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Patterns of Patient Flow to Obafemi Awolowo University Teaching Hospital Complex's Cancer Treatment Centre, Ile-Ife, Osun State, Nigeria

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Abstract. This study analyses the spatial dimensions of patronage of Obafemi Awolowo University Teaching Hospital Complex's Cancer Treatment Centre, Ile-Ife, Osun State, Nigeria, with a view to provide information on the sphere of influence of the centre and to inform future locational decisions. The geographic coordinates of relevant phenomena were obtained using a GPS receiver. Also, the medical records of cancer patients were assessed for relevant information. The collected data were analysed using descriptive and inferential statistics, and geo-spatial techniques. The data showed that a total of 1809 patients from 15 states in Nigeria were enrolled for the treatment of cancer at the hospital. The volume of patronage at the centre was seen to be inversely related to the distance travelled by patients ($r = -.657$, $p>0.05$). For instance, 85% of the patients came from the three (3) states nearest to the health facility, with Osun, the host State, accounting for about half (50.6%) of the total number. Additionally, the study revealed some demographic and socio-economic peculiarities among the cancer patients.

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1. Introduction

One of the major elements in improving efficiency in the delivery of healthcare services is patient flow. An understanding of patient flow can offer knowledge and insight to healthcare providers, administrators, and patients about healthcare needs. Also, an understanding of patient flow is needed to support a healthcare facility's operational activities. From an operational perspective, patient flow can be thought of as the movement of patients through a set of locations in a healthcare facility (Lovett et al., 2002). Effective resource allocation and capacity planning are contingent upon patient flow because patient flow, in the aggregate, is equivalent to the demand for healthcare services. Given the natural complexity of the healthcare environment, the healthcare setting greatly influences both the perception and analysis of patient flow. Fortunately, however, the healthcare environment can be easily characterised on the basis of the nature of healthcare services (Bretthauer, Côté, 1998).

Resources and persons are not equally distributed in space and for obvious reasons of economic viability and politics, the rural areas are disadvantaged in the distribution of facilities like hospitals (Babatimehin, 2013). However, increasing access to quality healthcare services in rural areas might reduce the pressure on the secondary and tertiary hospitals mostly located in cities. According to the National Cancer Society, 80% of cancer cases are curable if detected early (Oguntoke, 2002). The principal modalities used in cancer management, alone or in combination, are surgery, radiotherapy and chemotherapy (Oguntoke, 2002). Early detection is therefore pertinent for effective cancer management.

However, most cancer cases in Nigeria are detected at the late stage, which makes them difficult to cure. The late detection and reporting of cancer cases in Nigeria can be due to the lack of awareness among the population regarding cancer screening and inaccessibility to healthcare facilities which are largely concentrated in urban centres (Lyons, 2004). Hospital and screening facilities are inaccessible particularly to the poor, who live in areas that are far away from the urban areas and where public transportation can be quite inefficient (Philips, 1990; Murad, 2007). Accessibility to a hospital is essential in ensuring that patients get the necessary treatment easily. Ideally, the distance to a healthcare centre with treatment and screening facilities should be less than 12 kilometres or a 50-minute drive using private transport at a normal speed (Jordon et al., 2004).

The detection of patterns in the spatial distribution of features has been of great importance in many fields. An important goal in the detection process is to extract hidden relationships between some variables, possibly conditional on the values of other variables (Gebhert, 1998). Incidences of human diseases vary from place to place, and attempts at understanding this variation have shown that disease occurrence is a combination of environmental, socio-economic, cultural, physiological and other factors. For instance, the geographical distribution of diseases such as cancer, HIV/AIDS, tuberculosis, measles, influenza and pertussis among others reflects the social and environmental conditions that affect risk and susceptibility, and the social interaction and behaviours that facilitate occurrence (Croemley, McLafferty, 2002).

Geographic Information System (GIS) has many useful applications in the health services industry (Richards et al., 1999; Gardner, Harrington, 2003). Various examples abound, especially in the developed countries, where GIS was deployed to carry out analysis relating to spread of disease, accessibility to healthcare facilities, and a host of other factors relating to healthcare delivery. For instance, GIS analysis was used to develop a normative model of patient flow to hospitals using estimated travel times in North Carolina (Walsh et al., 1995), and

to investigate inequalities in healthcare coverage in rural North Carolina (Gesler et al., 1995). It has also been used to identify areas with low accessibility to health services and their socio-demographic traits through overlay functions (Horner, Mascarenhas, 2007), and to model patient flows (Murad, 2004). GIS analysis of hospital care, specifically a Canadian study by Lin et al. (2002) and a Kentucky study of cardiovascular care by Hare and Barcus (2007) yielded a few typical findings. Essentially, the studies show the distance decay effect.

Studies have shown that where there are inequalities in the delivery and take up of cancer services by cancer patients, these inequalities tend to lead to death (Elkan et al., 2007; Thomson, Van Der Molen, 2009). The uneven distribution of cancer registries in Nigeria; inadequate knowledge of available treatment centres; and the lack of knowledge of the patterns of flow to these facilities present serious challenges to the delivery of medical services to patients. One of these is the fact that many cancer patients are compelled to travel over long distances to receive care. Also worthy of note is the poor socio-economic status of most patients which tends to limits their accessibility as they cannot afford the cost of treatment. Undoubtedly, improved accessibility to treatment facility is a key factor that could help reduce the fatality of cancer. This could be enhanced by adequate information on available treatment centres and the services that they offer, and of course the patterns of flow to the available facilities.

In Nigeria, Ingwe (2012) employed the methods of geodemography, spatial analysis and clustering to analyse per capita shares of various health facilities to Nigeria's sub-national regions. Also, Babatimehin (2002) analysed the implications of healthcare provision on human capital development in Nigeria. Similarly, Babatimehin et al (2012, 2011, and 2015) employed geospatial techniques to analyse the distributional and accessibility patterns to healthcare facilities at various spatial levels in the Nigerian geo-political arrangement. Most other studies on the spatial patterns and utilisation of healthcare facilities in Nigeria (Ajala et al., 2005; Ademiluyi, Aluko-Arowolo, 2009; Sanni, 2010; Atser, Akpan, 2009; Abbas et. al., 2012; Ingwe, 2012; Adetunji, 2013; Wojuade, Fadare, 2014; Ujoh, Kwaghsende, 2014) present a scenario of inefficiency in distribution and poor accessibility. Despite concerted efforts at understanding the spatial and accessibility patterns of healthcare facilities at both the micro and macro levels in Nigeria, there has not been commensurate attention paid towards analysing the patterns of flow to healthcare facilities. This knowledge is germane for effective allocation of facilities and resources in the health sector, particularly tertiary and specialised facilities like Obafemi Awolowo University Teaching Hospital Complex's Cancer Treatment Centre (OAUTHC-CTC). Hence, this study employed geo-spatial techniques to analyse the spatial dimensions of patronage of this facility with a view to provide information on the sphere of influence of the centre and to inform future locational decisions.

2. Research materials and methods

The data for this study were derived from primary and secondary sources. The primary data involved the use of a Global Positioning System (GPS) receiver to obtain the geographic coordinates of OAUTHC-CTC and a straight line measurement of the various distances of the patients' State of origin to the treatment centre using the Euclidean distance tool in GIS. The secondary data were mainly the records of cancer patients between 2000 and 2010 which were obtained from the medical library of the cancer registry in OAUTHC from where information about cancer patients such as residential address, age, sex, date and month of admission and cancer type among others were retrieved. Also, relevant base maps were derived from the GIS Unit of the Department of Geography, Obafemi Awolowo University, Ile-Ife.

OAUTHC, a tertiary hospital located in Ile-Ife, Osun State constitutes the study area. Ile-Ife lies between Latitudes 7° 31' N and 7° 35' N and Longitudes 4° 30' E and 4 ° 35' E. For ease of administration, Nigeria is divided into six geo-political zones (North-Central, North-East, North-West, South-East, South-South and South-West), 36 States and 774 Local Government Areas (LGA). Ile-Ife falls within Ife Central and Ife East LGAs in the South-west geo-political zone (see Figure 1). All three tiers of healthcare facilities are represented in Ile-Ife, the study area. These include a teaching hos-

pital, two secondary healthcare facilities and 69 primary healthcare facilities made up of 31 public and 38 private ones. Like every other community in the country, Ile-Ife has its fair share of socio-economic and health problems.

The collected data were analysed using descriptive and inferential statistics. The nature of the relationship between the volume of patronage of patients at the treatment centre and their travel distance was analysed using correlation. The spatial analysis of the distance travelled by cancer patients to OAUTHC for treatment from various states involved a straight line measurement of the various distances of the patients' state of origin to the hospital using a straight-line or Euclidean distance tool in GIS. Also, various analyses and cartographic enhancement of maps were done in the ArcGis environment.

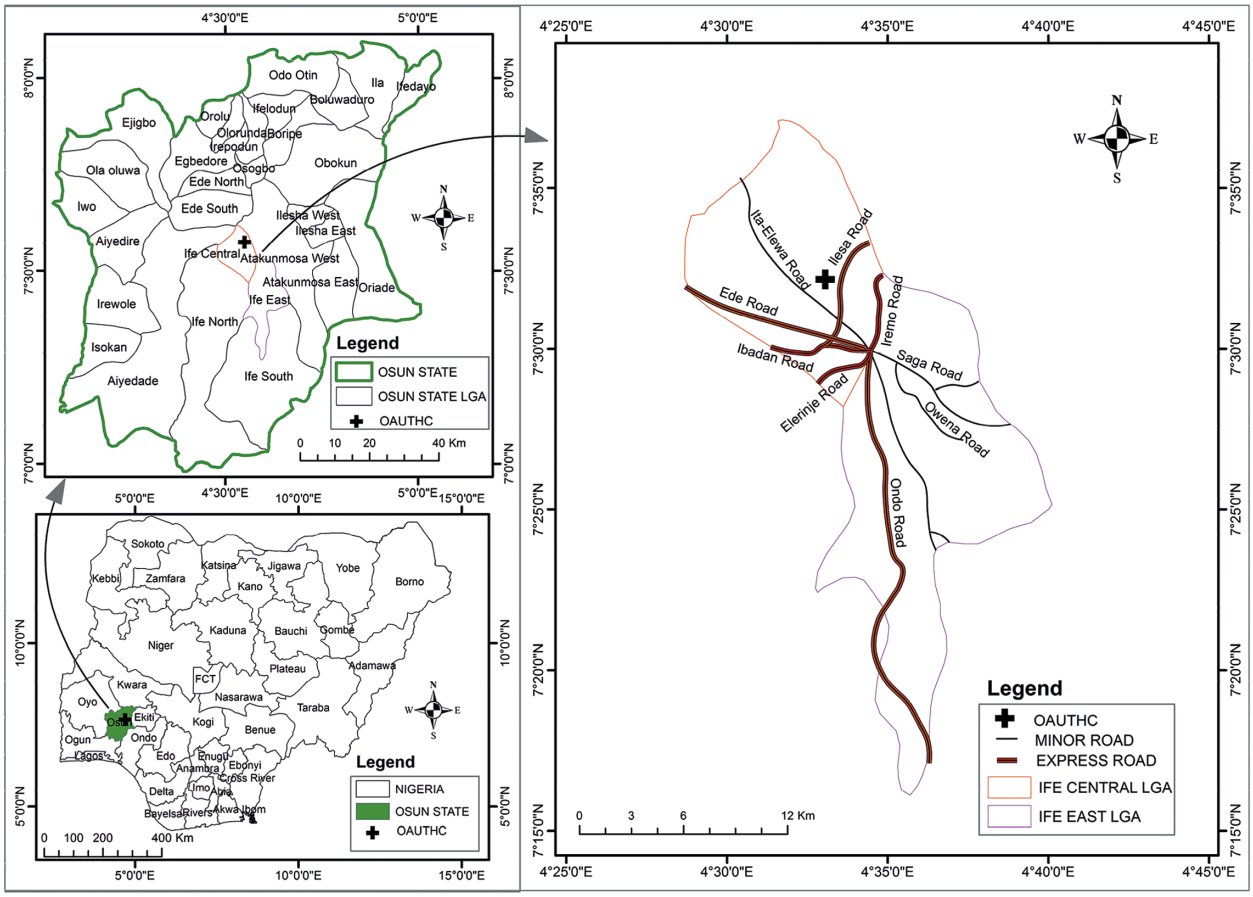

Fig. 1. The Study Area, Ile-Ife in its regional setting

3. Research results

3.1. Types of cancer cases reported and characteristics of cancer patients at the OAUTHC CTC, Ile-Ife

In all, 1809 cases of cancer were reported at the OAUTHC-CTC between 2000 and 2010. Most of the reported cases were on referral (1429, 78.9%) from other hospitals from within and outside the State. Most of the non-referral cases were reported directly to the hospital mostly from communities within Osun State where the hospital is situated. Others came from neighbouring Ondo, Ekiti, Lagos, Kwara and Edo States. About 54% of the cancer patients were females as opposed to 46% males. Well over half of the cancer patients were within the middle age bracket of 31-50 years and most of them were skilled (see Table 1 and Figure 2).

Table 1. Characteristics of Cancer Patients at the OAUTHC-CTC, Ile-Ife

Category	Frequency	Percentage
Referred	1429	78.9
Non Referred	380	21.0
Total	**1809**	**100.0**
Male	837	46.3
Female	972	53.7
Total	**1809**	**100.0**
10-30	178	9.8
31-50	1056	58.4
51 & above	576	31.8
Total	**1809**	**100.0**
Skilled	1228	67.9
Non Skilled	581	32.1
Total	**1809**	**100.0**

Source: Medical Records, OAUTHC, 2012

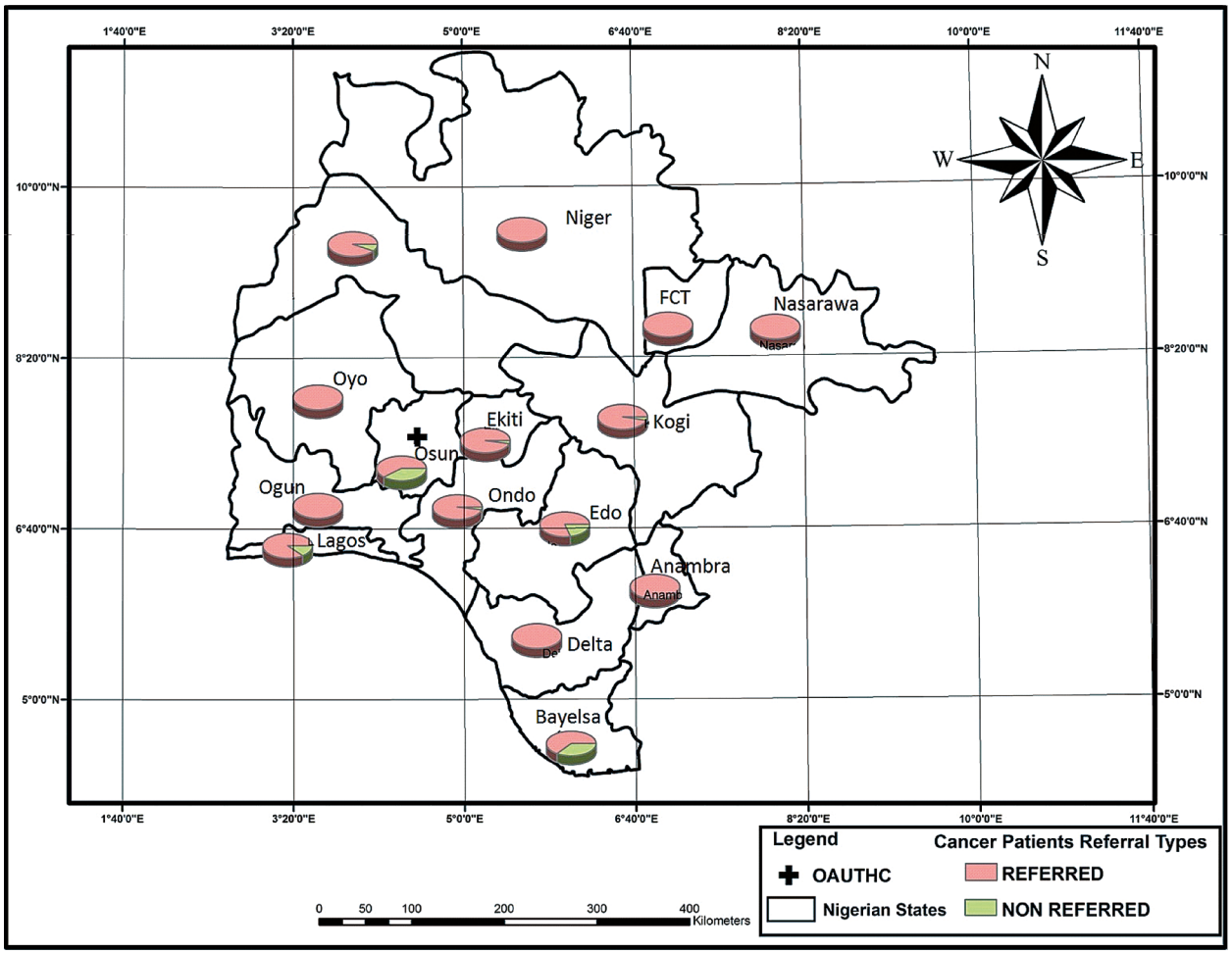

Fig. 2. Referral and Non-Referral Cancer Cases at the OAUTHC-CTC, Ile-Ife, 2000–2010.

Source: Authors' own elaboration

The cancer cases reported at the OAUTHC-CTC between 2000 and 2010 included 21 different types, out of which breast cancer was the most frequently occurring one with 261 (14.4%) cases, followed by cervical (180, 10%), abdominal (141, 7.8%) and ovarian cancer (112, 6.2%) respectively. The least occurring types were brain (28, 1.5%), leukaemia (29, 1.6%) and bone cancer (38, 2.1%) (see Table 2).

Table 2. Reported Cancer Cases at OAUTHC-CTC, Ile-Ife

Cancer type	Frequency	(%)
Abdominal	141	7.8
Bone	38	2.1
Brain	28	1.5
Breast	261	14.4
Cervical	180	10.0
Colon	72	4.0
Connective tissues & soft skin	41	2.3
Bile ductal	45	2.5
Eye	42	2.3
Vaginal	100	5.5
Kidney	44	2.4
Leukaemia	29	1.6
Liver	89	4.9
Lung	89	4.9
Non Hodgkin lymphoma	55	3.0
Ovarian	112	6.2
Pancreatic	92	5.1
Prostate	86	4.8
Stomach	102	5.6
Skin	92	5.1
Oral	71	3.9
Total	1809	100

Source: Medical Records, OAUTHC, 2012

3.2. Spatial interaction of cancer patients with OAUTHC-CTC

The study revealed that the 1809 patients that patronised the OAUTHC-CTC between 2000 and 2010 originated from 15 out of the 36 states in Nigeria. The states were expectedly located in the south-western part of the country, though some other states in the south-eastern and north-central parts of the country also recorded considerable number of patients. The states were Osun, Ondo, Ekiti, Ogun, Lagos and Oyo in the south-west; Kwara, Kogi, Niger, Nasarawa and the Federal Capital Territory in the north-central; Edo, Delta and Bayelsa in the south-south; and Anambra was the only state in south-east. The states form a kind of contiguous cluster around the facility as shown in Figure 3.

Furthermore, data show an inverse relationship between the volume of patronage of patients at the treatment centre and their travel distance; that is, the volume of patient flow decreased with increasing distance to OAUTHC-CTC (r = -.657 and significance level is 0.01, see Table 3).

Data shows that Osun State accounted for 915 patients travelling within the distance of 52.7km, followed by Ondo with 421 patients located within 80.2km from the hospital and Ekiti located within 86.9km from the hospital accounted for 203 of the patients. However, the distant states such as Nasarawa, 406.2km; Bayelsa, 345km; Abuja (FCT), 326.9km; and Anambra located 305.9km away from the hospital recorded 3, 5, 3 and 2 patients respectively. When analysed on a broad basis, it can be shown that a total of 1539 patients, 85.1% of the

Table 3. Results of Correlation Analysis between Distance and Patronage

Variables		Distance	Patronage
Distance	Pearson Correlation	1	-.657(**)
	Sig. (2-tailed)		.008
	N	15	15
Patronage	Pearson Correlation	-.657(**)	1
	Sig. (2-tailed)	.008	
	N	15	15

** Correlation is significant at the 0.01 level (2-tailed)

Source: Authors' own elaboration

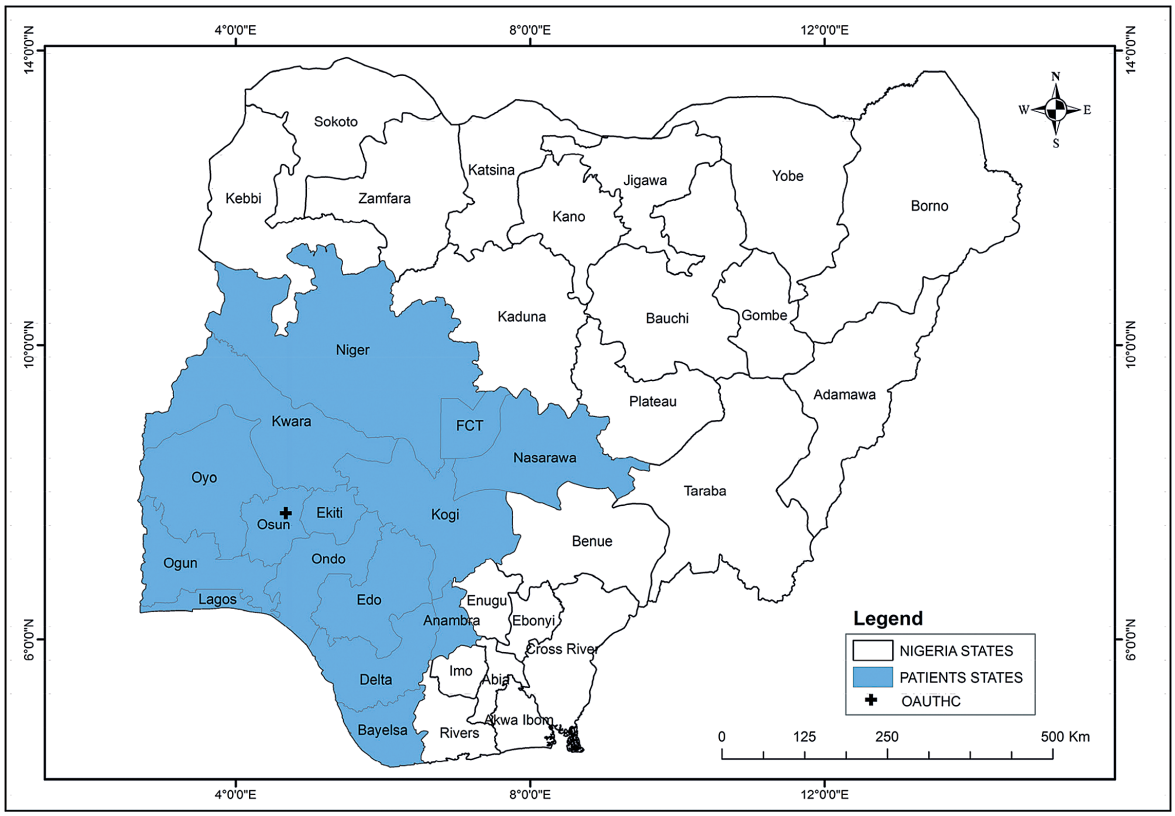

Fig. 3. The Origin of Cancer Patients that Received Treatment at OAUTHC-CTC, 2000–2010.

Source: Authors' own elaboration

sum total of patients generated during the period under consideration, came from 3 states, namely: Osun, Ondo and Ekiti located within 0km-100km from the Teaching Hospital. States such as Lagos, Oyo, Edo, and Ogun as well as Kwara, Niger, Kogi and Delta located within 100km to 300km from the Teaching Hospital, jointly accounted for 257 (14.2%) patients of the total patronage recorded, leaving the Federal Capital Territory, Anambra, Bayelsa, and Nasarawa States, all situated over 300km from the Hospital, with paltry 13 (0.8%) patients of the total patronage recorded (see Table 4 and Figure 4).

Table 4. Flow of Patients to OAUTHC-CTC, Ile-Ife

State	Distance (Km)	Number of Patients	Percentage
Osun	52.7	915	50.6
Ondo	80.2	421	23.2
Ekiti	86.9	203	11.2
Ogun	172.1	68	3.8
Lagos	152.1	25	1.4
Oyo	129.1	48	2.7
Kwara	218.9	58	3.2
Edo	178.9	15	0.8
Kogi	260.9	30	1.7
Niger	289.7	5	0.3
Abuja	326.9	3	0.2
Anambra	305.9	2	0.1
Delta	274.5	8	0.4
Bayelsa	345.0	5	0.3
Nasarawa	406.2	3	0.2
Total		1809	100

Source: Authors' own elaboration

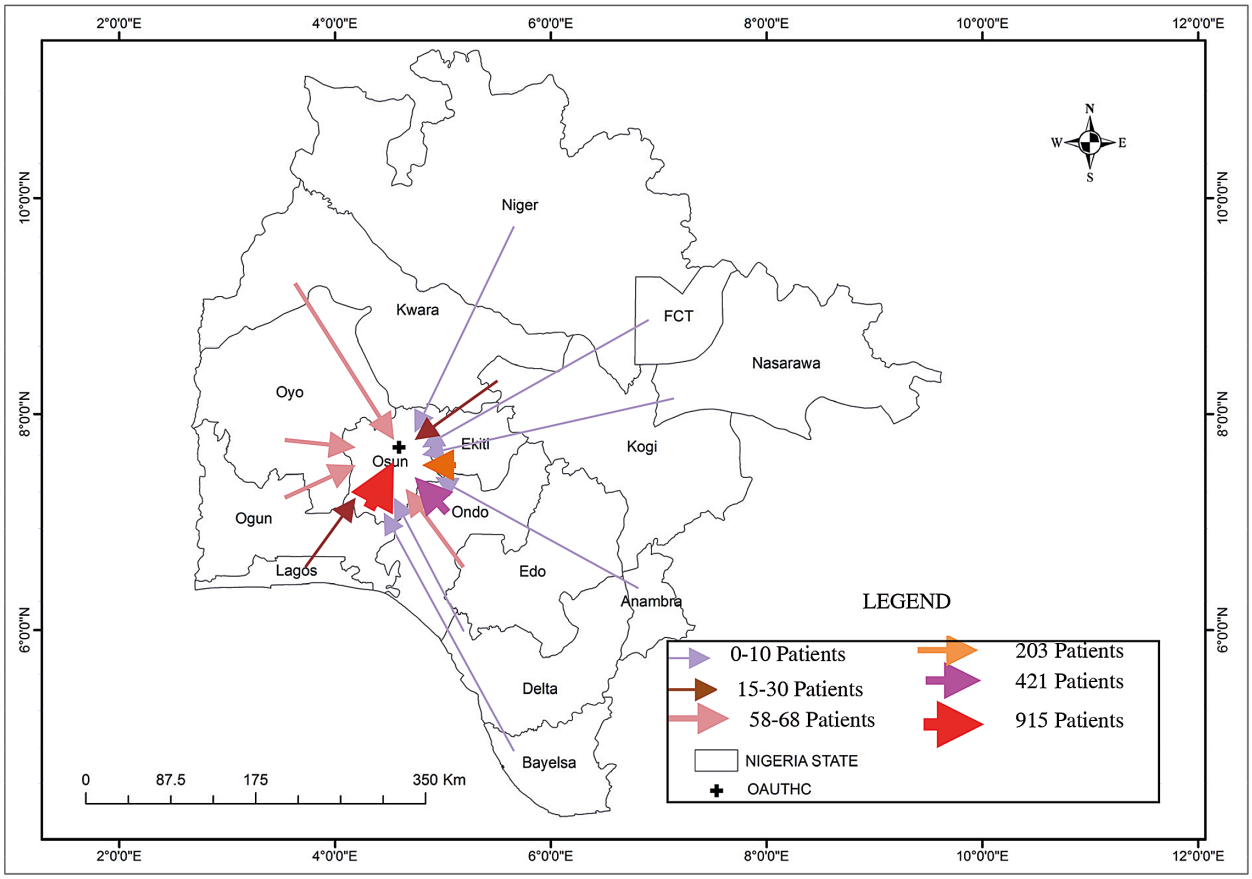

Fig. 4. Flow of Patients to the OAUTHC-CTC, Ile-Ife, 2000–2010.

Source: Authors' own elaboration.

4. Discussion

The conceptual basis for this study was drawn from two widely used models in geography – the gravity model and the central place theory. Newton's law of universal gravitation states that any two objects attract each other with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. The gravity model can be used to predict the degree of interaction between two places (Rodrigue et al., 2009). The basis for interaction is the fact that natural resources and the products of human efforts are not uniformly distributed over space and human and commodity flows are responses to these differences. Interaction is influenced by the friction of distance which has a retarding effect on human interaction because there are increasing consequences in time and cost associated with longer distance and more expensive interchanges. Common experiences clearly suggest that most interactions occur over short distances. That is, interchange decreases as distance increases, a reflection of the fact that transferability cost increases with distance. More generally stated, distance decay describes the decline of an activity or function with increasing distance from its point of origin. However, the rate of distance decay varies with the type of good or service. Beside distance, awareness of supplies or markets, cost of movement, size of facility, and the ability to pay for commodities and services are other factors that determine the nature of spatial interaction (Fellman et al., 2005).

For instance, one is more likely to visit simple nearby healthcare facilities to complain about simple illnesses, rather than farther and complex facilities that handle complicated and referral medical cases. Tertiary healthcare facilities with specialised services are likely to attract patients from a wide range because of the specialised services (such as cancer treatment and care) that they offer.

Therefore, the gravity model can be used to estimate traffic flow, migration between two areas, as well as the number of people likely to use one central facility. The gravity model can also be used to determine the sphere of influence of a central place by detecting the point at which customers find it preferable to travel to one centre rather than the other on account of distance, cost, time and other considerations (Rodrigue et al., 2009). The gravity model in spatial interaction is applied in the literature (examples includes Martinez-Zarzoso, 2003; Rodrigue et al., 2009; Luoma, Palomaki, 2010; Klapka, 2013; Kinces, Toth, 2014; among many others).

The gravity model of migration can be used to explain the patterns of flow (or movement) of cancer patients to Obafemi Awolowo University Teaching Hospital Complex (OAUTHC). The hospital serves its surrounding communities by providing cancer diagnosis, care and treatment to people. Patients report at the cancer treatment centre of the hospital because it has medical experts trained in cancer treatment and facilities for the treatment of the disease, as well as a record of delivery of good medical services. These act like a force of attraction for cancer patients from their various origins to the hospital, especially when these services are not readily available in most other medical institutions around. Therefore, it is expected that a large number of patients will be attracted to the OAUTHC-CTC from other places on referral.

The central place theory was propounded by Walter Christaller in 1933. The main thrust of the theory is that towns act as central places for the countryside, and that they come into being to carry out, at a central accessible place, the tasks which the life of the countryside creates. Although the central place theory deals with the location of towns and cities, it has come to be applied to the location of services within the city and the crucial thing is the centrality which to a large extent determines accessibility of the goods and services concerned.

Different levels of healthcare provision can be categorised as either high order or low order healthcare services which are consequently provided by a corresponding high order town or low order town. Conceptually, the theory holds that places or towns providing higher order healthcare services are fewer in number compared to those providing low order healthcare services. High order healthcare facilities are also widely spaced with a comprehensively vast hinterland, while the opposite is the case for low order healthcare facilities. Hence, cancer care services which are the focus of this study are viewed as high order healthcare services which obviously are provided at high order centres through highly specialised hospitals and facilities.

Therefore, the theory helps in understanding the spatial patterns of flow of cancer patients to OAUTHC-CTC, Ile-Ife which serves as a high order service centre providing high order healthcare services to a wide range of towns and villages.

Despite the understanding that OAUTHC-CTC, Ile-Ife should naturally have a wide range, it is worrisome that a considerable number of cases at the centre were reported from states in other geo-political zones of the country; such as the North-central (Kwara, Kogi, Niger, Nasarawa and the Federal Capital territory); the South-south (Edo, Delta and Bayelsa); and the South-east (Anambra). This calls for questioning the availability of the required services in these areas and, where available, their efficiency. Understandably, one could attribute the referral cases to the non-availability or inadequacy of some services, but how does one explain the non-referral cases that report at the centre? Could it be attributed to the lack of information on availability of service; lack of confidence in available facilities and services delivered; congestion at centres; escape from stigmatization; or could it be a combination of factors? These among many others are vital questions, the answers to which could help in improving the quality of existing services and also inform future locational decisions.

The fact that about 68% of reported cancer cases occurred among children and people in the middle ages shows that cancer can no longer be considered as just a disease of the aged. Therefore, concerted efforts must be made to control the disease, because the loss of lives in these age categories has some deleterious implications on the health parameters of the country.

The flow patterns of cancer patients to the cancer treatment centre of OAUTHC, Ile-Ife shows that the facility is a high order service centre which provides specialised medical services which are either inadequate or totally unavailable in the other hospitals around it. The range of the hospital's services is wide as people are willing to travel over long dis-

tances to enjoy the services provided there. For instance, data showed that people travelled from far away Nasarawa State covering about 406 kilometres to utilize the services provided at the centre.

The relevance of the distance decay concept in the gravity model is brought to bear by the inverse relationship between the volume of patronage of patients at the hospital and their travel distance to the hospital; that is the volume of patient flow to the centre decreased as distance increased. This was corroborated by the results of the correlation analysis ($r = -.657$, $p>0.05$). Also worthy of note here is the concept of intervening opportunity and its effect on the patronage of the hospital. For instance, Oyo State which is relatively close to Ile-Ife (the site of the hospital) recorded a relatively low patronage at the hospital. This might not be unconnected with the location of the University College Hospital (another quality tertiary hospital) in Ibadan, the Oyo State capital. Many patients that would have been attracted from Oyo and neighbouring Ogun and Lagos States might find it more convenient and cost effective to patronise the University College Hospital, Ibadan for their health needs rather than travel to the OAUTHC for the same service.

5. Summary and Conclusion

The study analysed the flow patterns of cancer patients to OAUTHC-CTC. It was revealed that a total of 1809 patients located within 15 different states in the country had patronised the cancer treatment centre of the hospital in the period under consideration. The study established the veracity of the distance decay concept; the volume of patient's interaction with OAUTHC-CTC decreased with increasing distance from the hospital. The six south western states where the hospital is located, viz: Osun, Ondo, Ekiti, Oyo, Ogun and Lagos, accounted for 92.9% of the total number of patients. Patronage was not recorded from the far North-eastern and North-western zones of the country. Another important point worthy of note is the concept of intervening opportunity and its effects on the range of high order service such as the tertiary hospital under consideration. Whereas states such as Ondo and Ekiti that are very close to Osun, the service centre, recorded a high number of patronage at the cancer treatment centre, the same cannot be said of Oyo, another equally close state to the service centre, which recorded a relatively low patronage. The low patronage from Oyo State is attributable to the presence of the University College Hospital (a foremost teaching hospital of high repute), in Ibadan, Oyo State which presents a cheaper and more accessible alternative to the residents of the state.

Beside the authentication of the distance decay concept, the study also showed that OAUTHC-CTC stands out as a high order service centre with a wide range of over 400km which attracted patronage from four out of the six geo-political zones in Nigeria.

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