Utilization of the Modified Tanahashi Model for Assessing Universal Effective Health Coverage: The Nigeria Bottleneck Instrument and its' Implications for Planning

By

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A Master's Paper submitted to the faculty of

the University of North Carolina at Chapel Hill

in partial fulfillment of the requirements for

the degree of Master of Public Health in

the Public Health Leadership Program

Chapel Hill

Spring 2018

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ABSTRACT

Background

The Sustainable Development Goal 3 (SDG-3) through evidence-based health coverage models; aim to mitigate the existing health disparities among populations. The Tanahashi model developed in 1978 and subsequently modified is one model that has been adapted to several countries to identify gaps and barriers in health systems performance. This modified Tanahashi model is referred to as the *Bottleneck Analysis instrument* for health systems delivery and highlights six determinants of effective coverage. This include *Essential Commodities, Human Resources, Geographical Access, Initial Utilization, Continuous Coverage*, and *Quality*. The first three determinants constitute the supply-side determinants and the other three, the demand-side determinants. The modified Tanahashi model was adapted to Nigeria context and is called the *Nigeria Bottleneck analysis* instrument. This study sort out to assess the nature of the relationships between these determinants that constitute this instrument, premised on the modified Tanahashi model, its ability to perform accurate bottleneck analyses in Nigeria Primary health care system and predict Universal Effective Health Coverage.

Methods

The study used cross-sectional data from 147 LGAs located in 11 states to examine the relevance of the Bottleneck Analysis instrument in UEHC planning. The measures include *Commodity, Human Resources, Geographical Access, Utilization, Continuity and Quality* and are continuous variables. Three analytic approaches—Pearson's correlation, Frequency count and Ordinary Least Squares regression—were used to address the research questions. For select tracer interventions: Routine immunization, Integrated Management of Childhood Illnesses,

Antenatal care and Skilled Birth Attendance and Newborn Care intervention, were evaluated in this study.

Results

Data consisted of Ninety-nine (68%) observations from Northern Nigeria and 47 (32%) from Southern Nigeria. Analysis to determine the correlation between the determinants for the select tracer interventions were predominantly not statistically significant on the supply-side. On the Demand side, the results showed linear relationships between Utilization and Continuity *($p < .001$)* as with Continuity and Quality *($p < .001$)*. The Nigeria bottleneck analysis instrument collectively explained 26-50% of the total variance in the effectiveness of Routine Immunization, Integrated Management of Childhood Illnesses, Antenatal Care and Skilled Birth Attendance and Newborn Care coverage. Another notable finding in this study was that there is significant decrease in the quality of routine immunization coverage in the northern states in comparison with southern states.

Conclusion

In this study, the Nigeria bottleneck analysis instrument was not a good predictor of quality coverage for the select tracer interventions. Aside *Utilization* and *Continuity*, other determinants that make up the instrument, did not significantly predict effective coverage. Furthermore, the few diminished relationships observed in this study— a criteria to perform true bottleneck analyses, impedes proper planning and monitoring of the nation’s progress to Universal Effective Health Coverage. To ensure appropriateness of use, improved healthcare information systems for better data quality and well-structured proxy-indicators are required. Likewise, the government should provide the necessary resources to drive competency in data management and collection.

ACKNOWLEDGEMENTS

My deepest thanks to my advisor, Professor Rohit Ramaswamy, for his invaluable guidance and support in developing the content and direction for this research paper.

I am very much thankful to my Second Reader, Dr. Ejemai Eboreime for his keen interest, support and enormous contribution to this paper.

I express my deep sense of gratitude and appreciation to the Ebhohon, Ansong and Malik family for their unwavering support during my Master's program.

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ABBREVIATIONS

ACT	Artemisinin Combination Therapy
ANC	Antenatal Care
BCG	Bacille Calmette-Guerin
DV	Dependent Variable
DTP	Diphtheria Pertussis Tetanus vaccine
HF	Health Facility
HIV	Human Immunodeficiency Virus
IDV	Independent Variable
IPT	Intermittent Preventive Therapy
IMCI	Integrated Management for Childhood Illnesses
IRB	Institutional Review Board
LGA	Local Government Area
LMICs	Low and Middle-Income Countries
MCV	Measles Conjugate Vaccine
M & E	Monitoring and Evaluation
NPHCDA	National Primary Health Care Development Agency
NSHDP	National Strategic Health Development Plan
OLS	Ordinary Least Squares
OPV	Oral Polio Vaccine
Penta	Pentavalent Vaccine
PHC	Primary Health Care
RI	Routine Immunization

SBANC	Skilled Birth Attendance and Newborn Care
UN	United Nations
UNICEF	United Nations Children Fund
UHC	Universal Health Coverage
UEHC	Universal Effective Health Coverage
WHO	World Health Organization

CHAPTER 1

Background

Disparities in health and care among and within countries is well known. The *Tracking Universal Health Coverage: 2017 Global Monitoring Report* by the World Health Organization (WHO) and the World Bank revealed that over 400 million people worldwide do not have access to primary care (WHO & World-Bank, 2015). These disparities are partly due to limited access, inequitable distribution of adequately trained health professionals, cost and poor service delivery (Adedini, Odimegwu, Bamiwuye, Fadeyibi, & De Wet, 2014), and are particularly problematic in Low and Middle-Income Countries (LMICs) (Leslie, Malata, Ndiaye, & Kruk, 2017).

Studies from High-Income Countries link primary health care and Universal Health Coverage (UHC) to lowered health costs, heightening the importance of improved primary health care in LMICs where progress towards UHC remains below expectations (Leslie et al., 2017; Macinko, Starfield, & Erinosho, 2009). Given the benefits of primary health care and UHC, the United Nations (UN) recommend that countries strengthen primary health care (PHC) systems to ensure coverage for all at every stage of life (ECOSOC, 2017). UHC has four core tenets: strengthening health systems, providing affordability of care, improving access to services, and building capacity (Ng et al., 2014). However, a critique of most UHC initiatives is that they guarantee extensive coverage, but not Universal Effective Health Coverage (UEHC) that encompasses both nominal coverage and health intervention quality (Guerrero-Núñez, Valenzuela-Suazo, & Cid-Henríquez, 2017; Ng et al., 2014). Therefore, there is a growing consensus that evaluation of health systems delivery towards UEHC attainment would benefit from performance analyses (Bitton et al., 2017; Chopra, Sharkey, Dalmiya, Anthony, & Binkin, 2012; Hayes, Parchman, & Howard, 2011; Reeve, Humphreys, & Wakerman, 2015; Tanahashi, 1978; Wong et al., 2010).

The Tanahashi coverage model developed in 1978 is one model introduced to monitor and evaluate health systems. The model, as depicted in Figure 1, consists of five distinct and indispensable stages required in sequential order to predict quality coverage (a measure of the proportion of people with health benefits).

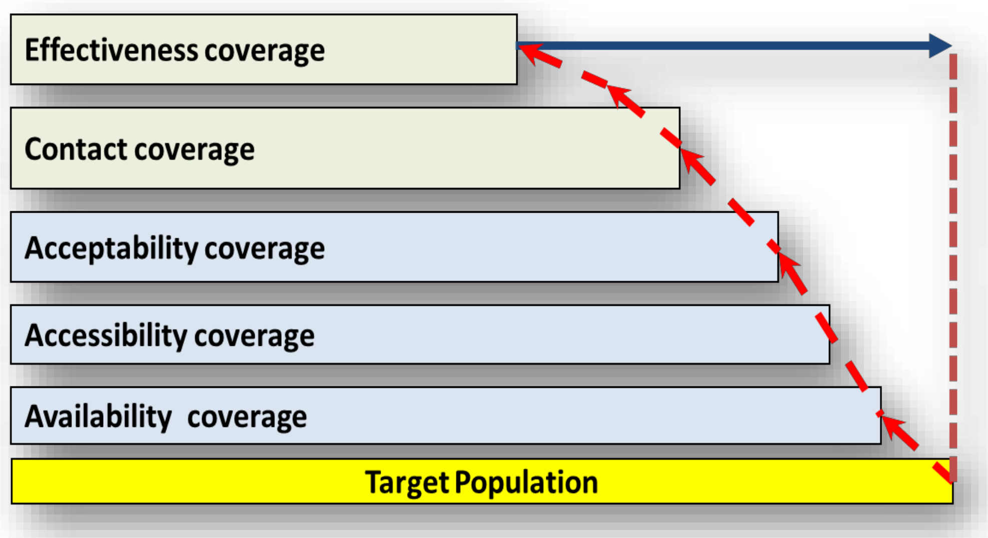

Fig. 1. Tanahashi coverage diagram and coverage measurements. Source: From (O'Connell & Sharkey, 2013).

The model highlights the need for availability of essential commodities and human resources (*availability coverage*) as the first step for the attainment of Universal Effective Coverage, followed by the development of strategies aimed at mitigating barriers to health intervention accessibility (*accessibility coverage*). Once *availability* and *accessibility coverage* are in place, Tanahashi proposed that other factors such as affordability, values, and beliefs be addressed, to increase a population's willingness to use an intervention (*acceptability of coverage).* Sequential execution of processes intended to address each of these stages is expected to increase a population's initial and continued interaction with the service providers and essential commodities (*contact coverage*) that will culminate in quality coverage (*effectiveness coverage*)

(Tanahashi, 1978). In Tanahashi's view, the gap in health systems delivery, which he identified as the difference between *effectiveness coverage* (the proportion of the target population that interacts with all five stages) and *nominal coverage* (the proportion of the target population that interacts with only the first three stages), needs to be filled (Kiwanuka Henriksson, Fredriksson, Waiswa, Selling, & Swartling Peterson, 2017; O'Connell & Sharkey, 2013; Tanahashi, 1978).

Several decades later, O'Connell and Sharkey (2013) revealed some limitations to the use of the Tanahashi model. They pointed out that all five stages (*availability, accessibility, acceptability, contact and effectiveness coverage)* are evaluated based on public sector data thought to be comprehensive, but in reality, there are challenges in obtaining comprehensive data on primary care and services rendered by the private health sector, resulting in underestimation of coverage indicators. The *availability (essential commodities and human resources)* and *accessibility coverage* indicators are the most susceptible to data challenges compared to the stages (*acceptability, contact and effectiveness coverage*), whose data are derived mainly from household and popualation surveys. This critique led to a critical modification focused on obtaining the appropriate proxy indicator measurements for monitoring and evaluation of each process stage. Furthermore, *availability coverage* was split into two separate determinants—*availability of essential commodities* and *availability of human resources*—to improve data management by service providers (see Fig. 2). The resulting six-stage determinant model is known as the *modified Tanahashi model* (three determinants each on the supply and demand side) (O'Connell & Sharkey, 2013).

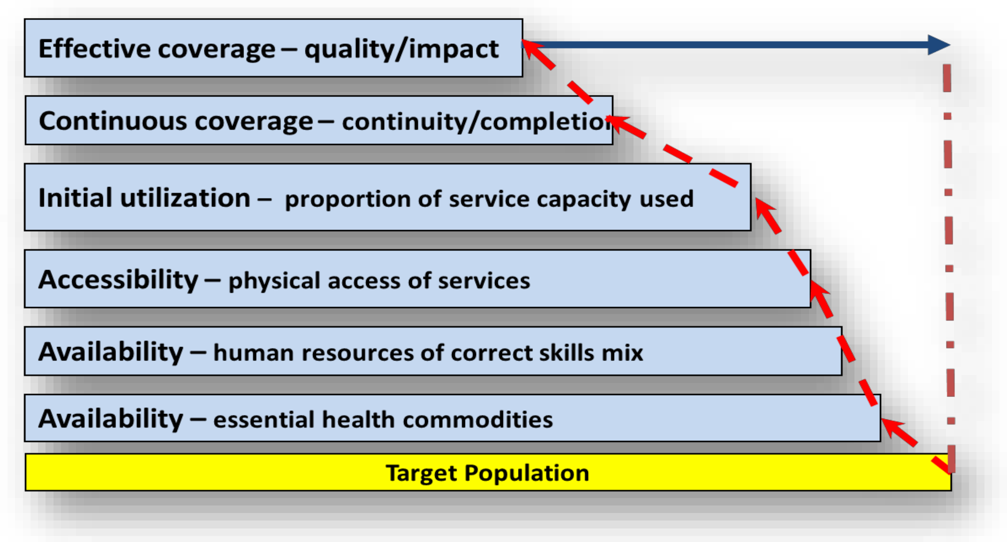

Fig. 2. The modified Tanahashi model for health systems. *Source: From (O'Connell & Sharkey, 2013)*

Two assumptions underlie this modified version:

Assumption 1: Supply side determinants should show positive correlations but there is no requirement for a cascade since each denominator on this side of the model might differ.

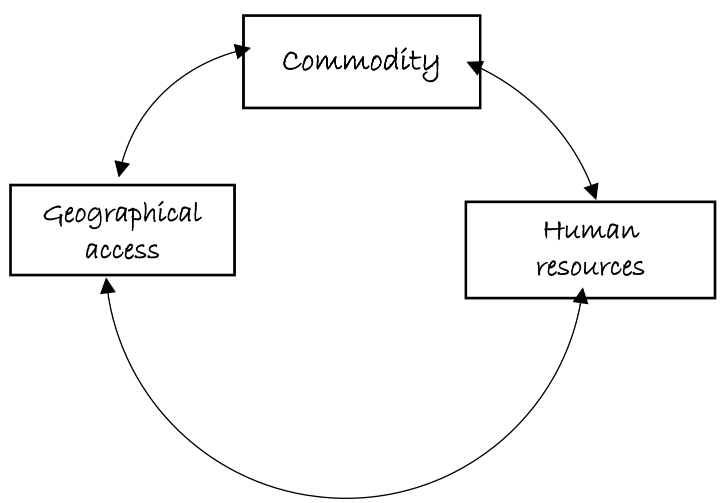

Fig. 3. Conceptualization of the assumed relationships between the supply determinants.

Assumption 2: On the demand side, linear realationships must be found that is, initial utilization value should determine continuous utilization value that in turn should determine effective coverage value. In addition, a diminished cascade between the demand-side determinants is a criteria to perform true bottleneck analysis (see Fig. 3) (Kiwanuka Henriksson et al., 2017; O'Connell & Sharkey, 2013).

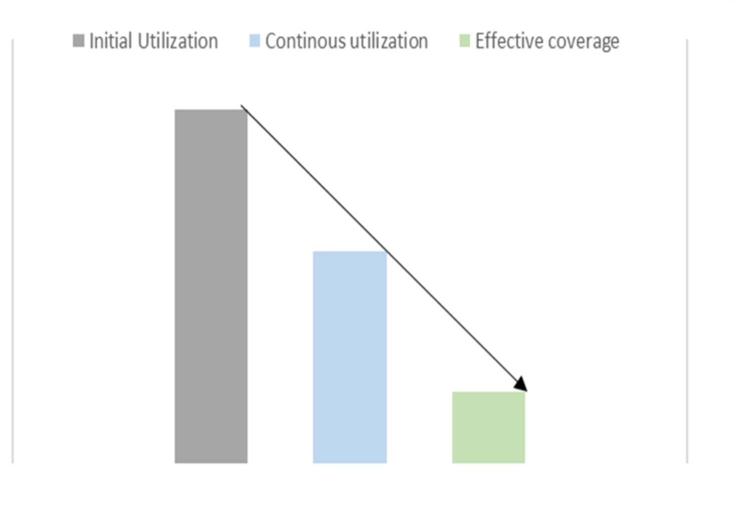

Fig. 4. Conceptualization of the diminished cascade between demand-side determinants.

Because it is not feasible to access the quality of all interventions provided in a given setting, O'Connell et al also introduced the concept of *"tracer interventions."* These are a set of selected interventions most relevant to a local context and generalizable to other health interventions in the country (Boerma, AbouZahr, Evans, & Evans, 2014; O'Connell & Sharkey, 2013). During the assessment of PHC system, the selected interventions are evaluated with the modified Tanahashi model and data obtained help estimate a nation's progress towards UEHC. The United Nations Children Fund (UNICEF) and other stakeholders have now applied the modified Tanahashi model to several LMICs, including Nigeria, to identify and address gaps in health systems delivery (Baker et al., 2015; Kiwanuka Henriksson et al., 2017; Rupani, Gaonkar, & Bhatt, 2016; Yawson et al., 2016).

Problem Statement

Following the adoption of a long-term National Strategic Health Development Plan (NSHDP) by Nigeria Federal Ministry of Health to address the disparities in health and care in the nation, the modified Tanahashi model was adapted to the Nigerian context and used to evaluate the nation's PHC system. The adapted tool—*Nigeria Bottleneck analysis (NBNA) instrument*—has been used to identify strengths, gaps, and barriers in health systems delivery. Tracer interventions evaluated by the NBNA instrument include *Routine Immunization (RI), Integrated Management of Childhood Illnesses-Malaria (IMCI), Antenatal care (ANC)* and *Skilled Birth Attendance and Newborn Care (SBANC)* (NPHCDA, 2009).

Thus far, the NBNA instrument demonstrates face validity as an effective tool for UEHC planning based on similarities to the modified model, content review by experts, and scholarly articles that cite availability, accessibility, and utilization of services as top contributors to improved population outcomes (Adedini et al., 2014; Baker et al., 2015; Kiwanuka Henriksson et al., 2017; Rupani et al., 2016). However, to test its effectiveness in the Nigeria context, it is critically important to ascertain empirically the instrument's ability to (a) predict UEHC, and (b) exhibit the characteristics of the modified Tanahashi model. In other words, does the assumption of a correlation between the supply-side determinants and linear relationship between the demand-side determinants hold when applied to field data from Nigeria? The present study aims to determine the applicability of the Nigeria BNA instrument in planning for UEHC to help provide clarity on these unanswered questions. The objectives are:

1. To assess the nature of the relationships between the indicators in the NBNA instrument and how it compares to the modified Tanahashi model.
2. To determine the ability of the NBNA instrument to perform accurate bottleneck analysis in Nigeria PHCs.
3. To examine the extent to which the NBNA instrument predicts effective coverage for the selected tracer interventions (*RI, IMCI, ANC and SBANC*).

Insights gained from this study will help validate the applicability of the NBNA instrument to evaluate Nigeria's progress towards UEHC and to make recommendations, if any, for improving the instrument validity for better measurement outcomes.

CHAPTER 2

METHODS

Study Setting and Design

The study used cross-sectional PHC data collected using the Nigeria BNA instrument from Local Government Areas (LGAs) located in the northern and southern regions (See Fig. 5). Per the World Bank's income classification, Nigeria is a Lower-Middle Income Country. Located in Western Africa, Nigeria has an estimated population of 196 million. The Federal Republic, comprising 36 states and the Federal Capital Territory (FCT, Abuja*)* is subdivided into 774 local government areas (Ishaku, Majid, Peters, & Ali Haruna, 2011). According to WHO data, the life expectancy in Nigeria at birth for male/female is estimated to be 53.4/55.6 years (WHO, 2015)

***red dots denote the eleven states included in the study**

Fig. 5: Map of North and South regions of Nigeria

The nation's health system comprises both public and private sectors categorized into tertiary, secondary, and primary health care. An estimated 30345 primary, 3993 secondary and 85 tertiary health facilities (n = 34423) make up the Nigeria health systems (Makinde et al., 2014).

The study sample is a list of PHCs in 147 Local Government Areas (LGA); 100 LGAs were from the northern region and 47 from the southern region (See Table 1). The total population size for the 147 LGAs was approximately 38 million. All data were collected during quarterly PHCs reviews from 2012 through 2016. Therefore, the likelihood that some of the data used in this study is obsolete is present.

Selection Criteria— PHC data from 156 LGAs were made available for this study. PHCs included in this study were those with sufficient data on the selected tracer interventions evaluated. PHC that did not meet the inclusion criteria were excluded from the study.

Table 1: Data Sources

Region	State	Freq.	%
South	Abia	16	10.96
	Lagos	4	2.74
	Ondo	17	11.64
	Ebonyi	2	1.37
	Imo	8	5.48
North	Adamawa	21	14.38
	Jigawa	9	6.16
	Kaduna	22	15.07
	Kano	22	15.07
	Kebbi	20	13.7
	Kogi	5	3.42
Total		**147**	**100**

Measures

The independent variables are *Commodity, Human Resources, Geographical Access, Utilization and Continuity* while *Quality* was the dependent variable. Both are continuous variables and defined as follows.

Independent Variables

1. ***Commodity**:* This corresponds to "*Availability Coverage for essential health commodities"* outlined in the modified Tanahashi model. It is generated as the number of health facilities (HFs) with health systems inputs divided by the number of facilities providing the intervention and expressed in percent. Systems inputs assessed include Oral Polio Vaccine or Pentavalent vaccine for RI; Artemisinin Combination Therapies (ACTs) for IMCI, Iron-Folate Supplements for ANC and delivery kits for SBNAC interventions.
2. ***Human resources***: This corresponds to *"Availability Coverage for human resources"*. This is calculated as sum of service providers that received adequate training in intervention (for example, maternal and newborn care) divided by sum of all service providers in a given facility. It is expressed in percent. The human resources assessed include trained vaccinators for RI, health providers for IMCI and Antenatal Care, as well as staff trained in basic emergency obstetric care or SBNAC interventions.
3. ***Geographical access***: This corresponds to *"Accessibility Coverage"*. It refers to physical accessibility of HFs. It is generated as the number of people living within a 5 km radius from HFs that offer basic delivery services divided by the population size of the LGA. It is expressed in percent.
4. ***Utilization***: This corresponds to *"Contact Coverage, i.e., initial utilization"* in the modified model. This refers to first contact or use of service(s) or intervention(s). It is

calculated as the sum total of the target population that interact or use the service and/or intervention for the first time divided by the target population living within the LGA. It is expressed in percent.

5. ***Continuity***: This corresponds to the *"Continuous Coverage"*. It is defined as the extent of continued contact achieved with the health system in accordance with existing guidelines. It is generated as the sum total of the target population who remained in full contact with an intervention and/or service divided by the number of target population living within the LGA. It is expressed in percent.

Dependent Variable (DV)

Quality: This corresponds to *"Effective Coverage"*. It is defined as the percentage of services or interventions that yield health benefits or maximal patient satisfaction. It is generated as the sum of the total of target population that received a specific intervention according to laid down guidelines divided by the number of target population living within the LGA. It is also expressed in percent.

Appendix A, B, C, and D contain tables that outline the variables, specific indicators, measures as well as data sources for each intervention that constitute the NBNA instrument.

Analytical Approach

All statistical analyses were performed in Stata version 14. First, descriptive statistics were generated to aid inspection of the data, to ensure that the distribution of each NBNA indicator fell within the expected range of 0 to 100%. Next, three analytic approaches—Pearson's correlation, frequency count and Ordinary Least Squares (OLS) regression —were used to address the research questions. The statistical significance level was set at $p < .05$.

Pearson's correlation was used to test the strength and direction of the relationships between the six determinants that constitute the NBNA instrument (***commodity, human resources, geographical access, utilization and continuity*** **and** ***quality)***. For interpretation purposes, the magnitude of the relationships were classified as either weak (*r* range: 0.0 to 0. 3), moderate (*r* range: 0.3 to 0.6) or strong relationship (*r* range: 7 or greater) (Godwin, Pike, Bethune, Kirby, & Pike, 2013).

Frequency count was used to determine the percentage of PHC facilities that met the criteria of a diminishing relationship from Utilization to Quality as assumed by the Tanahashi model.

OLS regression was used to investigate the predictive influence of the independent variables on the dependent variable that is effective coverage for the selected tracer interventions. Four OLS models were run, one model for each of the four select tracer intervention. The regression models also controlled for locality (northern vs southern region). Inclusion of a covariate for locality was informed by the possibility that the comparatively high illiteracy and low female empowerment in the north, compared to the south, influence utilization of PHCs. A variance inflation factor (VIF) greater than 5 was used to assess the presence of collinearity (Hair, 2011). The adjusted R^2 was used to determine the percentage of variance in the dependent variable across the four intervention that was collectively explained by the independent variables. Missing values in each variables were dealt with through list-wise deletion.

Ethical Approval

Secondary data used was devoid of personal identifiers. Permission for the use of data was received from Nigeria Primary Health Care Development Agency (NPHCDA). The study is under broader research that received ethical approval from Nigeria's National Health Research

Ethics Committee ***(NHREC/01/01/2007-13/08/2016)***. The Institutional Review Board (IRB) of the University of North Carolina at Chapel Hill ***(IRB Number 18-0213)*** deemed the study exempt.

CHAPTER 3

RESULTS

Characteristics of the Sample

Table 2 presents the descriptive statistics of the sample. The sample consisted of 147 PHC observations, 100 from the north while 47 came from south. Missing values in the variables ranged from 1.37% to 20.55%. The average population per LGA was 259,458 (149532.40). There were variations in the availability of determinants and use of interventions across the LGAs in this study. The average percent of health facilities (HFs) with systems inputs (commodity) during the reporting period across all four interventions ranged from 57 (33.91) to 90 (19.99). The average percent of health workers with adequate training in specific health intervention ranged from 13 (12.56) to 78 (23.93). The average percent of the population with physical accessibility of HFs range from 36 (24.62) to 57 (25.71). The average percent of first contacts or use of service and/or intervention ranged from 15 (16.46) to 59 (24.64). The average percent of the target population that remained in contact with an intervention ranged from 06 (7.89) to 52 (24.72) while the average percent of the target population that received an intervention according to specified guidelines ranged from 06 (7.21) to 46 (25.51).

Table 2: Descriptive Statistics

Variables	**RI**		**IMCI**		**ANC**		**SBANC**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Commodities	90.07	19.99	57.18	33.91	79.91	25.02	61.09	34.58
Human resources	77.79	23.93	42.27	29.13	22.82	21.43	13.25	12.56
Geographical access	56.97	25.71	52.59	24.50	47.16	23.66	35.94	24.62
Utilization	59.03	24.64	19.60	24.98	36.91	26.40	14.46	16.46
Continuity	52.12	24.72	13.88	21.17	28.62	23.85	5.52	7.89
Quality	46	25.51	8.28	17.68	18.77	19.89	5.87	7.21
Population size per LGA	259457.90 (149532.40)							
Sample Size (n)	147 (North = 100, South = 47)							

SD = Standard Deviation

Correlations between the Determinants in the NBNA Instrument

The relationships between the determinants that constitute the NBNA instrument and how they compare to the modified Tanahashi model were examined using Pearson's Correlation. Results for the four select tracer interventions are as follows (See Appendix E).

Routine immunization (RI)**:** On the ***supply-side***, no statistically significant correlations were found among the variables. On the ***Demand side***, findings revealed strong positive correlation between *RI Utilization and Continuity ($r = 0.91$, $p <.001$)*. Similarly, strong positive correlation was observed between *RI Continuity and Quality ($r = 0.73$, $p <. 001$).*

Integrated Management for Childhood Illnesses (IMCI): As for RI, no statistically significant correlations were found on the supply side. On the ***demand side***, findings revealed a strong positive correlation between *IMCI Utilization* and *Continuity (r = 0.77)*. A strong positive correlation was also found between IMCI Continuity and Quality *(r =0.75).*

Antenatal Care **(*ANC):*** On the ***supply-side***, the only statistically significant correlation was a weak positive correlation was found between ANC Commodity and Human resources *(r = 0.27, p <.01).* On the ***demand side***, the results showed moderate positive correlation between ANC Utilization and Continuity *(r = 0.65)* as well as ANC Continuity and Quality *(r =0.64).*

Skilled birth Attendance & Newborn Care **(*SBANC):*** On the ***supply-side***, a weak positive correlation was found between SBANC Commodity and Human resources *(r = 0.3, p <.01.* On the ***Demand side***, findings showed strong positive correlation between SBANC Utilization and Continuity *(r = 0.63)*. Similarly, findings revealed strong positive correlation between SBANC Continuity and Quality *(r =0.78).*

Diminishing Relationship between Demand Side Variables

Because a prerequisite for the valid use of the modified Tanahashi model involve a diminished cascade on the demand side, frequency count was carried out to determine the ability of the Nigeria BNA instrument to perform accurate bottlenecks analysis at PHC reviews. From the results, a diminished cascade was found on the demand side for a few PHCs. For RI — 47 (32 %), IMCI —38 (26 %), ANC —51 (35 %) and for SBANC— 22 (14 %).

Multivariate Results

Table 3 presents the results of all four best-fitting regression models. In the table, the standardized coefficients (β) are presented with the standard errors (SE) and *p-values*. Statistically significant associations are denoted with asterisks.

Routine Immunization (RI): Column 1 of Table 3 represents the relationships between the predictors of effective RI coverage. The regression coefficient associated with Utilization was statistically significant (β = 0.60, SE = 0.07, $p < .001$) and suggests that when all other variables are held constant, a one unit rise in Utilization is associated with a 0.60% increase in RI Quality. The coefficient associated with northern LGAs was statistically significant and suggests that when other variables are held constant, the northern LGAs have an average RI Quality score that is 15.64% less than the southern LGAs (β = -15.64, SE = 3.73, $p < .001$). The adjusted R-Squared was 0.55.

Integrated Management for Childhood Illnesses (IMCI): The association between IMCI Utilization and Quality was also statistically significant (β = 0.30, SE = 0.06, $p < .001$) and suggest that as utilization of IMCI intervention increases, when all other variables are held constant, a 1-unit rise in IMCI Utilization was associated with a 0.30% increase in RI Quality. There was no difference between the northern and southern states. The adjusted R-Squared was 0.26.

Antenatal Care (ANC): Column 3 of Table 3 represents the relationships between the determinants of the effectiveness of ANC coverage. The association between ANC Utilization and Quality was also statistically significant (β = 0.46, SE = 0.07, $p < .001$) and suggests that when all other variables are held constant, a 1-unit increase in ANC Utilization was associated with a 0.46% increase in ANC Quality. There was no difference between the northern and southern states. The adjusted R-Squared was 0.36.

Skilled birth Attendance & Newborn Care* (*SBANC*)*: Column 4 of Table 3 represents the relationships between the predictors of effective SBANC coverage. The association between SBANC Utilization and Quality was statistically significant (β = 0.48, SE = 0.05, $p < .001$) and suggests that when all other variables are held constant, a 1-unit increase in SBANC Utilization is associated with a 0.48% increase in SBANC Quality. There was no difference between the northern and southern states. The adjusted R-Squared was 0.36.

Table 3: Results of Regression Models

Categorical variable	RI β SE	IMCI β SE	ANC β SE	SBANC β SE
Commodity	-0.16	0.07	0.05	0.01
	0.08	0.04	0.07	0.02
Human Resources	0.04	0.05	0.13	0.06
	0.06	0.05	0.08	0.05
Geographical Access	0.05	0.003	0 .01	-0.02
	0.06	0.05	0.07	0.03
Utilization	0.60***	0.30 ***	0.46***	0.48***
	0 .07	0.06	0.07	0.05
Northern LGAs	-15.64 ***	2.07	-3.20	-3.36
	3.73	2.68	3.58	1.71
Constant	29.48**	-5.41	-2.08	1.62
	9.85	4.45	6.62	2.13
Model Fit				
***F* (df)**	25.28 (5.00)***	6.97(5.00)*	13.81 (5.00)***	22.88 (5.00)***
Adjusted R-Squared	0.55	0.26	0.36	0.50
N	100	107	117	112

Notes * *p < .05, ** p < .01, *** p < .001; RI- Routine Immunization; IMCI-Integrated Management for Childhood Illnesses; ANC-Antenatal Care; SBANC- Skilled Birth Attendance and Newborn Care*

CHAPTER 4

DISCUSSION

The purpose of this study was to determine the relevance of the NBNA instrument for assessing UEHC and its' implications for future planning. This study identified four important findings related to the research questions. First, the results offer support for the presence of linear relationships between the demand-side determinants —*Utilization, Continuity and Quality* since these were positively correlated for all the interventions. Conversely, the findings were not consistent with the modified Tanahashi model's expectation of positive correlations among the supply determinants — *Commodity, Human resources and Geographical access*. Second, the ability of the NBNA instrument to perform valid bottleneck analysis was limited in this study as less than 40% of the PHCs data on the select tracer interventions evaluated by this study, demonstrated a diminishing relationship from *Utilization* to *Quality*. Third, findings from the study suggest that the NBNA instrument is not a good predictor of quality intervention for UEHC planning in Nigeria. Notably, this study also revealed that routine immunization coverage is of lesser quality in northern regions.

Correlation analyses of the determinants of effective coverage showed that the relationships on the demand-side are consistent with Tanahashi as well as O'Connell et al (2013) assertions that initial utilization is correlated with continuous coverage and this in turn, correlated with quality coverage (O'Connell & Sharkey, 2013; Tanahashi, 1978). Furthermore, this finding supports Kiwanuka Henriksson et al study that the quality of an intervention is highly dependent on the availability of these determinants (Kiwanuka Henriksson et al., 2017). The findings are also consistent with multiple studies that cite lack of initial utilization of health interventions or services particularly in rural areas as barriers to effective coverage (Adedini et al., 2014; Douthit, Kiv, Dwolatzky, & Biswas, 2015; Oyekale, 2017; Weinhold & Gurtner, 2014). However, on the demand side, data from only a few PHCs data demonstrated the diminishing relationship conceptualized by Tanahashi (1978) and O'Connell et al (2013). One probable cause might be the proxy-indicators used in the collection of data. The IMCI Continuity and Quality as with SBANC Continuity and Quality indicator measures utilized for PHC reviews are not sequential. Therefore, a diminished cascade is not to be expected between Continuity and Quality for IMCI and ANC interventions. On the hand, though RI and ANC Utilization to Quality indicator measures offer uninterrupted measurements, a majority of the RI and ANC PHC data did not reveal diminished cascades. One possibility is the poor data quality from the nation's health information systems. Another possible explanation is that the target population might begin utilizing services in one PHC facility (initial utilization) and then decide to complete 'the dose' of the intervention (continous utilization) at another health facility that provides same service, which could be private. This is compounded by poor data linkages between health facilities, making it difficult to account for who begun and stayed in full contact with the intervention or services according to laid down guidelines, particularly when the transition is between private and public health facilities. Similarly, the demand-side determinants rely on population estimates which are largely affected by migration in and out of the population. This finding offers support for Hahn et al (2013) study that report that health information systems in resource-limited settings like low- and middle-income countries are plague with poor data quality and lost to follow-up (Hahn, Wanjala, & Marx, 2013).

On the supply- side, findings were not consistent with O'Connell et al's (2013) assertion of the existence of purely positive correlations though of vary magnitude between essential commodities, human resources and physical accessibility. This might be in part due to the data quality issues arising from lack of expertise and right tools to ensure proper data collection and management. Although consistency of positive correlation is not a requirement for accurate bottleneck analysis, understanding the relationship on the supply-side, and how they affect health intervention or service utilization has policy and practical implications for UEHC planning.

Overall, the regression analyses showed that *Commodity, Human resources* and *Physical accessibility* are not significant predictors of intervention *Quality*. In this study, only *Utiliization* and *Continuity* were found to be significant predictors of effective coverage for RI, IMCI, and ANC. These findings are not consistent withTanahashi (1978) and O'Connell et al (2013) assertions and scholarly articles that cite *availability coverage for essential commodities, human resources, geographical accessibility, initial use, and continuous utilization* as significant contributors to the quality of any health intervention or service (Kiwanuka Henriksson et al., 2017; Rupani et al., 2016).

Another noteworthy finding in this study is that the quality of routine immunization coverage in the north is lower compared to the south. This reinforces findings from Eboreime, Bozzani, and Abimbola (2015)'s research on disparities in routine immunization across the regions of Nigeria. A possible explanation is the misconception that vaccines cause more harm than good (Jegede, 2007; Nasiru et al., 2012), cultural and religious practices that act as barriers to good-health seeking behavior on vaccination in this region, and made worse by certain religious and campaign groups that spread anti-vaccine messages (Oku et al., 2017; Ophori, Tula, Azih, Okojie, & Ikpo, 2014). Similarly, the greater lack of female empowerment and cultural constraint to make decisions on some issues of importance in northern Nigeria (Ibrahim & Zalkuwi, 2014) lingers and threatens the health of the under-fives.

Recommendations for Leadership

Based on the findings from this study, I recommend the following actions to be undertaken by those in public health leadership positions in the government:

Policy and regulations

- Government should provide resources for capacity building in health information systems to ensure standardization of the nation's health metrics as regards data management and analyses for decision-making.
- The lesser quality of immunization coverage in Northern as compared to Southern Nigeria calls for the enactment of policies aimed at incentivizing northern caregivers to vaccinate their wards. Policies that make vaccination of the under-fives, a prerequisite for enrollment into schools should be considered.

Health care delivery and practice

- Public health leaders should collaborate with other stakeholders of health particularly those involved in health statistics to ensure the proper linkage of data from the both private and public health domains, required to provide quality data for informed decision making and planning towards UEHC.
- Stakeholders of health should collaborate with local partners and international partners to improve M & E systems in the country.

Research and evaluation

- Further studies with larger sample size are required to draw better conclusions of the true relationship on the supply-side and to validate or invalidate if there is a significant difference in the effectiveness coverage on SBANC and ANC interventions in the north compared to the south. This is necessary to identify priority areas that need focusing on, to facilitate UEHC progress.

- Rigorous evaluation of the demand side proxy-indicators for SBANC and IMCI intervention should be considered to provide more empirical clarity on the instrument capability to perform true bottleneck analysis as well as improve the accurracy of the instrument.

Limitations

There are limitations regarding internal and external validity in this study. The most notable is the use of dataset that may not be representative of all LGAs in Nigeria thus limiting the extent to which findings can be generalized to the different LGAs in the nation. Furthermore, because of data integrity concerns and limited sample size, one must exercise caution when interpreting the results of this study. Notwithstanding these limitations, this study yielded valuable findings by offering insights on the applicability of the NBNA instrument to assess intervention quality and predict UEHC for planning in Nigeria. This study could also contribute to the current body of knowledge, to improve health systems performance in Nigeria.

Conclusion

This study drew on the modified Tanahashi model and data collected with the NBNA instrument to assess its validity that is crucial to strengthening of primary health care and planning for UEHC in Nigeria. The lack of diminishing relationships – a prerequisite for bottleneck analysis, from majority of PHC data may impede proper UHEC planning to mitigate health disparities between LGAs and regions (north & south) in the country. Likewise, the poor quality in routine immunization coverage in the north as compared to the south identified in this study as with existing scholarly articles, remain a significant barrier to the nation's progress towards UEHC.

Stakeholders of health should prioritize proper linkages of public and private health sector data for better measurement of outcomes. Future research efforts should explore the results of this study with a sample size that is more representative of PHCs in Nigeria to yield further empirical clarity on the applicability of the Nigeria bottleneck analysis instrument as a tool for bridging health disparities within the country.

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APPENDICES

Table A: Adapted Coverage Indicators for Routine Immunization

DETERMINANTS	INDICATORS	MEASURES	DATA SOURCE
Commodity	Percentage of Health Facilities (HFs) without stock out of OPV or Pentavalent vaccine in the reporting period	Numerator: Number of HFs without stock out of OPV or Pentavalent vaccine Denominator: Number of HFs that provide immunization services	HMIS
Human Resources	Percentage of HFs with at least two trained vaccinators	Numerator: Number of HFs with at least two trained vaccinators Denominator: Number of HFs that provide immunization services	HMIS, Integrated health care services HMIS
Geographical Access	Percentage of population living within 5 km radius from immunization service points (HFs and outreach locations)	Numerator: Population living within 5 km radius from immunization service points (HFs and outreach locations)[1] Denominator: Total population living in the LGA	LGA record based on Maps NPopC or IPDs Micro-plans
Utilization	Percentage of children aged 0-11 months that received Penta1 or OPV1	Numerator: Number of children aged 0-11 months who received Penta1 or OPV1 vaccination Denominator: Number of children aged 0-11 months	HMIS NPopC or IPDs Micro-plans
Continuity	Percentage of children aged 0-11 months that received Penta3 or OPV3	Numerator: Number of children aged 0-11 months who received Penta3 or OPV3 vaccination Denominator: Number of children aged 0-11 months	HMIS NPopC or IPDs Micro-plans
Quality	Percentage of children fully immunized (BCG, OPV3, Penta3 and measles) before their first birthday	Numerator: Number of children who received all vaccines (BCG, OPV3, Penta3 and measles) before their first birthday within reporting period Denominator: Number of children 0-11 months	HMIS NPopC or IPDs Micro-plans

[1] to identify the population living within a radius of 5 km from a service delivery point, first identify the number of facilities that provide the service and for each of these facilities determine the population living within the 5 km radius.

Table B: Adapted Coverage Indicators for Integrated Management of Childhood Illnesses

DETERMINANTS	INDICATORS	MEASURES	DATA SOURCE
Commodity	Percentage of HFs without stock out of ACTs in the reporting period	Numerator: Number of HFs without stock out of ACTs in the reporting period. Denominator: Number of HFs that provide IMCI services	HMIS HMIS
Human Resources	Percentage of health workers trained in the management of childhood illnesses	Numerator: Number of health workers trained in the management of malaria Denominator: Number of health workers that provide IMCI services	Program Integrated Health Care Services HMIS
Geographical Access	Percentage of population living within 5 km radius of HFs offering services for management of childhood illnesses	Numerator: Population living within 5 km radius from HFs that provide management of childhood illnesses[1] Denominator: Total population living in the LGA	LGA record based on Maps NPopC or IPDs Micro-plans
Utilization	Percentage of children under the age of 5 years having fever and using HF services for the management of childhood illnesses	Numerator: Number of children under the age of 5 years having fever who present at a HF that offers services for the management of malaria Denominator: Number of expected cases of malaria among children under the age of 5 years within the catchment area	HMIS To be calculated
Continuity	Percentage of children under the age of 5 years having fever and that were treated with ACT	Numerator: Number of children under the age of 5 years having fever and who were treated with ACT Denominator: Number of expected cases of malaria among children under the age of 5 years within the catchment area	HMIS To be calculated
Quality	Percentage of children under the age of 5 years having fever, that were tested with RDT and treated with ACT	Numerator: Number of children under the age of 5 years who tested positive to RDT and who were treated with ACTs Denominator: Number of expected cases of malaria among children under the age of 5 years within the catchment area	Program HMIS To be calculated

[1]to identify the population living within a radius of 5 km from a service delivery point, first identify the number of facilities that provide the service and for each of these facilities determine the population living within the 5 km.

Table C: Adapted Coverage Indicators for Antenatal Care (ANC)

DETERMINANTS	INDICATORS	MEASURES	DATA SOURCE
Commodity	Percentage of HF offering ANC services without stock-out of Iron-Folate Supplements in the reporting period	Numerator: Number of HFs providing ANC services without stock out of Iron Folate in the reporting period	HMIS
		Denominator: Number of HFs providing ANC services	HMIS
Human Resources	Percentage of ANC service providers who have been trained in Focused Antenatal Care	Numerator: Number of ANC service providers who have been trained in Focused Ante-natal Care	LGA record, HMIS, Integrated Health Care Services
		Denominator: Number of ANC service providers	LGA Record
Geographical Access	Percentage of population living within 5 km radius of HFs offering ANC	Numerator: Population living within 5 km radius from HFs offering ANC[1]	LGA record based on Maps
		Denominator: Total population living in the LGA	NPopC or IPDs Micro plans
Utilization	Percentage of pregnant women attending at least one ANC service	Numerator: Number of pregnant women who attended ANC services for the first time during the reporting period	HMIS (2 infos available: < 20 and >20 weeks)
		Denominator: Estimated number of pregnant women in the catchment area during the reporting period	NPopC or IPDs Microplans
Continuity	Percentage of pregnant women who attended 4 ANC visits	Numerator: Number of pregnant women who completed the fourth ANC visit during the reporting period	HMIS
		Denominator: Estimated number of pregnant women in the catchment area during the reporting period	NPopC or IPDs Microplans
Quality	Percentage of pregnant women who had 4 ANC in a timely manner in accordance with Focused ANC guidelines	Numerator: Number of pregnant women who received IPT2 at ANC clinic during the reporting period	HMIS
		Denominator: Estimated number of pregnant women in the catchment area during the reporting period	NPopC or IPDs Microplans

[1] to identify the population living within a radius of 5 km from a service delivery point, first identify the number of facilities that provide the service and for each of these facilities determine the population living within the 5 km.

Table D: Adapted Coverage Indicators for Skilled Birth Attendance & Neonatal Care

DETERMINANTS	INDICATORS	MEASURES	DATA SOURCE
Commodity	Percentage of HFs offering delivery services experiencing no stock out of delivery kits in the reporting period	Numerator: Number of HFs offering delivery services without stock-out of delivery kits during the reporting period Denominator: Number of HFs offering delivery services	Program (MSS or Reproductive Health) HMIS
Human Resources	Percentage of maternity staff trained in Basic Emergency Obstetric Care	Numerator: Number of maternity staff trained in Basic Emergency Obstetric Care Denominator: Number of maternity staff	Program (MSS or Reproductive Health)
Geographical Access	Percentage of population living within 5 km radius of HFs offering basic delivery services	Numerator: Population living within 5 km radius from HFs offering basic delivery services[1] Denominator: Total population living in the LGA	LGA record based on Maps NPopC or IPDs Micro plans
Utilization	Percentage of deliveries in HFs	Numerator: Number of deliveries in the HFs Denominator: Total number of expected deliveries	HMIS NPopC or IPDs Micro plans
Continuity	Percentage of mother/infant pairs who received at least one follow up home visit within the first month after delivery	Numerator: Number of mother/infant pairs who received at least one follow up home visit within the first month after delivery Denominator: Total number of expected deliveries	Program(MSS or Reproductive Health) NPopC or IPDs Micro plans
Quality	Percentage of deliveries receiving postnatal check-up within 48 hours at HFs	Numerator: Number of women receiving postnatal check-up at HFs within 48 hours after delivery Denominator: Total number of expected deliveries	Program(MSS or Reproductive Health) NPopC or IPDs Micro plans

[1] to identify the population living within a radius of 5 km from a service delivery point, first identify the number of facilities that provide the service and for each of these facilities determine the population living within the 5 km.

Table E: Correlation Matrices

Intervention	(1) Commodity	(2) Human Resources	(3) Geographical Access	(4) Utilization	(5) Continuity	(6) Quality
RI						
(2)	0.1372	1.0000				
(3)	-0.0857	-0.0514	1.0000			
(4)	0.1431	0.0456	0.0375	1.0000		
(5)	0.1801	0.0848	0.1649	0.9089***	1.0000	
(6)	-0.0560	0.0602	0.0880	0.6748***	0.7266***	1.0000
IMCI						
(2)	0.1502	1.0000				
(3)	-0.1142	-0.0881	1.0000			
(4)	0.0280	0.1697	-0.0592	1.0000		
(5)	0.2283*	0.1399	-0.0940	0.7666***	1.0000	
(6)	0.1715	0.1914*	-0.0383	0.4676***	0.7487***	1.0000
ANC						
(2)	0.2665**	1.0000				
(3)	0.0758	-0.0438	1.0000			
(4)	0.2132*	0.1823	0.2296*	1.0000		
(5)	0.1811	0.2179*	0.0926	0.6501***	1.0000	
(6)	0.2027*	0.2829**	0.1431	0.5978***	0.6398***	1.0000
SBANC						
(2)	0.3009**	1.0000				
(3)	-0.1723	0.1271	1.0000			
(4)	0.1094	0.3153***	0.1650	1.0000		
(5)	0.0902	0.4434*	0.0934	0.6297***	1.0000	
(6)	0.0884	0.3078***	0.1328	0.7046***	0.7764***	1.0000

Notes * p < .05, ** p < .01, *** p < .001

Table F: Ordinary Least Squares Models

A. RI

Number of observations	= 100
F (5, 94)	= 25.28
R-squared	= 0.5735
Adjusted R-squared	= 0.5508
Root MSE	= 17.16
Prob > F	= 0.0000

Source |	SS	df	MS
Model |	37225.1943	5	7445.03886
Residual |	27680.1157	94	294.469316
Total |	64905.31	99	655.609192

IMQ |	Coefficient	Std. Err.	t	P>|t|	[95% Conf. Interval]	
RIC |	-0.1585036	0.0794356	-2.00	0.049	-0.3162248	-0.0007824
RIH |	0.0403704	0.0642187	0.63	0.531	-0.0871374	0.1678782
RIG |	0.0541388	0.0606468	0.89	0.374	-0.0662768	0.1745544
RIU |	0.603572	.0733818	8.23	0.000	0.4578707	0.7492732
1. North |	-15.63863	3.732956	-4.19	0.000	-23.0505	-8.226754
_cons |	29.47848	9.849336	2.99	0.004	9.922392	49.03457

VIF estimate

Variable |	VIF	1/VIF
RIC |	1.05	0.949674
RIH |	1.02	0.983381
RIG |	1.01	0.988204
RIU |	1.17	0.857408
1. North |	1.14	0.880487
Mean VIF |	1.08	

B. IMCI

Number of observations = 107
F (5, 101) = 6.97
Prob > F = 0.0000
R-squared = 0.2566
Adjusted R-squared = 0.2198
Root MSE = 12.775

Source |	SS	df	MS
Model |	5690.63137	5	1138.12627
Residual |	16483.2752	101	163.200744
Total |	22173.9065	106	209.187798

IMCIQ|	Coefficient	Std. Err.	t	P>|t|	[95% Conf. Interval]	
IMCIC |	0.068331	0.0376375	1.82	0.072	-0.0063318	0.1429937
IMCIH |	0.0446089	0.0448066	1.00	0.322	-0.0442753	0.133493
IMCIG |	0.0030047	0.0484277	0.06	0.951	-0.093063	0.0990723
IMCIU |	0.2971236	0.0573831	5.18	0.000	0.183291	0.4109562
1. North |	2.069711	2.67942	0.77	0.442	-3.245538	7.38496
_cons |	-5.407194	4.448918	-1.22	0.227	-14.23265	3.418263

VIF estimate

Variable |	VIF	1/VIF
IMCIC |	1.10	0.908443
IMCIH |	1.07	0.938081
IMCIG |	1.03	0.966578
IMCIU |	1.03	0.966377
1. North |	1.09	0.917172
Mean VIF |	1.07	

C. ANC

Number of observations =	117
F (5, 111) =	13.81
Prob > F	= 0.0000
R-squared	= 0.3835
Adjusted R-squared	= 0.3557
Root MSE	= 17.083

Source |	SS	df	MS
Model |	20150.431	5	4030.0862
Residual |	32394.3382	111	291.840885
Total |	52544.7692	116	452.972149

ANCQ |	Coefficient.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
ANCC |	0.0459878	0.0710015	0.65	0.519	-.0947064	.186682
ANCH |	0.1304089	0.0750204	1.74	0.085	-.018249	.2790668
ANCG |	0.0068157	0.0680772	0.10	0.920	-.1280838	.1417153
ANCU |	.4584046	0.066476	6.90	0.000	.326678	.5901313
1. North |	-3.201592	3.582647	-0.89	0.373	-10.30085	3.897663
_cons |	-2.083101	6.616274	-0.31	0.753	-15.19369	11.02749

VIF estimate

Variable |	VIF	1/VIF
ANCC |	1.11	0.903565
ANCH |	1.10	0.908733
ANCG |	1.14	0.877463
ANCU |	1.29	0.776851
1. North |	1.18	0.844527
Mean VIF |	1.16	

D. SBANC

Number of observations = 112
F (5, 106) = 22.88
Prob > F = 0.0000
R-squared = 0.5190
Adjusted R-squared = 0.4963
Root MSE = 7.5781

Source |	SS	df	MS
Model |	6568.75339	5	1313.75068
Residual |	6087.24661	106	57.4268548
Total |	12656	111	114.018018

SBANCQ |	Coefficient.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
SBANCC |	0.0063133	.0228394	0.28	0.783	-.0389679	.0515946
SBANCH |	0.0572807	.0529868	1.08	0.282	-.0477708	.1623321
SBANCG |	-0.0212227	.0307656	-0.69	0.492	-.0822185	.0397731
SBANCU |	0.4679281	.0489993	9.55	0.000	.3707822	.565074
1. North |	-3.362201	1.710065	-1.97	0.052	-6.752572	.0281698
_cons |	1.620003	2.129718	0.76	0.449	-2.602371	5.842377

VIF estimate

Variable |	VIF	1/VIF
SBANCC |	1.26	0.792556
SBANCH|	1.25	0.797102
SBANCG |	1.23	0.814917
SBANCU|	1.23	0.814008
1. North |	1.35	0.741293
Mean VIF |	1.26	