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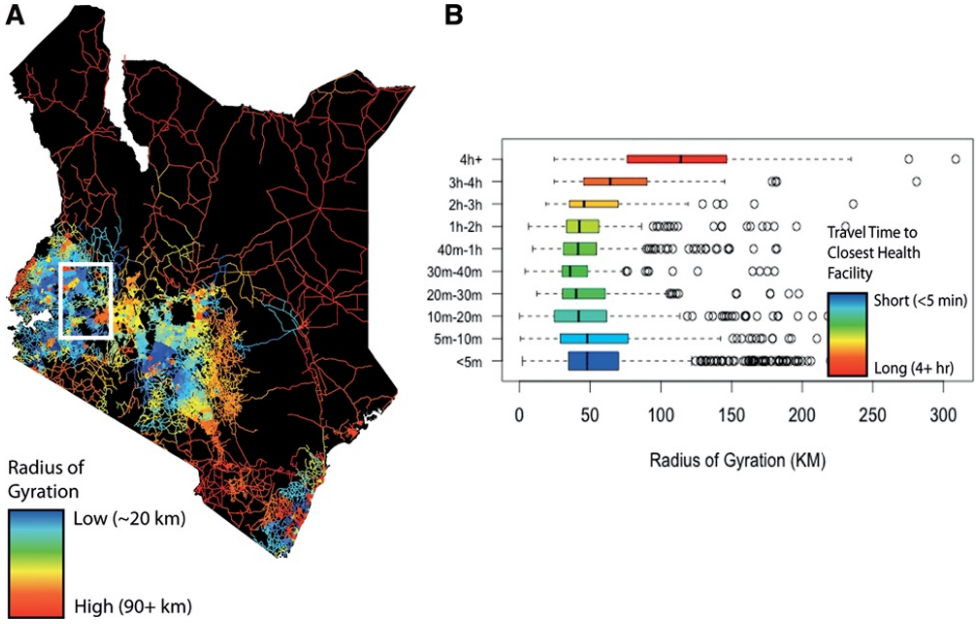
Methodological Investigation

The accessibility of healthcare facilities and services is crucial for the health and wellness of all people and could be a determining factor of a person's survivability. It is one's ability to travel to and arrive at a healthcare facility and receive the necessary medical attention and treatment to survive. In Amartya Sen's book, *Development as Freedom*, Sen explains how "a great many people have little access to health care … spend their lives fighting unnecessary morbidity, often succumbing to premature mortality," (Sen). Sen also explains how freedoms are connected to each other in his description of instrumental freedoms: "These instrumental freedoms directly enhance the capabilities of people, but they also supplement one another, and can furthermore reinforce one another," (Sen). Accessible healthcare influences and is influenced by other freedoms, extending to beyond just the health of a person.

Countries across the world experience varying levels of success in providing and also supporting accessible healthcare to citizens. However, in general, low- and middle-income countries are much more likely to have difficulty in attaining adequate levels of accessible healthcare and historically have suffered from a multitude of issues that lead to premature mortality (Wariri). I decided to focus my research on Sub-Saharan Africa because of the multitude of low- and middle-income countries that comprise the land and that have historically struggled with quality healthcare (Ariyo & Jiang). The issue of accessible healthcare is rampant in Africa, with large populations with a great number of health conditions and issues attempting to seek help and treatment from a very small number of doctors, healthcare professionals, and healthcare facilities (Ajala & Onyima). I further narrowed my research to focus on Nigeria, due to the larger population size and influence. I then established my central research question and the angle through which I wanted to understand my findings: *What are the influential factors in determining the accessibility and usage of adequate healthcare for citizens of Nigeria?* By understanding this, solutions can be proposed and implemented to improve the poor conditions in Nigeria, as well as not only being limited to just Nigeria but potentially being applicable to other countries around the world. Two data science methods that have been used are mobile phone data that provide individual and spatially aggregated travel patterns and logistic regression models.

Understanding human mobility behaviors is an essential part to understanding the issue of accessible healthcare. In one study, researchers have attempted to learn human mobility through the utilization of mobile phones. When a person uses their mobile phone, mobile phone operators log cell tower locations, to which the researchers were able to use longitudinal information and model travel patterns of that person (Wesolowski et al). Mobile phones are commonplace in society today, leading to a massive dataset and strong indication of recurring patterns. The researchers used a measure of individual mobility that consists of both range and frequency traveled by a person, and the radius of gyration to assess the mobility of a person. They determined a primary location for each person dependent upon the tower locations over the course of the year of data collection. The study also contained geospatial techniques to estimate the travel time to the nearest health facility. Population distribution was calculated with the use of land cover and census data, where the travel times between two points were

determined using a cost-distance algorithm that was able to compute the “cost” of traveling on a regular raster grid based on information about the transportation network provided by the Kenyan National Bureau of Statistics (Wesolowski et al). The study took into account two primary outcome variables: completed childhood immunizations and antenatal care for pregnant women. What the researchers found was that people living in counties with poor physical access to healthcare were also the most mobile.



In this figure, it can be observed how as the gyration radius increases, the travel time to the nearest health facility increases. It was determined that “radius-of-gyration values decreased nonlinearly as county population density increased and travel times to reach resources were reduced” (Wesolowski et al). Essentially, the findings were consistent with the hypothesis that those living in more remote communities further out had increased travel.

The second data science method involves using logistic regression models to understand more clearly the use of skilled birth attendants. The study that I researched that used logistic regression utilized data from Nigerian Demographic and Health Survey NDHS reports over many years (Fagbamigbe et al). Through these reports, information about households, sexual and reproductive health, and birth history was collected. In the study, sociocultural factors, perceived benefit/need of skilled attendance, economic accessibility, and physical accessibility were all identified as independent variables (Fagbamigbe et al). The outcome variable was identified as the use of skilled birth attendants. The researchers used descriptive statistics as displayed in the tables to show the distribution of eligible participants.

Table 1 Weighted distribution of women who had given birth in the 5 years preceding the survey by analysis variables and survey year

Characteristics	DHS year				
	1990	2003	2008	2013	Total
Number	4,892	3,775	18,028	20,192	46,887
SBA used					
Unskilled	32.4	38.7	36.6	38.5	36.8
Skilled	67.6	61.3	63.4	61.5	63.2
Age (years)					
15–19	7.9	8.3	6.9	6.3	7.0
20–24	20.8	20.5	19.4	19.5	19.7
25–34	48.0	46.7	46.5	46.7	46.7
35–49	23.3	24.6	27.2	27.5	26.6
Mothers education					
No education	63.9	49.9	49.1	46.9	50.3
Primary	23.3	24.2	22.5	20.0	22.0
Secondary	11.6	22.2	23.2	26.6	22.7
Higher	1.3	3.7	5.2	6.4	5.0
Marital status					
Never married	0.8	2.6	2.5	2.6	2.3
Married/LWSP	95.9	93.4	94.5	94.3	94.5
Formerly married	3.3	4.1	3.0	3.1	3.2
Religion					
Islam	58.8	14.4	55.2	58.9	53.7
Xtiin	37.3	23.5	42.3	39.6	39.5
Other	3.9	62.1	2.5	1.5	6.8
Tribe					
Hausa/Fulani	–	31.0	36.7	40.6	37.5
Yoruba	–	10.9	11.9	11.4	11.7
Igbo	–	11.6	10.1	9.7	10.1
Other	–	46.5	41.4	38.3	40.8
Involved in their own income spending					
Yes	–	90.3	84.3	89.9	86.9
No	–	9.7	15.7	10.1	13.1
Involved in their own health care decision					
Yes	–	23.2	40.9	36.1	37.8
No	–	76.8	59.1	63.9	62.2
Urban	31.6	34.7	26.6	33.0	29.7
Rural	68.4	65.3	73.4	67.0	70.3
Zone					
North central	15.6	16.5	18.5	14.8	16.9
Northeast	11.5	23.2	22.0	20.3	20.3
Northwest	35.5	30.9	26.8	32.4	29.8
Southeast	10.1	8.1	8.2	8.1	8.4
South–south	8.1	10.1	11.8	11.9	11.3
Southwest	19.2	11.4	12.7	12.7	13.3
Distance to health facility being a problem					
No problem	–	26.1	40.6	32.5	36.7
Problem	–	74.0	59.4	67.5	63.3
Currently employed					
Yes	64.5	65.4	68.3	70.8	68.4
No	35.5	34.6	31.7	29.2	31.7
Wealth category					
Poorest	45.2	44.2	49.7	45.7	47.6
Middle	13.9	20.3	19.6	19.9	19.0
Richest	40.9	35.5	30.7	34.4	33.4
Child was planned					
Planned	87.4	84.8	89.6	90.3	89.2
Unplanned	12.6	15.2	10.4	9.7	10.8
ANC attendance					
None	39.4	33.9	39.1	34.5	37.4
Inadequate	10.9	14.4	10.9	12.6	11.7
Adequate	49.7	51.7	49.9	53.0	50.9
SBA used for the last child					
Unskilled	66.2	66.9	68.1	67.0	67.4
Skilled	33.8	33.1	31.9	33.0	32.6
Birth order					
1	16.4	19.2	17.0	17.7	17.3
2–3	30.2	29.0	31.3	30.8	30.9
4–6	33.3	31.1	32.2	32.5	32.4
7+	20.0	20.6	19.5	19.0	19.5
Total	12.0[a]	7.3[a]	51.6[a]	29.0[a]	100

Note: [a]Percentage of total.
Abbreviations: ANC, antenatal care; DHS, Demographic and Health Survey; SBA, skilled birth attendant; LWSP, living with sexual partner.

Table 2 Trends in the percentage of married women who had given birth in the 5 years preceding survey who used SBA

Characteristics	Prevalence of SBA use					Percentage change		
	1990	2003	2008	2013	Total[a]	1990–2013	2003–2013	2008–2013
Age, years								
15–19	33.7	30.1	34.9	35.7	35.4[b]	2.0	−4.5	0.8
20–24	30.8	33.4	32.0	34.3	32.6[b]	3.5	0.9	2.3
25–34	34.3	41.1	40.5	41.3	40.0[b]	7.1	0.1	0.7
35–49	33.1	41.6	36.1	39.9	37.3[b]	6.9	−1.6	3.8
Mothers education								
No education	16.0	15.5	12.4	12.3	13.1[b]	−3.7	−2.9	−0.1
Primary	51.4	46.6	42.4	42.0	43.8[b]	−9.4	−4.7	−0.3
Secondary	78.6	74.5	69.6	69.0	70.3[b]	−9.3	−5.5	−0.9
Higher	93.4	92.0	91.9	93.1	92.4[b]	−0.3	1.1	1.2
Marital status								
Never	65.6	70.9	68.5	69.1	51.3[b]	−16.4	−21.7	0.6
Married/LWSP	31.7	37.5	36.0	38.0	36.2[b]	6.3	0.5	2.0
Formerly married	42.7	45.7	44.1	45.6	44.9[b]	2.9	−0.1	1.5
Religion								
Islam	17.5	18.9	31.5	32.6	22.1[b]	5.0	3.6	1.3
Christianity	37.3	62.0	37.7	62.8	39.3[b]	3.4	0.8	1.1
Other	18.0	22.9	19.0	25.0	22.0[b]	6.2	2.1	6.0
Tribe								
Hausa/Fulani	–	13.6	13.8	13.1	11.8[b]	–	−0.5	2.3
Yoruba	–	78.9	78.7	87.0	81.4[b]	–	8.1	8.3
Igbo	–	77.7	77.5	80.2	79.3[b]	–	3.5	3.7
Other	–	34.4	37.3	39.6	37.9[b]	–	3.2	2.3
Involved in their own income spending								
Yes	–	–	44.0	43.1	42.8	43.1	–	−1.2
No	–	–	53.6	39.0	48.3	40.0	–	−5.3
Involved in their own health care decision								
Yes	–	–	60.6	51.0	59.1	54.1	–	−1.5
No	–	–	52.1	35.7	26.1	36.5[b]	–	−6.1
Place of residence								
Urban	60.1	59.7	63.9	68.2	64.5[b]	8.1	8.5	4.3
Rural	19.6	37.5	26.7	23.9	25.1[b]	4.3	−3.7	−2.8
Zone								
North central	37.3	48.1	43.8	52.4	48.6[b]	15.1	4.3	8.6
Northeast	13.0	20.4	17.1	19.9	18.1[b]	6.9	−0.6	2.7
Northwest	5.5	15.7	9.9	12.5	10.5[b]	7.0	−3.2	2.6
Southeast	55.0	77.5	75.5	82.4	76.7[b]	27.4	4.9	6.9
South–south	61.8	68.6	51.4	68.6	58.5[b]	6.6	−13.2	−0.8
Southwest	73.0	78.5	77.4	81.5	77.9[b]	8.6	3.3	4.1
Distance to health care facility being a problem								
Problem	–	–	19.6	15.7	21.3	24.1[b]	–	1.8
No problem	–	–	45.5	44.1	46.9	48.5[b]	–	1.4
Currently employed								
Yes	39.3	43.4	41.1	42.4	41.4[b]	3.1	−1.0	1.3
No	19.8	29.8	26.9	29.3	26.8[b]	9.5	−0.5	2.4
Wealth category								
Poorest	13.3	18.0	13.4	11.9	13.3[b]	−1.4	−6.9	−1.5
Middle	22.3	32.8	27.9	48.0	36.8[b]	17.7	7.2	2.1
Richest	57.0	66.9	72.1	73.0	70.3[b]	16.0	6.1	−0.2
Child was planned								
Planned	31.0	36.0	35.4	36.0	35.3[b]	5.0	0.9	1.5
Unplanned	41.3	54.0	48.7	55.5	50.0[b]	14.0	1.9	6.8
ANC attendance								
None	2.0	4.0	4.4	4.6	4.1[b]	2.6	0.5	0.2
Inadequate	28.0	29.4	31.4	27.3	29.0[b]	−0.7	−2.1	−4.1
Adequate	58.1	64.1	63.1	68.3	62.7[b]	5.0	−0.9	0.1
SBA used for the last child								
Unskilled	5.3	6.2	6.6	6.7	6.4[b]	1.3	0.4	0.1
Skilled	81.7	86.4	87.0	88.0	87.2[b]	7.1	2.4	1.0
Birth order								
1	38.8	50.1	47.0	49.8	47.2[b]	11.0	−0.3	2.8
2–3	30.6	40.7	41.3	43.5	40.6[b]	12.9	2.9	2.3
4–6	31.9	36.7	39.3	36.8	35.6[b]	5.0	0.1	1.7
7+	30.3	38.4	32.4	32.7	34.0[b]	−7.8	−5.6	0.4
Total	32.4	38.7	36.6	38.5	36.8[b]	6.3	−0.2	1.9

Notes: [a]Significant at 5% if test of association/SBA use for all the data pooled together irrespective of survey years.
Abbreviations: ANC, antenatal care; DHS, Demographic and Health Survey; SBA, skilled birth attendant; LWSP, living with sexual partner.

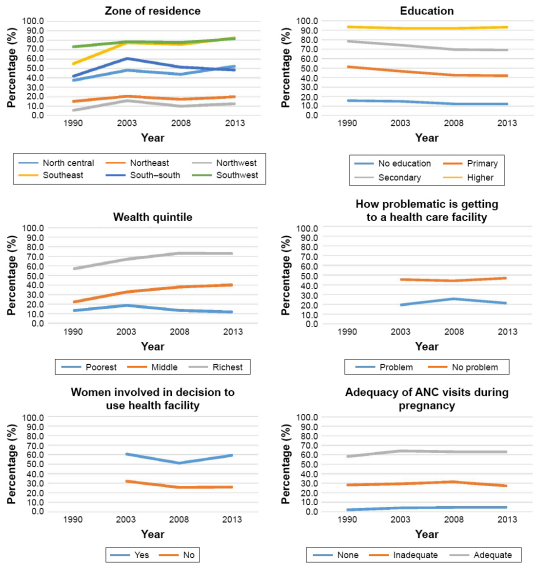


Figure 1 Trends in SBA utilization by selected women characteristics.
Abbreviations: ANC, antenatal care; SBA, skilled birth attendant.

Table 2 presents the prevalence of the use of skilled birth attendants by the women by their characteristics. From 1990 to 2013, skilled birth attendant use rose from 32.4% to 38.5%. An extremely intriguing and indicative correlation was that skilled birth attendants of more educated women was approximately 92.4% while less educated women was approximately 13.1%, a drastic difference.

This figure of logistic regressions illustrates the various trends in skilled birth attendant usage by several different women characteristics. The researchers found significant association among the categories of all variables considered, save for women involvement in her income spending. The study determined that there were notable correlations between characteristics of women (zone of residence, education, wealth quintile, how problematic is getting to a health care facility, women involved in decision to use health facility, and adequacy of ANC visits during pregnancy) and the usage of skilled birth attendants (Fagbamigbe et al).

This second study took a much broader approach towards accessible and adequate healthcare, considering more factors than simply distance as in the first study. It should be noted that both studies offer helpful information and data analysis to support decision making. In this

second study, the discovery of the existence of these correlations is intriguing and suggests that there are multiple areas that solutions can arise from in order to improve the accessibility of healthcare. For example, as shown by the education correlation, the improvement of education that would increase understanding of the severity of illness and life-threatening symptoms would most likely increase usage of healthcare facilities. The wealth quintile is probably indicative of the economic freedom that people may or may not possess, and if they are able to afford healthcare fees or the means of transportation to healthcare facilities. The gender roles are also interesting, and suggest that the usage and decision to travel to healthcare facilities is based on cultural norms and who makes decisions in a household.

As I researched more into accessible healthcare, I came across more and more studies evaluating factors that I had not foreseen and considered as influential. Originally, I was under the impression that physical distance from facilities and geographical barriers would serve as the most important factors. However, with a greater understanding of circumstances and unforeseen components, there are some areas that I think have not been explored sufficiently. I think that the cultural aspect is a significant factor in a person's capability to reach healthcare facilities. I also believe that the level of education is not considered nearly enough as it could have many impacts.

Works Cited

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