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A NOVEL METHODOLOGICAL APPROACH OF ESTIMATING URBAN POPULATION IN NIGERIA

ABSTRACT. The primary source of population data in Nigeria is the census despite its inconsistency. Consequently, efforts made to estimate population from such census figures and sometimes vital registration system has proved inadequate because of diverse problems. This study is aimed at developing a technique of population estimation in Nigeria using symptomatic data. The data for this study were collected through survey method, immunization and school enrolment data were collected from the Expanded Programme on Immunization and Ministry of Education, respectively. The average number of people per house or crowding index (CI) for Kabba was combined with immunization and school enrolment to establish a relationship which was subsequently used in regression analysis to estimate population. The results show that the population of Kabba and Kogi State were 70,870 and 4,230,382, respectively. The study recommended that the model can be used for population estimation in Nigeria and in places that have similar population data generation problems.

KEY WORDS: Population, Symptomatic, Census, Estimate, Crowding Index

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INTRODUCTION

The census is the main source of population data. Evidence from literature suggests that population data collection dates back to 1789 in Nigeria, but there has never been any consistency in the process. Despite this, population data have remained the main ingredient on which every social, economic and spatial development planning is based. The need for population data is felt more than ever before in Nigeria because of rapid urbanization. Previous studies revealed that increases in population at various times in spatially defined areas of the world usually creates different settlement pattern on the land scape. Oftentimes, a very small village soon becomes so big, covering several hectares of land within a few decades. The inhabitants of such areas are faced with poor roads, poor/ inadequate housing, inadequate water supply, poor power supply, as well as poor dietary intake, among others.

In ameliorating such situations, researchers have concerned themselves with how to unveil population distribution pattern, dynamics, as well as the composition and structure of the population. These and many

other effects that often result from man environment-relation have constituted the geographers' domain of study. Most often, data on the number of people living at such places are generated through the census and where not available through indirect techniques.

The usual and most common method is through projections that are based on the application of the annual growth rate index and through the use of indirect techniques of population estimation (Ekanem 1972; Afolayan 1978; Ayeni 1980; Olorunfemi 1981, 1984, 2005; Mba 2006; Akanbi 2006). Nigeria's total population figures had been estimated from tax records at various times in the past (Adediji 2011). About the middle of the 20th century, the method of generating population data shifted to making estimates from fertility and mortality records. This shift can best be illustrated by Ayeni's work on Katsina (Ayeni 1980). But, as at 2014, registration of births in Nigeria covered only 42% of the rural dwellers (NPC 2014). Thus, using data from this source would appear unsuitable because of low coverage.

The challenges of the techniques above require that research must continue to find improved techniques of population estimation in the absence of the actual census. It is for this reason that the possibility of using immunization and school enrolment data becomes relevant in Nigeria because immunization of children has a wide coverage and its documentation since it was introduced in 1979 has been good. It should be recalled that immunization was introduced to address the prevalent high death rate of children in Nigeria. Among a number of vaccines that were injected on both children and pregnant women is BCG. The BCG usually has the highest coverage because it is first injected at birth, while others are injected at various stages of life thereafter.

Primary and secondary school enrolments in Nigeria have received wider coverage and good documentation in recent times because of the several efforts made by government to encourage secondary school education. Government's quest to encourage education through school enrolment made attendance of primary school and junior secondary school free and compulsory for children of school age. Hence, the enrolment rate improved and actually increased. The present effort is an attempt at evolving a population estimation model based on immunization and school enrolment. If successful, it could become a source of population data generation for local and urban development planning purposes in Nigeria.

THE STUDY AREA

This study was carried out in Kabba, a town in Kabba/Bunu Local Government Area (LGA). The LGA is located on Latitudes of 70 45' and 8028' North and Longitudes of 60 5' and 60 30' East. The Local Government is bounded by Yagba West, Mopamuro and some parts of Ijumu Local Government to the West, the southern part of Ijumu Local Government and Okehi Local Government to the South, Lokoja Local Government to the East, Kogi Local Government and Kwara State to the North (Fig. 1, 2). Kabba in recent times has merged with some of the settlements in its suburbs and a number of people from the settlements in the neighborhood migrated to the town. This has substantially increased the physical expansion of the town to make it worthy of study.

Kabba has three political districts (Kabba, Odolu and Aofin) and seven political wards namely: Aiyetuju/Kakola, Odolu/Fehinti, Ayewa, Asuta, Oke-koko Bolorunduro and Otugunbe. The town is situated at about 78km away from Lokoja, the Capital of Kogi State and about 130km from Abuja, the Federal Capital Territory of Nigeria. Kabba people are Yoruba by tribe. They are believed to have migrated from Ife in Osun State over 900 years ago. Kabba, being the primate town in the Kabba/Bunu Local Government Area, has attracted several other tribes from other settlements. The emigrants are mostly Ebira, Igbo, Tikfi and Hausa.

The 1991 population of Kabba was 36,124, while that of the local government was 79,276 (NPC 1991). However, the 2006 population census did not release the total

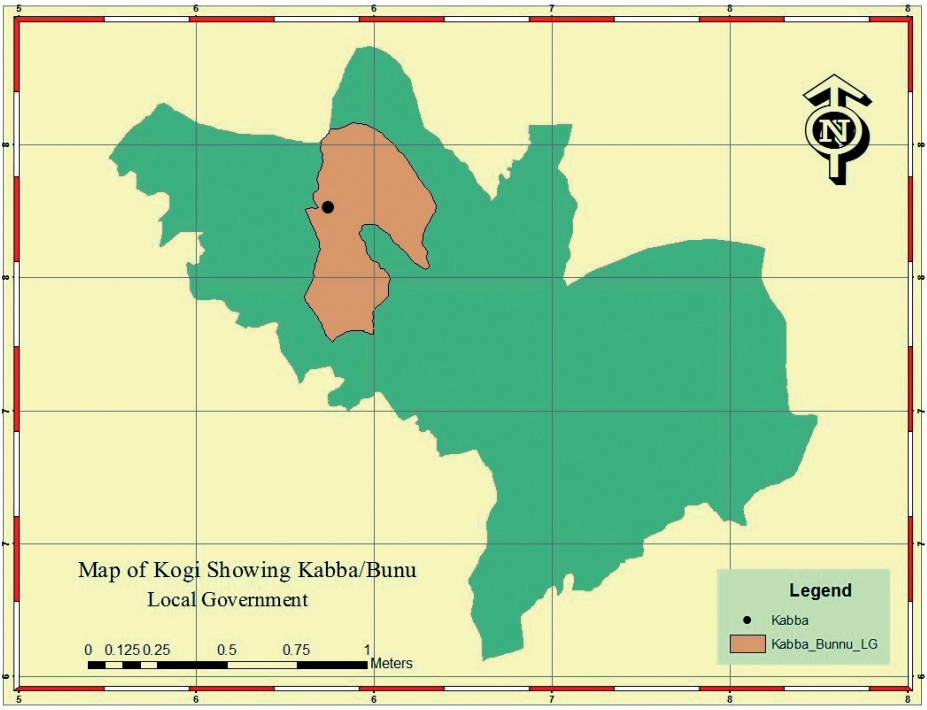

Fig. 1. Map of Kogi State Showing Kabba/Bunu Local Government Area (Kogi State Lands and Survey 2014)

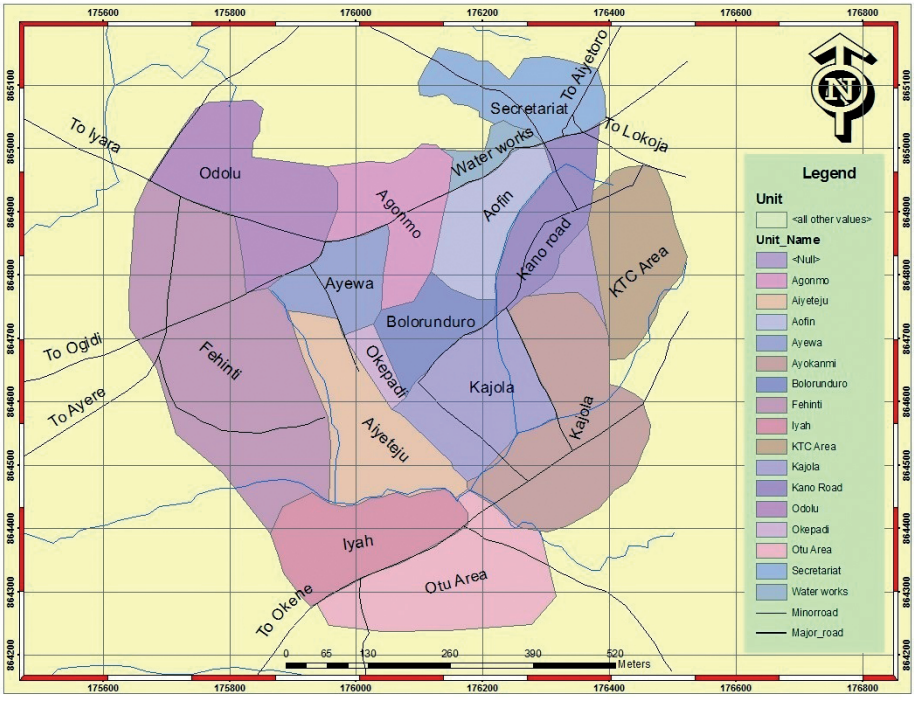

Fig. 2. Map of Kogi State Showing Kabba/Bunu Local Government Area (Kogi State Lands and Survey 2014)

population of Kabba, rather it gave the total population of the local government as 144,579 (NPC 2006). Even at this, evidence of the spatial expansion of Kabba suggests that the population has greatly increased. All the hitherto undeveloped spaces in the South, South-West, West and North-West axes of Kabba have been developed and occupied by residential houses.

Kabba is strategically situated in a low land, but surrounded by hills (Fig. 3). These hills are low-high lands of 305-610 meters in height. Kabba is underlain by Igneous and Metamorphic rocks of the basement complex with Out-crops as massive ridges and rocky hills extended over a greater part of the area (Udo 1975). This landform is characterized by smooth and rounded Inselberg hill particularly, in the West and North of Kabba.

MATERIALS AND METHODS

Both primary and secondary data were used for this study. Data on immunization were collected from the Expanded Programme on Immunization (EPI), the National Programme on Immunization (NPI), and the Ministry of Health. Also, data on primary school and junior secondary school enrolments were collected from the Ministry of Education, National Bureau of Statistics and United Nations Education's Fund (UNICEF). The primary data that includes demographic characteristics, number of houses and household structure were collected through the survey method using questionnaire administration.

The existing 34 quarters in Kabba town were grouped into 16 quarters. Some of the new and smaller quarters were merged to have some fairly big ones for this study. The total number of houses in the study area was obtained from direct house counting conducted in all the quarters. Although the approach was cumbersome, it was the available option. Besides, direct counting of house may be the most appropriate technique of population estimation in an emerging urban centre such as Kabba, especially at the modeling level. Ordinarily if town planning records were reliable, this would have been a faster source of house number. Aerial photographs or large-scale satellite data if available would also have provided a faster source of data on house numbers.

Fig. 3. Oblique Aerial Photo of Kabba Taken by the researcher at the eastern side, the highest point of one of those mountains surrounding Kabba

In selecting the samples, 420 copies of a questionnaire were administered on the household heads. Of these, 411 which accounted for 10% of the household heads in Kabba (NPC 2010) were returned valid. The 10% sample, of course, satisfies the required percentage for social science research particularly, in demographic studies (Oludoyi 2007; Oriola 2002). A systematic sampling technique was employed to select the samples from the sixteen quarters. The first sample was randomly selected in every first street in the quarter, while subsequent samples were selected from every fourteenth house until the last sample in each quarter was secured. The Product Moment Correlation Coefficient was used to determine the degree of association among the paired dependent (population) and the independent variables (immunization, primary school and junior secondary school

$$\bar{Y} = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + e.... \quad (1)$$

enrolments), while the multiple regression analysis was employed to estimate population. The multiple regression formulae adopted is of the form:

Where:

Y = The population of Kabba obtained from average number of people per house;

X_1 = (BCG) Immunization coverage of Kabba;

X_2 = Primary schools enrolment data of Kabba;

X_3 = Junior secondary enrolment data of Kabba;

a = Intercept;
b = Slope of regression; and
e = error term.

RESULTS AND DISCUSSION

Data on population distribution, average number of people per house in the quarters and wards were generated from the questionnaire administered during the field survey.

Crowding Index Pattern in Kabba and Population per Quarter in Kabba

The crowding index of Kabba is 12.2. Expectedly, spatial variation exists between the quarters. Table 1 shows that Ayewa quarter has the highest crowding index of 20.9, while KTC has the lowest of 8.6. The crowding index for the sixteen quarters in Kabba is presented in Table 1.

Using this index, the population per quarter in Kabba was calculated and also presented in Table 1. The data provided the raw material for regression analysis used to establish the relationship between population and the symptomatic data.

Population, Immunization, Primary School Enrolment (PSE) and Junior Secondary School Enrolment (JSSE).

The relationship between population and the selected symptomatic data of immunization, primary school enrolment and junior secondary school enrolment was determined, fitting the collected data into Equation 1. When population was regressed against immunization, primary school enrolment and junior secondary school enrolment data, population correlates strongly and positively with immunization (0.840) and only fairly but positively with primary school enrolment (0.638), and

Table 1. Crowding Index per Quarter in Kabba

S/No	Quarter	C I per Quarters	No of People per Quarter
1	Agonmo	10.2	2,468
2	Aiyeteju	14.9	7,331
3	Aofin	15.5	4,049
4	Ayewa	20.9	3,386
5	Ayokanmi	9.2	2,158
6	Bolorunduro	16.4	3,887
7	Fehinti	9.1	6,834
8	Iyah	9.5	3,620
9	Kajola	16.1	7,052
10	Kano Road	14.7	5,851
11	KTC	8.6	2,245
12	Odolu	10.0	4,550
13	Okepadi	15.5	5,647
14	Otuegunbe	9.3	2,297
15	Secretariat	9.5	4,399
16	Water work	10.3	4,439
	Average	12.2	-

poorly and inversely with junior secondary school enrolment (-0.052) (Table 2a). This suggests that, while immunization and primary school enrolment increase as population increases, junior secondary school Enrolment decreases. The positive correlation with immunization and primary school enrolment is perhaps not surprising, while the low and negative correlation of population and junior secondary enrolment is surprising. Indeed, this development should be a source of major concern for policy makers, because it may be due to mass drop out in the area. The model is:

$$Y = 1413.225 + 28.975x_1 + 0.136x_2 - 2.235x_3 \ldots \quad (2)$$

with a coefficient of determination 0.72.

Further effort to examine the feasibility of having an improved relationship between population and the symptomatic data led to per ward relationship. In Kabba, a number of quarters are usually found within a ward. Thus, when population per ward was regressed against immunization, primary school enrolment and junior secondary school enrolment data, population strongly and positively correlates with immunization (0.817); and it fairly and positively correlates with primary school enrolment (0.657) (Table 2b). Just like the previous relationship between population and junior secondary school enrolment determined in Table 2a, population correlates negatively with junior secondary school enrolment (-0.320) (Table 2b). The table also shows a coefficient of determination of 0.674. This thus implies that 67% of the variation in the population can jointly be explained by immunization, primary school enrolment and junior secondary school. The equation of the regression model is of the form:

$$Y = 3201.609 + 30.182x_1 + 0.101x_2 - 1.808x_3 \ldots \quad (3)$$

Table 2c reveals that the relationship between population and immunization and primary school enrolment in this analysis is the same with the relationship observed in Tables 2a when the three independents variables of immunization, primary school enrolment and junior secondary school enrolment were used. The regression coefficient (0.841) and the coefficient of determination (0.707) for this regression are also the same with that of Table 2a. This indicates that about 71% of the variation in population can be explained by immunization and primary school enrolments only. This suggests that junior secondary school enrolment data has little or no contribution to the value observed in Table 2a. Perhaps, this is why the regression between population and JSSE has continuously indicated an inverse relationship. The equation for the model is

$$Y = 719.746 + 31.465x_1 + 0.141x_2 \ldots \quad (4)$$

Having regressed immunization and primary school enrolment data against population per quarter, each of the two symptomatic data was singly regressed against population to determine their individual relationship. Table 2d shows that, population correlates strongly and positively with immunization (0.840). The regression indicates a coefficient of determination of 0.706. In other words, about 71% of the variation in population can be explained by immunization data alone. It would be observed that, this was the same value observed when immunization and primary school enrolment data were regressed against population Table 2c.

When primary school enrolment data were regressed against population, it indicated that population fairly and positively correlates with primary school enrolment (0.637), with a coefficient of determination is 0.406. This thus suggests that primary school enrolment explained only about 41% of the variation in population. This is by far smaller than the coefficient of determination recorded between population and immunization (0.706) in Table 2d. The results of these two linear regression analyses suggest that immunization data alone can be used to estimate population without losing its quality. Based on the results in Table 2, the immunization derived model

$$Y = 748.865 + 30.014x_1 \ldots \quad (5)$$

would appear the best in the present situation. The implication of the result is

Table 2. Population and Symptomatic Data

A. Population per Quarters, Immunization, Primary School and JSSE				
Variable	Y	x_1	x_2	x_3
Population	-	.840	.637	-.052
Imm. x_1		-	.782	.076
Pri. Sch x_2			-	.360
JSSE. x_3				-
Regression				.849
Coefficient				.720
B. Population per Ward, Immunization, Primary School and JSSE				
	Y	x_1	x_2	x_3
Population Y	-	.817	.657	-.320
Imm. x1		-	.823	-.301
PriSch x2			-	-.173
JSSE. x3				-
Regression				.821[a]
Coefficient				.673
C. Population per Quarter, Immunization and Primary School Enrolment				
	Y	x_1	x_2	
Y	1.000	.840	.637	
x1		1,000	.782	
x2			1.000	
Regression			0.841	
Coefficient			0.707	
D. Linear Regression of Population and Each Symptomatic Data				
Variable	Regression coefficient		Coefficient of determination	
Immunization	0.840		0.706	
Primary school	0.637		0.406	

that population of an area can be estimated based on the immunization data alone. Consequently, model (5) was employed to estimate the population of Kabba town and Kogi State.

The Population of Kabba

$$Y = 748.865 + 30.014x_1 \ldots \quad (5)$$

Using the model developed from the immunization data, the population of Kabba was estimated and put at 70,870 (Table 3).

Further, the model was used to estimate the population of the 21 local government areas in Kogi State and the results are as presented in Table 4. The estimated population for the State is 4,230,359, while the NPC projected

Table 3. Population Estimate Using Immunization Data

S/No	Quarter	Population Estimate
1	Agonmo	3,510
2	Aiyeteju	7,592
3	Aofin	3,450
4	Ayewa	3,480
5	Ayokanmi	4,441
6	Bolorunduro	3,990
7	Fehinti	7,831
8	Iyah	4,621
9	Kajola	7,261
10	Kano Rd.	5,581
11	KTC Area	2,520
12	Odolu	3,450
13	Okepadi	5,311
14	Secretariat	3,900
15	Otuegunbe	3,270
16	Water-work	3,660
	Total	70,870

population is 4,238,836. The estimated population is slightly lower than the NPC by 0.20%. This suggests that the difference is insignificant. Thus, it may be concluded that the model is good for population estimation.

CONCLUSION

The crowding index of Kabba generated through field survey was combined with symptomatic data of immunization, primary school enrolment and junior secondary school enrolment to establish a relationship. The model evolved was used to estimate the population of Kabba as 70,870 and that of Kogi State as 4,230,382. The estimated population of the State is slightly lower than the projected NPC population by 0.20%.

Based on this study, it is recommended that reliable population estimate can be generated using immunization data. This is most especially because immunization programme in Nigeria is universal. This will surely provide quick and reliable source of population for planning purposes, especially at the local level. In addition, immunization data is not sensitive as may not be exposed to the political restitutes of the census. The effort made at developing alternative population estimation techniques, notwithstanding, efforts must continually be made to ensure regular conduct of censuses in Nigeria. In spite of the contribution of the present study, data from the National Identity Management Commission (NIMC), Tax Identification Number in Nigeria (TIN), GSM service provider, Independent National Electoral Commission (INEC) and the present bank verification numbers (BVN) are areas that demand and deserve further research.

Table 4. Population Estimate of Kogi State

S/No	LG Name	Population Estimate	NPC Projection
1	Adavi	277,988	279,778
2	Ajaokuta	157,002	157,697
3	Ankpa	340,477	342,884
4	Bassa	179,032	179,917
5	Dekina	333,814	336,127
6	Ibaji	163,575	164,313
7	Idah	102,526	102,724
8	Igalamelo	188,426	189,395
9	Ijumu	152,110	152,748
10	Kabba/Bunu	185,275	186,218
11	Kogi	147,637	148,249
12	Lokoja	251,726	253,576
13	Mopamuro	56,605	56,863
14	Ofu	245,123	245,626
15	Ogori/Magongo	51,563	51,771
16	Okehi	286,092	287,963
17	Okene	416,323	416,402
18	Olamaboro	203,013	204,135
19	Omola	138,543	139,063
20	Yagba East	189,177	190,162
21	Yagba West	179,332	180,227
Total		4,230,359	4,238,836

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