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Effective Health Care Plan for National Health Insurance Scheme Patients with Non-Communicable Diseases in Plateau North Senatorial District

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ABSTRACT

Patients of non-communicable diseases (NCDs) are usually placed on a life-long prescription or procedure. This is sometimes a problem in itself. They could get tired since they are in most cases, not sickly, they could get careless as a result of familiarity or boredom, etc. The greatest challenge is that they could decide not to access care or continue to access care at a particular location for several reasons which may be culturally, politically, or socially influenced. Consequently, their situation could become more complicated. The location of access points to healthcare for them becomes a critical issue here. In this research, we looked at location of healthcare access points for NCD patients living in Plateau North Senatorial district who are also registered with the National Health Insurance Scheme (NHIS). Data on specialist opinions as to the relevance of each specialist and equipment for the effective management of the associated NCD was collected and analysed to determine relevance ratings. These ratings along with data on availability of specialists and equipment from each care provider registered with the NHIS in the study area, was analysed using the Patient-based Set Covering Location Model (Davwar, Wajiga & Okolo, 2021). The results show care providers that can provide healthcare services to such patients at a quality level T, the threshold value for patients in each location, below which a service provider is not considered. This was done for each NCD (Diabetes and Cancer) under consideration. In the analysis, each NCD was considered a scenario. For each patient of diabetes and or cancer, in each location in the study area, this research determines points of access to quality care.

INTRODUCTION

Patients of chronic non-communicable diseases are usually placed on a life-long prescription or procedure. This is sometimes a problem in itself. They could get tired since they are in most cases, not sickly, they could get careless as a result of familiarity or boredom, etc. The greatest challenge is that they could decide not to continue to access care at a particular location for a number of reason which may be cultural, political, or social. They are mostly healthy looking and so may feel uncomfortable that other people know that they are sick. They may prefer to pretend they have no problems.

They most times prefer to access medical care in some concealed manner. So this study attempts to locate points of access to healthcare service for them. Since this is a medical problem, it is required that a total coverage is achieved. Ordinarily, the classical set covering facility location model would suffice, except that if the classical model optimizes well, a patient will be assigned to one point of healthcare service only. Therefore, if this patient has other psychological considerations but compelled to access care in this one facility prescribed by the model, he may do so but suffer from a psychological stress which may complicate the management of his case over time.

The objective of this research is to locate points of access to health care services for patients suffering from either diabetes or Cancer and who reside in any of the local government areas in Plateau North senatorial district. These points of access provide 'cover' for each of these patient locations at a quality level of at least a threshold

value as prescribed by the patient-based facility location model (Davwar, Wajiga & Okolo, 2021).

LITERATURE REVIEW

NCDs results from a mixture of genetic, physiological, environmental and behavioural factors with pronounced dangers because of its chronic nature. Annually, its global mortality is 41 million people, which accounts for 70% of global deaths. Approximately 40% of these deaths occur among people aged between 30 and 69 years (WHO, 2018a), while 80% of these early deaths occur in low and middle-income countries (WHO, 2018b). Global Health Observatory data in 2018 predicted that deaths from NCDs would rise to about 52 million worldwide in the year 2030 (WHO, 2020).

Of all NCDs, cardiovascular disease accounts for about 40% of all deaths annually while cancers, respiratory diseases and diabetes account for 22%, 10% and 4% respectively. These four diseases similarly account for over 80% of all premature deaths (Olukoya, 2017).

In a WHO report, the probability of dying prematurely from NCDs in Nigeria is put at 20% (WHO, 2018c) while the projected prevalence estimate of diabetes in Nigeria is 4.04% (IDF, 2011). According to the 2012 Globocan data, Nigeria's top five cancer burdens are breast, cervix uteri, liver, prostate and colorectal cancers (Awodele, Adeyomoye, Awodele, Fayankinnu & Dolapo, 2011).

Workable and evidence-based solutions must be provided (Ezzati & Riboli, 2012) to relieve the burden of NCDs in Nigeria which is the aim of this research. Current,

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Daskin, & David (2001) maintained among others that location decisions are often strategic in nature, frequently impose economic externalities and often extremely difficult to solve. He further puts it that there does not exist a general location model that is appropriate for all potential or existing applications.

Therefore, different models are developed for different location decisions. The model employed in this study Davwar, Wajiga & Okolo (2021) was developed to cater for the peculiarities of patients with NCDs.

It will be recalled that Diabetes and Cancer are both NCDs. They are probably the most common chronic health challenges in the contemporary society.

Any research that could lead to an enhanced management of NCDs is very needful because NCDs are an important contemporary health issue, and is growing in importance, because:

- i. A person's social circumstances affect the chance of him/her having a NCD greatly. So, the chances are right that more people will come down with one NCD or the other.
- ii. Some patients have multiple NCDs, which make their care particularly complex.
- iii. NCDs usually have a mild beginning, a simple social habit, or what appears to be a normal life, but gradually grow into a life-threatening monster.
- iv. There is evidence that NCDs can be better managed through increased ease of access to special medical help.

METHODOLOGY

Data from Plateau North Senatorial district on Diabetes and Cancer were collected for this study. Data on availability of specialists and equipment/procedures were collected from all NHIS service providers in the district and used for the analyses. The Microsoft EXCEL solver was used to analyse the data. The analyses and results are presented below:

The Patient-Based Set Covering Facility Location model developed by Davwar, Wajiga & Okolo (2021) was used in this analyses.

Given a set of NHIS service providers in the study area, $N_i = \{j \mid Q_{js} \geq T_s\}$, $\forall j \in J, \forall i \in I$ and for each scenario s , $s = 1,2$

And given that:

N_i is a set of facilities capable of offering service to

patients in location i with scenario s at a quality level of at least T_s

Where:

T_s = Quality threshold for scenario s .

$$Q_{js} = 1/d_{ij} \{F_{js} + E_{js}\} \quad (1)$$

F_{js} = Rating of Specialists at service point j for management of scenario s .

E_{js} = Rating of equipment at service point j for management of scenario s .

Q_{jis} = Quality of service facility j can provide to patient location i with scenario s .

And d_{ij} = Distance from patient location i to hospital j

Then the minimum number of health facilities Z_s that can provide coverage for patients with chronic condition

$$\left. \begin{aligned} \text{Minimize } Z_s &= \sum_{j \in J} x_j, \quad s=1,2 \\ \text{Subject to: } \sum_{j \in N_i} x_j &\geq 2, \quad \forall i \in I \\ x_j &= 0,1, \quad \forall j \in J \end{aligned} \right\} \quad (2)$$

s in all patient locations is given as:

Where: Z_s = minimum number of facilities required to offer complete coverage to all patient locations with scenario s .

J = the set of eligible NHIS facilities (Indexed by j)

I = the set of patients' locations (Indexed by i)

$$x_j = \begin{cases} 1, & \text{if a facility is located at } j \\ 0, & \text{otherwise} \end{cases}$$

RESULTS AND DISCUSSION

To evaluate equation (1) we require the following:

The Specialists and Equipment/Procedure Ratings (F_{js} and E_{js}) respectively for every specialist and equipment/procedure

Using the data collected a score was determined for each specialist and equipment/procedure respectively, as a measure of their relevance to the management of a particular condition (scenario). The rating which is from a five-point scale is the average rating from the responses of professionals in the field of health care provision (Doctors, Laboratory Scientists, Pharmacists, others) on the relevance of a given specialist or equipment/procedure in the management of the particular chronic challenge as presented in table 1 below:

Table 1: Showing Specialists and Equipment/Procedure Ratings

Scenario	Specialists	F_{js}	Equipment	E_{js}
1. Diabetes	Dietician	5.00	Spectrophometer	4.83
	Endocrinologists	4.80	Glucometer	4.80
	Pharmacists	4.80	Insulin Infusion Pump	4.08
	Lab. Scientists	4.71		
	Emergency Rm Med	4.50		
	Dialysis Nurses	3.45		
2. Cancer	Oncologists	4.97	Radiation Machines	4.66
	Pathologists	4.59	Microscopes	4.53
	Surgeons	4.46	CT Scan MRI	4.24

	Pharmacists	4.44	Immunohistochemistry	4.21
	Psychologists	3.47	X-Ray Machine	3.83
	Psychotherapists	3.15		

*Key to abbreviations in table above: CT Computerized Tomography, MRI Magnetic Resonance Imaging

Determination of Health Service Centre Potentials (Total Scores for Specialists and Equipment/Procedure Availability ($F_{js} + E_{js}$))

Data on the availability of specialists and equipment/

procedure at each facility was collected and used to determine specialists' availability score F_{js} and equipment/procedure availability score E_{js} (ie Potential) for each facility as presented in table 2 below:

Table 2: Hospital Potentials (Total Scores for Specialists and Equipment/Procedure Availability ($F_{js} + E_{js}$))

S/N	HOSPITAL	DIABETES	CANCER
1	PL/0057	14.29	14.02
2	PL/0163	14.29	14.02
3	PL/0003	14.29	14.02
4	PL/0172	14.29	14.02
5	PL/0171	14.29	14.02
6	PL/0150	27.21	30.78
7	PL/0014	14.29	14.02
8	PL/0103	14.29	17.86
9	PL/0159	14.29	14.02
10	PL/0116	14.29	14.02
11	PL/0169	14.29	14.02
12	PL/0100	41.13	40.60
13	PL/0168	14.29	14.02
14	PL/0010	14.29	17.86
15	PL/0067	14.29	14.02
16	PL/0079	14.29	14.02
17	PL/0021	14.29	14.02
18	PL/0008	14.29	14.02
19	PL/0075	22.71	26.28
20	PL/0104	14.29	17.86
21	PL/0170	14.29	14.02
22	PL/0009	14.29	17.86
23	PL/0076	14.29	14.02
24	PL/0064	14.29	14.02
25	PL/0120	14.29	14.02
26	PL/0176	14.29	14.02
27	PL/0058	14.29	14.02
28	PL/0019	14.29	14.02
29	PL/0018	14.29	14.02
30	PL/0115	14.29	14.02
31	PL/0111	14.29	14.02
32	PL/0077	14.29	14.02
33	PL/0020	14.29	14.02
34	PL/0066	14.29	17.86
35	PL/0158	28.21	31.94
36	PL/0007	14.29	14.02
37	PL/0057	14.29	14.02

38	PL/0153	14.29	14.02
39	PL/0023	14.29	14.02
40	PL/0108	14.29	14.02
41	PL/0117	14.29	14.02
42	PL/0080	14.29	14.02
43	PL/0139	14.29	14.02
44	PL/0148	14.29	14.02
45	PL/0161	14.29	14.02
46	PL/0165	14.29	14.02
47	PL/0106	14.29	17.86
48	PL/0122	14.29	14.02
49	PL/0164	14.29	14.02
50	PL/0107	14.29	14.02
51	PL/0167	14.29	14.02
52	PL/0102	23.79	27.36
53	PL/0162	14.29	14.02
54	PL/0141	14.29	17.86
55	PL/0121	17.71	21.28
56	PL/0001	14.29	14.02
57	PL/0071	14.29	14.02

Note: See Appendix III for key to Hospital Codes.

Determination of the Quality of Facility j to Handle Patients In Location i With Scenario s. (Q_{jis})

We required the distances from the patient location to the various potential facilities (Appendix II) and the potentials ($\sum(E_{js} + F_{js})$) of these facilities to handle each of the chronic conditions. The potentials were appropriately combined with the distance factors (d_{ij}) to form the quality level of facility j to handle patients in location i,

with scenario s. This quality level of facility j to handle patients in location i, with scenario s is computed as distance weighted. This is because of the negative effect distance has on the quality of service. It is computed for the two scenarios (Diabetes and Cancer) therefore as:

$$Q_{jis} = 1 / (d_{ij} \{E_{js} + F_{js}\})$$

And presented in 3A (for Diabetes) and 3B (for Cancer) below:

Table 3: Quality level of Facility j to Handle Patients in Location i With Scenario s. (Q_{jis})

Hospital	Diabetes						Cancer					
	Bassa	Jos Nth	Jos Est	Jos Sth	B/Ladi	Riyom	Bassa	Jos Nth	Jos Est	Jos Sth	B/Ladi	Riyom
PL/0057	4.76	0.41	0.19	0.27	0.18	0.17	4.67	0.40	0.19	0.27	0.18	0.17
PL/0163	4.76	0.41	0.19	0.27	0.18	0.17	4.67	0.40	0.19	0.27	0.18	0.17
PL/0003	4.76	0.41	0.19	0.27	0.18	0.17	4.67	0.40	0.19	0.27	0.18	0.17
PL/0172	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0171	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0150	0.78	9.07	0.70	1.60	0.60	0.58	0.88	10.26	0.79	1.81	0.68	0.65
PL/0014	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0103	0.41	4.76	0.37	0.84	0.32	0.30	0.51	5.95	0.46	1.05	0.40	0.38
PL/0159	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0116	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0169	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0100	1.18	13.71	1.05	2.42	0.91	0.88	1.16	13.53	1.04	2.39	0.90	0.86
PL/0168	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0010	0.41	4.76	0.37	0.84	0.32	0.30	0.51	5.95	0.46	1.05	0.40	0.38

PL/0067	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0079	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0021	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0008	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0075	0.65	7.57	0.58	1.34	0.50	0.48	0.75	8.76	0.67	1.55	0.58	0.56
PL/0104	0.41	4.76	0.37	0.84	0.32	0.30	0.51	5.95	0.46	1.05	0.40	0.38
PL/0170	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0009	0.41	4.76	0.37	0.84	0.32	0.30	0.51	5.95	0.46	1.05	0.40	0.38
PL/0076	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0064	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0120	0.41	4.76	0.37	0.84	0.32	0.30	0.40	4.67	0.36	0.82	0.31	0.30
PL/0176	0.19	0.37	4.76	0.30	0.19	0.17	0.19	0.36	4.67	0.29	0.19	0.17
PL/0058	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0019	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0018	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0115	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0111	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0077	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0020	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0066	0.27	0.84	0.30	4.76	0.51	0.38	0.34	1.05	0.37	5.95	0.64	0.47
PL/0158	0.54	1.66	0.59	9.40	1.01	0.74	0.61	1.88	0.67	10.65	1.14	0.84
PL/0007	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0057	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0153	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0023	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0108	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0117	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0080	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0139	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0148	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0161	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0165	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0106	0.27	0.84	0.30	4.76	0.51	0.38	0.34	1.05	0.37	5.95	0.64	0.47
PL/0122	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0164	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0107	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0167	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0102	0.46	1.40	0.50	7.93	0.85	0.63	0.53	1.61	0.57	9.12	0.98	0.72
PL/0162	0.27	0.84	0.30	4.76	0.51	0.38	0.27	0.82	0.29	4.67	0.50	0.37
PL/0141	0.27	0.84	0.30	4.76	0.51	0.38	0.34	1.05	0.37	5.95	0.64	0.47
PL/0121	0.34	1.04	0.37	5.90	0.63	0.47	0.41	1.25	0.44	7.09	0.76	0.56
PL/0001	0.18	0.32	0.19	0.51	4.76	0.30	0.18	0.31	0.19	0.50	4.67	0.30
PL/0071	0.18	0.32	0.19	0.51	4.76	0.30	0.18	0.31	0.19	0.50	4.67	0.30

Determination of the Quality Threshold (T)

The threshold value T is determined as the lowest quality level a service point can offer a demand point to qualify that service point for consideration as a candidate in the

analysis for the scenario under consideration. It therefore varies from scenario to scenario and is set by experiment as the smallest quality value for which the model has a feasible solution.

Results from Model Analyses

The results from the model analyses shows the hospitals selected and the patient location that can enjoy service from them for each of the two scenarios (Diabetes and

Cancer respectively) at a quality level of at least T (the quality threshold for that scenario). These results are here presented on the table below.

The results shown below are identical. This is a pure

Table 4: Showing results of the Model Analyses

Diabetes							Cancer						
Facility	Patient Location						Facility	Patient Location					
	Jos North	Jos South	Jos East	B/Ladi	Bassa	Ryom		Jos North	Jos South	Jos East	B/Ladi	Bassa	Ryom
PL/0150	ok	ok	ok	ok	ok	ok	PL/0150	ok	ok	ok	ok	ok	ok
PL/0100	ok	ok	ok	ok	ok	ok	PL/0100	ok	ok	ok	ok	ok	ok
PL/0075	ok	ok	ok	ok	ok	ok	PL/0075	ok	ok	ok	ok	ok	ok
PL/0158	ok	ok	ok	ok	ok	ok	PL/0158	ok	ok	ok	ok	ok	ok
PL/0102	ok	ok	ok	ok	ok	ok	PL/0102	ok	ok	ok	ok	ok	ok

*Key: OK Means Covered by the Corresponding Facility

coincidence and does not mean that other scenarios will have identical results. From the above results, a patient in any of the six patient locations ($i = 1,2,...6$) can access service from any of the five hospitals ($j = 1,2,...5$) chosen by the model with a quality level of at least T ($T= 0.2$ for Diabetes and $T=0.24$ for Cancer).

CONCLUSION

This study therefore concludes that the five hospitals (Bingham University Teaching Hospital, Jos University Teaching Hospital, Our Lady of Apostles Hospital, Dee Medical Centre and Plateau Specialist Hospital) shown in the results provide adequate coverage (makes accessible) to patients with any of the chronic conditions (Diabetes or Cancer) who reside in any part of the Plateau North Senatorial District and who are NHIS subscribers.

RECOMMENDATION

The study recommends any of the five identified hospitals to NHIS subscribers (patients) having Diabetes or Cancer and who reside in any part of the Plateau north senatorial district. Policies that allow the establishment of community parks, sidewalks, bike lanes, playgrounds or village square areas with beautiful landscapes where people can gather, jog, meet and play during leisure encourages people to participate in physical activity.

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