5 ± 23.2 at Eleme, Onne, Akpajo, Ebubu and Alesa respectively. Also PAH in ng/m^3 recorded were 5.21 , 3.31×10^4 , 1.88×10^4 and 1.91×10^1 at Onne, Akpajo, Alesa and Ebubu communities, respectively

Table 1. Air quality in Ibadan and Port Harcourt environments.

| S/N | Parameter | Ibadan(*) | Port Harcourt(#) | P-value |
|-----|--------------------------|-----------------|--|---------|
| 1 | TSP (ug/m ³) | 461.1± 28.6 | 123.4 ±14.9 | <0.01 |
| 2 | PAH (ng/m ³) | ND | 7.99 ×10 ³ ±1.31 ×10 ⁴ | - |
| 3 | Fe (mg/m ³) | 0.385 ± 0.13 | 0.09 ± 0.06 | <0.01 |
| 4 | Zn (mg/m ³) | 0.041± 0.01 | 0.05 ± 0.03 | <0.01 |
| 5 | Cd (mg/m ³) | ND | 0.009 ± 0.01 | - |
| 6 | Cr (mg/m ³) | ND | ND | - |
| 7 | Ni (mg/m ³) | 0.0003 ± 0.0001 | 0.03 ± 0.02 | <0.01 |
| 8 | Pb (mg/m ³) | 0.002 ± 0.0013 | 0.06 ±0.03 | <0.01 |

* FEPA (1998a); # Ana (2003).

Table 2. Surface water quality in Ibadan and Port Harcourt environments.

| S/N | Parameter | Ibadan | Port Harcourt | P-value |
|-----|-----------|-----------------|---|---------|
| 1 | pH | 6.5 ± 0. 53 | 5.72 ± 0.75 | <0.001 |
| 2 | PAH | ND | 2.21 × 10 ⁴ ± 2.76×10 ⁴ | - |
| 3 | Fe | 2.213 ±1.98 | 0.05 ± 0.03 | <0.01 |
| 4 | Zn | 0.0058± 0.0047 | 0.05 ± 0.03 | <0.01 |
| 5 | Cd | 0.00038± 0.0002 | 0.05 ±0.02 | <0.01 |
| 6 | Cu | 0.0089 ± 0.0064 | ND | - |
| 7 | Mn | 1.155 ±0.91 | ND | - |
| 8 | Pb | 0.0131 ±0.009 | 0.75 ± 0.06 | <0.001 |

* Ajayi and Osibanjo (1981); # Ana (2003).

(Ana et al., 2010).

Environmental characteristics for Ibadan area

Ibadan though not as industrialized as Port Harcourt has its own peculiar environmental problems contributed largely by poor and unfriendly urban activities. The report indicated that water pollution was one of the most serious environmental problems in the area. This water pollution resulted in water borne diseases including diarrhea which kills several thousands of children every year.

The results from the report indicated a pH range of 7.32 to 8.50 for all the samples, Ca (mg/l) were higher in ground water than the surface water samples, inorganic cations like Fe, Cu, Mn, Mg and Zn were all within the FEPA guideline limits and the trend was similar to the inorganic anions such as SO₂, Cl, NH₄. A very high population density for bacteria and a very high coliform count were recorded in all the samples analyzed. Pathogenic strains like *Vibrio* were present ranging from 1.6-3.0 × 10² in ground water samples and from 5.3 to 1.87 × 10³ in surface water samples. *Salmonella* spp. were also present in samples ranging from 3.3 × 10¹ to 6.7 × 10¹.

Air pollution though lower especially in terms of levels of PAHs when compared to the magnitude in the Port Harcourt environment was also an environmental problem in Ibadan arising mainly from dust particles emitted from concrete and quarry industries, pollutants from domestic fires, bush burning, exhaust of motor vehicles and power generators and gases from fuel oil comprising mainly carbon dioxide, sulphur dioxide, nitrogen oxide and lead.

Over 70% of solid wastes generated in Nigerian cities including Oyo state are putrescible and organic in nature. At national level, the average generation rate is 0.43 kg/c/day. The composition varies from leaves which constitutes the highest percentage (40 to 50%) and closely followed by food remnants (30 to 45%), papers, rags, plastic, metals, bottles and ash/dusts (FEPA, 1998). The estimated domestic solid waste generation rate reported in this study was 0.14 to 0.17 kg/c/day.

Industrial solid wastes which were not included in these estimates accounted for 46,871 tons per year which is rather a conservative estimate. Figure 2 shows typical municipal solid wastes characteristics in the area and the inadequate management of these wastes constitutes a major public health risk. Table 3 shows the level of soil pollution in the study areas with Ibadan area recording

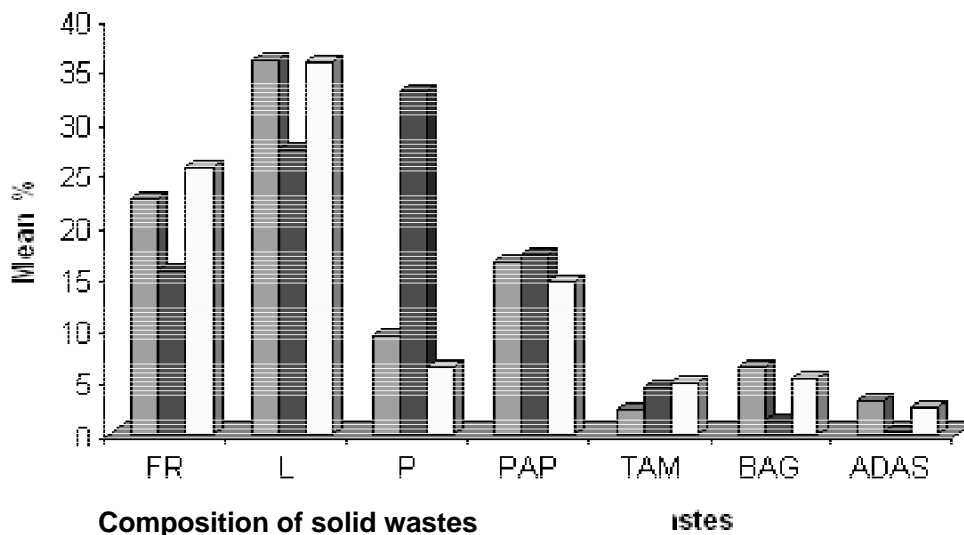


Figure 2. Composition of domestic wastes in Ibadan (results expressed as mean percent on fresh weight basis). O: Oje; OIR: Old Ibe road; OAI: Oke Ado/Irefin; FR: Food remnants; L: Leaves; P: Papers; PAP: Paper and plastics; TAM: Tin and metals; BAG: Bottle and glass; ADAS: Ash, dusts and stones. Source: Federal Environmental Protection Agency (1998a).

Table 3. Soil quality in Ibadan and Port Harcourt environments.

| S/N | Parameter | Ibadan(*) | Port Harcourt(#) | P-value |
|-----|-----------|-------------|---|---------|
| 1 | pH | 5.82-7.58 | 6.78 ± 1.47 | <0.001 |
| 2 | PAH | ND | 8.64 × 10 ⁵ ± 7.37 × 10 ⁵ | - |
| 3 | Zn | 2.13 ± 2.00 | 0.09 ± 0.05 | <0.05 |
| 4 | Cd | 4.4 ± 4.2 | 0.04 ± 0.02 | <0.001 |
| 5 | Cu | 4.0 ± 3.6 | ND | - |
| 6 | Cr | 1.31 ± 9.6 | ND | - |
| 7 | Ni | 7.90 ± 5.60 | 0.03 ± 0.02 | <0.01 |
| 8 | Pb | 1.50 ± 1.43 | 0.04 ± 0.03 | <0.05 |

* FEPA (1998a); # Ana (2003).

higher concentrations of heavy metals.

Proportion of cancers among males in UPTH and UCH

The relative frequency of cancers among males in Port Harcourt and Ibadan shows that the reporting rate of male cancer cases was higher in Ibadan than Port Harcourt. Among male populations in both locations other recorded the highest frequency. However, in terms of other less dominant cancer types, skin cancers were more prevalent in Port Harcourt (23.7%) than in Ibadan (18.4%) while lung cancers were more prevalent in Ibadan (7.3%) than in Port Harcourt (4.7%). On the whole, there was significant difference ($p < 0.001$) for all

the cancer types in both locations (Table 4).

Proportion of cancers among females in UPTH and UCH

The relative frequency of cancers among females in Port Harcourt also shows that the reporting rate of female cancer cases was higher in Ibadan than Port Harcourt. Among the female populations in both locations other cancers with the dominant being breast cancers recorded the highest frequency. However, in terms of the less dominant but emerging cancer types, skin cancers were more prevalent in Port Harcourt (15.6%) than in Ibadan cancers with the dominant types like prostate cancers (6.2%). Unlike for the males, lung cancers were higher

Table 4. Relative frequencies of male cancers at UPTH and UCH.

| Cancer types | Port Harcourt (N=380) | Ibadan(N=1213) | χ^2 | p- value |
|--------------|-----------------------|----------------|----------|----------|
| Lung | 18 (4.7) | 88(7.3) | 2.95 | <0.086 |
| Skin | 90(23.7) | 223(18.4) | 5.15 | <0.023 |
| Eye | 9(2.4) | 148(12.1) | 31.47 | <0.001 |
| Others | 263 (69.2) | 754(61.1) | 6.23 | <0.013 |

Table 5. Relative frequencies of female cancers at UPTH and UCH.

| Cancer types | Port Harcourt (N=524) | Ibadan(N=2310) | χ^2 | p- value |
|--------------|-----------------------|----------------|----------|----------|
| Lung | 15 (2.9) | 25(1.1) | 9.73 | <0.001 |
| Skin | 82(15.6) | 142 (6.2) | 52.97 | <0.001 |
| Eye | 6(1.1) | 110 (4.8) | 14.23 | <0.001 |
| Others | 421 (80.4) | 2033 (86.5) | 16.72 | <0.001 |

Table 6. Total cancer proportions at UPTH and UCH.

| Cancer types | Port Harcourt (N=904) | Ibadan(N=3521) | χ^2 | p- value |
|--------------|-----------------------|----------------|----------|----------|
| Lung | 33(3.7) | 113(3.2) | 0.44 | 0.508 |
| Skin | 172(19.0) | 365(10.4) | 50.59 | <0.001 |
| Eye | 15(1.7) | 258(7.3) | 39.92 | <0.001 |
| Others | 684(75.4) | 2787(79.1) | 5.18 | 0.023 |

among females in Port Harcourt (2.9%) than those in Ibadan (1.1%). There was a significant difference ($p < 0.001$) for all cancer types in both locations (Table 5).

Comparison of total cancer proportions between UPTH and UCH

The total cancer cases in both locations show a ratio of 1:4 reporting rate for UPTH (904) and UCH (3521) respectively. The results indicate that other cancers (which have both prostate and breast cancers) were higher in Ibadan (79.1%) than in Port Harcourt (75.4%). Both the lung and skin cancers were more prevalent in Port Harcourt than in Ibadan unlike the cancer of the eyes that were more prevalent in Ibadan (7.3%) than Port Harcourt (1.7%). There was also a significant difference ($p < 0.001$) for all cancer types in both locations (Table 6).

DISCUSSION

The environmental characteristics of the two study locations show that water pollution and solid waste contamination of the ecosystems are the major visible environmental risk factors associated with the Ibadan

environment although there may be other subtle risk factors. However, the Port Harcourt area records indicate the presence of a major risk factor viz air pollution caused largely by industrial and municipal activities. This is in addition to water pollution and waste contamination of the various ecosystems.

The striking difference between the two environments is that there is an increased likelihood of higher environmental pollution magnitude in the Port Harcourt area owing to its industrial status as compared to the Ibadan area and this may certainly have implications for various health outcomes particularly cancers in the affected communities (Ana et al., 2009).

The assessment of ten-year cancer records (1992 to 2001) from the University of Port Harcourt Teaching Hospital (UPTH) located in Port Harcourt and the University College Hospital (UCH) Ibadan in Nigeria was aimed at assessing the pattern of distribution of cancers particularly the environmentally induced ones in the two locations by types and sex. The observations that there were higher cancer cases in Ibadan than in Port Harcourt could be explained by the fact that UCH is the largest and foremost teaching hospital in Nigeria with a corresponding higher reporting rate.

A comparison of cancer frequency between male and female populations in each location showed that apart

from the dominant cancers, breast in females and prostate in males, (classified under other cancer) the males recorded the highest frequencies of lung, skin and eye cancers. This observation in part is found to be at variance with previous reports that cancer is more frequently diagnosed in females than males (Osuji, 1976) Though not the main focus of the study, observations showed that breast cancer was the most dominant cancer in the populations of both locations. Cervical cancer though present in high numbers was not also given much prominence in this study. According to sex differences, cancer of the breast was still the most prevalent among females while prostate cancer was the most prevalent among the males. This observation is consistent with previous studies on this subject (Perkin et al., 1997).

From the comparison of the total cancer rates in Port Harcourt and Ibadan, it was observed that although the latter had more cancer cases than the former, the percentage of lung cancer was slightly higher in Port Harcourt than in Ibadan. This observation is consistent with studies by Ana et al. (2009) which indicated increased lung cancers in the Port Harcourt environment due to exposure to atmospheric emissions. Similarly, the higher percentage of skin cancer in Port Harcourt over and above that recorded in Ibadan could be explained though with some degree of uncertainty by the increased environmental risk factors in the more highly industrialized Port Harcourt area.

It is important to mention that the higher skin and lung cancer levels reported in Port Harcourt could be associated with a combination of other risk factors including age, race, family history, access to healthcare, and diet (Persau., 1977). On the other hand, the higher total cancer rates in Ibadan though associated with both genetic and environmental factors may not necessarily depict an increased prevalence of the disease in Ibadan when compared to Port Harcourt but a corroboration of the fact that there is increased reporting in the location following better screening and diagnostic procedures (Adembamowo and Adekunle, 1999).

CONCLUSIONS

The study had demonstrated that there are increased environmental risk factors in Port Harcourt area as compared to Ibadan and this may have constituted major contributory predisposing factors for the reported cancers cases.

The higher number of cancer cases reported in UCH Ibadan as compared to UPTH Port Harcourt does not necessarily imply a higher prevalence of cancers in Ibadan.

The high frequency of skin cancers particularly in the Port Harcourt environment may be associated with

exposure of the populations to industrial emissions in the Niger Delta Area.

The higher frequency of lung cancers in males than females in both locations suggests a higher exposure of the males to both outdoor and indoor emissions from domestic and occupational environment.

The number of cases for breast cancers in females and prostate cancers in males contributed largely to the ominously high figures recorded for cancers classified as others in both locations confirming them as the dominant cancers in Nigeria.

It is apparent that populations living in highly industrialized communities such as Port Harcourt with higher environmental risk factors may be more vulnerable to pollution related morbidities including a higher predisposition to cancers of the lung, skin and eye.

However, this study has not been able to establish the empirical linkages and the levels of association between the identified environmental risk factors and the various cancers reported. There is a need therefore to carry out an in-depth study in this area.

ACKNOWLEDGEMENTS

The authors wish to appreciate the efforts of individuals like Late Prof T Solanke of the Department of Surgery, University College Hospital Ibadan and Dr S Wokocha, of the Department of Surgery, University of Port Harcourt Teaching Hospital, Port Harcourt for their unwavering support and encouragement in the course of this study. The statistical input from Dr B Adedokun of the Department of Epidemiology, Medical Statistics and Environmental Health (EMSEH) is also highly acknowledged. We are particularly grateful to the management of the University College Hospital Ibadan and the University of Port Harcourt Teaching Hospital for granting us access to their cancer records within the period under review.

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