

UNIVERSITY OF GHANA

COLLEGE OF HEALTH SCIENCES

CONTINUITY AND FRAGMENTATION OF ANTENATAL AND
DELIVERY CARE IN THE VOLTA REGION OF GHANA

BY

SAMUEL KENNEDY KANGTABE DERY

(ID. NO. 10235646)

THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF
GHANA, LEGON IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE AWARD OF PhD PUBLIC HEALTH
DEGREE

SCHOOL OF PUBLIC HEALTH

MARCH 2017

Declaration

I hereby declare that this Ph.D. thesis entitled “Continuity and Fragmentation of Antenatal and Delivery Care in the Volta Region of Ghana”, and the work presented in it are my own and has been produced by me as the result of my own original research for the degree of Doctor of Philosophy in Public Health under the supervision of Prof. Moses K. S. Aikins and Dr. Ernest Tei Maya. I have faithfully and accurately cited all my sources, including books, journals, reports, unpublished manuscripts, as well as any other media, such as the Internet etc.



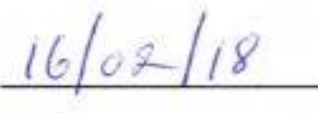
Samuel Kennedy Kangtabe Dery
(Candidate)



Date



Prof. Moses Kweku Sekyi Aikins
(Primary Supervisor)



Date



Dr. Ernest Tei Maya
(Secondary Supervisor)



Date

Abstract

Maternal mortality has over the years remained a global health issue with most of the deaths occurring in sub-Saharan Africa. With skilled antenatal care (ANC), many of these deaths can be prevented and as such skilled ANC attendance and skilled delivery have become key global indicators for measuring maternal health programmes across the world. The World Health Organization, until recently (2016) had recommended a minimum of 4 antenatal visits for pregnant women without any medical condition and whose pregnancies were progressing smoothly. This has since been updated to a minimum of 8 ANC contacts for a positive pregnancy experience.

Ghana, over the years has been improving on the skilled ANC and delivery indicators with the 2014 Ghana Demographic and Health Survey (GDHS) showing that 87% of the pregnant women received the minimum 4 ANC visits, an increase from the 69% in 2003 while skilled delivery increased from 46% in 2003 to 74% in 2014. However, what remained unanswered is whether these ANC visits were made to several health facilities or to a single facility. In addition, it is unclear whether some pregnant women change their ANC facilities during delivery considering that labour and delivery constitute a critical point in the fight against maternal mortality, since complications during labour and delivery account for most of the maternal deaths in Ghana. In addition, though evidence from other studies show that some pregnant women receive care from multiple facilities, the extent of continuity and fragmentation of care during pregnancy and childbirth have not been quantified in Ghana. This study therefore sought to measure the level of longitudinal continuity and fragmentation of care during pregnancy and childbirth in the Volta Region of Ghana.

Using National Health Insurance claims data for 2013 in the Volta Region, all the ANC and obstetrics data from all the facilities for the various months were merged into one file, deliveries were identified and classified as cesarean section or vaginal delivery. Visits of all the women that delivered were extracted from the data. Five continuity of care (CoC) indices (MFPC, MMCI, CoC, SECON and PDC) were calculated for each pregnant woman. Extent of repeat visits to each facility (provider continuity) and repeat visits to facilities in a district (district continuity) were calculated to represent the average of the proportion of visits that a facility/district got for all the women who visited the facility/district compared to other facilities/districts that those same women visited.

Client-sharing between facilities and districts were identified. Two facilities shared a pregnant woman during ANC if the woman moves from facility of previous visit to the other facility of subsequent visit. A woman is said to have fragmented her care during delivery if she delivers at a facility different from where she sought most of her antenatal care. Five different types of network graphs were constructed using Gephi to help visualize the fragmentation of care among facilities and districts during ANC and delivery.

A total of 14,474 pregnant women with a total of 92,095 visits (average of 5 visits per woman) were included in the study with 15.1% delivering by cesarean section (CS). The median maternal age was 27 and those that had CS were slightly older with a median age of 29. Although hospitals constituted 13% of the facilities in the study, they accounted for 73% of all visits and 83% of all deliveries. About 58% of all the pregnant women had perfect CoC: maintaining only one facility throughout ANC and delivery. There were medium to high levels of CoC among the various CoC indices (MFPC: 0.82 ± 0.25 ; MMCI: 0.86 ± 0.20 ; COC: 0.76 ± 0.30 ; SECON: 0.80 ± 0.28 ; PDC: 0.68 ± 0.41). In addition, 32% of all the women and

78% of those that visited multiple facilities made less than three quarters of their visits to the most frequently visited facility. The average provider (facility) continuity and district continuity in the region were 67% and 81% respectively and varies by districts and type of provider.

About 19% of all subsequent visits, 26% of all deliveries, 32% of all CS deliveries, 63% of all deliveries by women with multiple facilities, 73% of all CS deliveries by women with multiple facilities were fragmented among facilities. In addition, 15% of all deliveries (36% among those with multiple facilities) and 20% of all CS deliveries (45% among those with multiple facilities) were performed at facilities that the pregnant women did not receive any ANC services from. Nine percent (8.9) of all subsequent visits, 13% of all deliveries, 20% of all CS deliveries and 30.5% of all deliveries by women with multiple facilities were fragmented across districts. In addition, 51.6% of all deliveries performed at facilities that the pregnant women never received ANC services from were fragmented across districts.

Despite the high levels of CoC among the pregnant women, there is high fragmentation during the critical period of labour and delivery among those who visited multiple facilities. This situation seems to be exacerbated by the fact that there is high preference for hospital delivery, resulting in high levels of fragmentation of care during delivery among the various care facilities and across districts in the region, and is even more profound in districts that do not have hospitals, with higher proportions of the women moving from these districts to other districts with hospitals for delivery services. There is therefore the need for concerted effort to guarantee continuity and coordination of care throughout the ANC and delivery period by requiring every pregnant woman to have a primary care provider who will be responsible and accountable for coordinating the care that she receives.

Dedication

This work is dedicated to my wife Gabriella N. Dery, my daughters Jessica Bawapagranaa, Jenny Ngmenbuobo, Jacqueline Ngmentero and Joycelyn Song and to my mother Yvonne Dery and my late father Augustine Dery for all the love, support and prayers throughout this academic journey.

Acknowledgement

To God almighty be the glory. I am grateful to the almighty God for life, good health and His continuous guidance, blessings and protection in my life.

I would like to express my sincere gratitude to my supervisors: Prof. Moses K. S Aikins and Dr. Ernest Tei Maya for their continuous support of my PhD study and related research, their mentorship, patience, motivation, and immense knowledge. Their professional guidance has been of great benefit throughout the research and writing of this thesis.

My sincere thanks also goes to Prof. Richard Adanu (Dean of the School of Public Health), Prof. Thomas Robins, Dr. Cheryl Moyer, Dr. Kathleen Sienko, Dr. Qiaozhu Mei and Dr. Julia Adler-Milstein from the University of Michigan (US), and Dr. Elsie Effah Kauffman (University of Ghana) who provided the opportunity for me to study at the University of Michigan as part of the Ghana-Michigan Post-doctoral And Research Trainee Network (PARTNER II) fellowship during the second year of my PhD work. This project gave me the exposure and provided the foundation for me to undertake this research. I will forever be grateful for this opportunity.

I am forever grateful to my family, my wife and children for all the patience, for the sleepless nights, prayers, encouragement and support throughout this journey. I would like to thank my parents, brothers and sisters for supporting me spiritually throughout writing this thesis and my life in general.

I thank the Head of Department and staff of Biostatistics especially, and staff of the School of Public Health for the encouragement, support, critique and suggestions during the research work. I thank my fellow course mates for the stimulating discussions, encouragement and support throughout these four years.

Table of Contents

Abstract.....	iii
Dedication	vi
Acknowledgement	vii
List of Abbreviations	xvi
Operational Definitions.....	xix
Chapter 1: Introduction and Background.....	1
1.0 Background.....	1
1.1 Maternal and Child Health.....	6
1.2 Continuity of Care	10
1.3 Fragmentation of Care	11
1.4 NHIS and Continuity of Care	12
1.5 Problem Statement.....	15
1.6 General Objective	17
1.6.1 Specific objectives.....	17
1.7 Research Questions.....	18
1.8 Justification.....	18
1.9 Conceptual framework for measuring continuity and fragmentation of care.....	19
Chapter 2: Literature Review.....	23
2.1 Review of NHIS Literature in Ghana.	23
2.1.1 Claims Data.....	23
2.1.2 Maternal and Child Health.....	27
2.1.3 General Studies	31

2.2	Continuity of Care	39
2.2.1	Dimensions of Continuity	39
2.2.2	Measuring Continuity of Care	43
2.2.3	Health Facility Level Continuity of Care.....	45
2.2.4	Continuity of Maternal Care	46
2.2.5	Continuity of Care and Health Outcomes	48
2.2.6	Limitations of Continuity of Care	53
2.3	Using Claims Data for Healthcare Analytics.....	54
2.4	Health Care Fragmentation.....	59
2.5	Social Network Analysis in Health Care Setting.....	60
2.5.1	Social Network.....	60
2.5.2	Network Data Representation	62
2.5.3	Network Measures.....	64
2.5.4	Application of Social Network Analysis in Health.....	67
2.6	Summary of the Key Issues from the Literature.....	70
	Chapter 3: Method	74
3.1	Research Philosophy.....	74
3.2	Study Design.....	74
3.3	Research framework for measuring continuity and fragmentation	75
3.4	Study Area	78
3.5	Study Variables.....	84
3.6	Data Compilation and Processing.....	86
3.6.1	Identification of Deliveries.....	87
3.7	Application of the Inclusion Criteria	91
3.7.1	Data Transformation	93

3.8	Continuity of Care Measures	93
3.8.1	Most Frequent Provider Continuity (MFPC)	94
3.8.2	Modified, Modified Continuity Index (MMCI)	95
3.8.3	Continuity of Care index (COC)	95
3.8.4	Sequential Continuity Index (SECON)	96
3.8.5	Place of Delivery Continuity Index (PDC)	96
3.8.6	Provider Continuity of Care Score.....	97
3.9	Patients Sharing by Providers and Social Network Construction	98
3.10	Patients Sharing by Districts and Social Network Construction	101
3.11	Statistical Analysis.....	102
3.11.1	Social Network Measures.....	105
3.12	Quality Control	106
3.13	Ethical Issues	106
	Chapter 4: Results	108
4.0	Background of Facilities and Participants	108
4.1	Sequential Patterns of Seeking Care.....	115
4.2	Extent of Continuity of Care.....	117
4.3	Extent of Repeat Visits to Providers (Provider Continuity)	122
4.3.1	Summary for the extent of repeat visits to providers	126
4.4	Extent of Care Fragmentation among Providers	127
4.4.1	Fragmentation during Entire ANC and Delivery Visits.....	127
4.4.2	Fragmentation during Delivery	131
4.5	Extent of Care Fragmentation among Districts	147
4.5.1	Fragmentation during Entire ANC and Delivery Visits.....	147
4.5.2	Fragmentation during Delivery	150

Chapter 5: Discussion	155
5.0 Introduction.....	155
5.1 Continuity of Care	157
5.2 Provider Continuity of care	162
5.3 Fragmentation of care	163
5.4 WHO recommendation on Midwife-led Continuity of care model.....	169
5.5 Evaluation of the Conceptual framework.....	171
5.6 Limitations.....	172
Chapter 6: Conclusion and Recommendations	175
6.1 Conclusion	175
6.2 Recommendations.....	176
6.3 Contribution to Knowledge	176
6.4 Future Research	177
References:.....	179
Appendices.....	195
8.1 Appendix A1: Details of providers included in the study	195
8.2 Appendix B: Samples of the computer codes.....	201

List of Figures

FIGURE 1.1: TREND OF MIDWIVES TO WIFA POPULATION RATIO, 2009-2014.....	3
FIGURE 1.2: OUT-PATIENT UTILIZATION OF HEALTHCARE SERVICES UNDER NHIS	4
FIGURE 1.3: PERCENT OF OPD ATTENDANTS INSURED BY REGION, 2012-2014	5
FIGURE 1.4: TREND IN INSTITUTIONAL NEONATAL MORTALITY RATE, 2010-2014	8
FIGURE 1.5: CONCEPTUAL FRAMEWORK FOR MEASURING CONTINUITY AND FRAGMENTATION OF CARE.....	22
FIGURE 2.1: NETWORK KITE BY KRACKHARDT	65
FIGURE 3.1: RESEARCH FRAMEWORK TO LEARN ABOUT HEALTHCARE CONTINUITY AND FRAGMENTATION	77
FIGURE 3.2: DISTRICT MAP OF VOLTA REGION	79
FIGURE 3.3: FLOWCHART FOR IDENTIFYING CESAREAN SECTION DELIVERIES	89
FIGURE 3.4: FLOWCHART FOR IDENTIFYING SPONTANEOUS VAGINAL DELIVERIES.....	90
FIGURE 3.5: FLOWCHART OF PARTICIPANTS' INCLUSION INTO THE STUDY	92
FIGURE 4.1: COMPARISON OF C-SECTION REPORTED BY GHS AND STUDY FOR 2013	112
FIGURE 4.2: PROPORTION OF VISITS AND DELIVERY BY FACILITY TYPE, 2013.....	112
FIGURE 4.3: SEQUENCE OF VISITS DURING PREGNANCY AND DELIVERY	116
FIGURE 4.4: NETWORK DIAGRAM OF CLIENT SHARING DURING ANC AND DELIVERY	129
FIGURE 4.5: PROVIDER CLIENT SHARING NETWORK DURING DELIVERY	135
FIGURE 4.6: COMMUNITIES IN THE PROVIDER NETWORK FOR DELIVERY AT A NEW PROVIDER.	138
FIGURE 4.7: PROVIDER NETWORK FOR DELIVERY AT A NEW PROVIDER BY TYPE OF PROVIDER.	139
FIGURE 4.8: PROVIDER NETWORK DURING C-SECTION DELIVERY BY NETWORK COMMUNITIES	142
FIGURE 4.9: PROVIDER NETWORK DURING C-SECTION DELIVERY BY PROVIDER TYPE.....	143

FIGURE 4.10: PROVIDER NETWORK DURING C-SECTION AT NEW FACILITY	144
FIGURE 4.11: CLIENT SHARING AMONG DISTRICTS DURING ANC AND DELIVERY IN THE VOLTA REGION, 2013	148
FIGURE 4.12: CLIENT SHARING AMONG DISTRICTS DURING DELIVERY IN THE VOLTA REGION, 2013	151
FIGURE 4.13: PROPORTION OF “POTENTIAL DELIVERIES” GOING TO DELIVER IN OTHER DISTRICTS	152
FIGURE 4.14: CLIENT SHARING AMONG DISTRICTS DURING CS DELIVERY	153
FIGURE 4.15: CLIENT SHARING AMONG DISTRICTS DURING DELIVERY AT NEW PLACE (ON FIRST VISIT).....	153

List of Tables

TABLE 1.1: REGIONAL ENROLMENT ON NHIS, 2013	13
TABLE 2.1: CLAIMS DATA STUDIES	24
TABLE 2.2: STUDIES ON MATERNAL AND CHILD HEALTH	28
TABLE 2.3: GENERAL STUDIES	31
TABLE 2.4: DIMENSIONS OF CONTINUITY OF CARE	42
TABLE 2.5: ADJACENCY MATRIX REPRESENTATION	62
TABLE 2.6: EDGE LIST REPRESENTATION	63
TABLE 2.7: ADJACENCY LIST REPRESENTATION	64
TABLE 3.1: DISTRIBUTION OF POPULATION BY DISTRICTS	80
TABLE 3.2: HEALTH FACILITY OWNERSHIP, VOLTA REGION	81
TABLE 3.3: DISTRIBUTION OF HEALTH FACILITIES BY DISTRICTS, VOLTA REGION	82
TABLE 3.4: ANC AND DELIVERY STATISTICS FOR VOLTA REGION, 2012-2014	83
TABLE 3.5: LIST OF VARIABLES FOR THE STUDY	85
TABLE 3.6: PATIENT BY FACILITY MATRIX - FREQUENCY OF FACILITY VISITS BY PATIENT	98
TABLE 3.7: PATIENT BY FACILITY MATRIX - PROPORTION OF VISITS BY PATIENT	98
TABLE 3.8: NETWORK MEASURES	105
TABLE 4.1: FACILITY AND PROPORTION OF AVAILABLE REPORTS BY DISTRICT AND FACILITY TYPE, 2013.	109
TABLE 4.2: DISTRIBUTION OF PARTICIPANTS, VISITS AND DELIVERIES BY DISTRICT AND PROVIDERS, 2013.....	113
TABLE 4.3: DEMOGRAPHIC AND VISIT CHARACTERISTICS OF RESPONDENTS.	115
TABLE 4.4: SEQUENTIAL CLIENT MOVEMENTS AMONG FACILITIES IN THE VOLTA REGION OF GHANA, 2013.	116

TABLE 4.5: NUMBER AND PROPORTION OF WOMEN BY CONTINUITY OF CARE MEASURES, VOLTA REGION 2013.....	120
TABLE 4.6: MEAN CONTINUITY OF CARE MEASURE BY AGE GROUPS, VOLTA REGION, 2013...	121
TABLE 4.7: FACTORS ASSOCIATED WITH VAGINAL DELIVERY	121
TABLE 4.8: TOP 25 PROVIDERS WITH THE HIGHEST CONTINUITY OF CARE SCORE VOLTA REGION, 2013	124
TABLE 4.9: DISTRICT AND PROVIDER CONTINUITY OF CARE, VOLTA REGION, 2013.	125
TABLE 4.10: PROVIDER CONTINUITY OF CARE BY PROVIDER TYPE AND OWNERSHIP FOR PREGNANT WOMEN ATTENDING ANC IN THE VOLTA REGION OF GHANA, 2013.....	126
TABLE 4.11: TOP TWENTY PROVIDERS IN THE CLIENT NETWORK SHARING DURING ANC AND DELIVERY IN THE VOLTA REGION, 2013	130
TABLE 4.12: MOVEMENT OF PREGNANT WOMEN AMONG FACILITIES DURING DELIVERY, VOLTA REGION, 2013.....	134
TABLE 4.13: NETWORK CHARACTERISTICS OF PROVIDERS WITH THE HIGHEST WEIGHTED DEGREE DURING DELIVERY IN THE VOLTA REGION, 2013.....	136
TABLE 4.14: NETWORK CHARACTERISTICS OF THE PROVIDERS WITH THE HIGHEST NUMBER OF PREGNANT WOMEN DELIVERING AT FACILITY THEY DID NOT VISIT DURING ANC, 2013..	140
TABLE 4.15: NETWORK CHARACTERISTICS OF FACILITIES INVOLVED IN CS DELIVERY IN THE VOLTA REGION, 2013.....	145
TABLE 4.16: SUMMARY TABLE FOR THE EXTENT OF FRAGMENTATION AMONG PROVIDERS	146
TABLE 4.17: CHARACTERISTICS OF DISTRICT-CLIENT SHARING DURING ANC AND DELIVERY IN THE VOLTA REGION, 2013.....	149
TABLE 4.18: SUMMARY OF THE EXTENT OF FRAGMENTATION	154

List of Abbreviations

ANC	Antenatal Care
ANOVA	Analysis of Variance
AR	Ashanti Region
BAR	Brong Ahafo Region
CE	Catastrophic Expenditure
CHAG	Christian Health Association of Ghana
CHPS	Community-based Health Planning and Services
CI	Confidence Interval
CoC	Continuity of Care
COCI	Continuity of Care Index
CR	Central Region
CS	Caesarian Section
CSV	Comma Separated Values
CTP	Content & Timing of Pregnancy
DHIMS	District Health Information Management System
EHR	Electronic Health Records
EMR	Electronic Medical Records
ER	Eastern Region
FoC	Fragmentation of Care
FP	Family Planning
GAR	Greater Accra Region
GDHS	Ghana Demographic and Health Survey
G-DRG	Ghana Diagnostic Related Group
GHS	Ghana Health Service
GLSS	Ghana Living Standard Survey

GT	Geographic Targeting
HC	Health Centres
HIV	Human Immunodeficiency Virus
ICD10	International Classification of Disease version 10
ID	Identification (Number)
IOM	Institute of Medicine
LoS	Length of Stay
M&E	Monitoring and Evaluation
MCH	Maternal & Child Health
MH	Maternity Home
MICS	Multiple Indicator Cluster Survey
MDGs	Millennium Development Goals
MFPC	Most Frequent Provider Continuity
MGP	Midwifery Group Practice
MMCI	Modified, Modified Continuity Index
MOH	Ministry of Health
NGO	Non-Governmental Organization
NHIA	National Health Insurance Authority
NHIS	National Health Insurance Scheme
NR	Northern Region
OBGY	Obstetrics and Gynaecology
OOPE	Out-of-pocket Expenditure
OPD	Out Patient Department
OR	Odds Ratio
PDC	Place of Delivery Continuity
PHC	Primary Health Care
PMT	Proxy Means Testing

PNC	Postnatal Care
PTB	Preterm Birth
PWR	Participatory Welfare Ranking
RCT	Randomised Control Trial
RR	Relative Risk
SECON	Sequential Continuity
SNA	Social Network Analysis
SD	Standard Deviation
SDGs	Sustainable Development Goals
SVD	Spontaneous Vaginal Delivery
UER	Upper East Region
UNFPA	United Nations Population Fund
UNICEF	United Nations Children’s Fund
UPC	Usual Provider Continuity
US	United States
UWR	Upper West Region
VD	Vaginal Delivery
VR	Volta Region
WHO	World Health Organization
WIFA	Women in Fertile Age
WR	Western Region

Operational Definitions

Potential delivery: for every provider/facility, the number of pregnant women who had their most ANC with the provider/facility.

Proportion of potential deliveries that moved out: The proportion of women who moved from their regular ANC facility to deliver at a different facility.

Movement (during ANC and delivery period): The link between the facility of previous visit and facility of subsequent visit during the entire ANC and delivery.

Movement (during delivery): The link between the regular ANC facility and delivery facility.

Place of delivery continuity (PDC): The proportion of ANC visits made to the facility where the woman delivered.

Provider (facility) continuity: The average proportion of visits that the pregnant women made to a facility compared to all other facilities that those same women also visited.

District continuity: The average proportion of visits that the pregnant women made to facilities in a given district compared to all other districts that those same women also visited.

Delivery at new facility (place) or on first visit: Delivery at a facility that the woman never visited during ANC.

Weighted In-Degree: The number of pregnant women that moved from other facilities to the index facility.

Weighted Out-Degree: The number of pregnant women that moved from the index facility to other facilities.

Chapter 1: Introduction and Background

1.0 Background

Ghana's health system is under the direction and supervision of the Ministry of Health (MoH), which is responsible for translating government policies into sector policies to aid implementation by all agencies. In addition, the Ministry leads the strategic planning for the health sector and monitoring the implementation of such policies from a sector-wide perspective. The MoH seeks to "improve the health status of all people living in Ghana through effective and efficient policy formulation, resource mobilization, monitoring and regulation of delivery of health care by different health agencies" (Ministry of Health, n.d.-b). The Ministry works with a number of agencies to fulfill its mandate. These agencies include but not limited to; the Ghana Health Services (GHS), Christian Health Association of Ghana (CHAG), National Health Insurance Authority (NHIA), Mental Health Authority, National Ambulance Service, National Blood Service, the Teaching Hospitals, Universities, Research institutions etc (Ministry of Health, n.d.-c).

The health services in Ghana are organized in a five-tier functional architecture consisting of the Community-based Health Planning and Services (CHPS) zones, sub-district, district, regional and the national levels. The CHPS compound is the lowest level of service delivery point located at the community level (Ministry of Health, 2016). The CHPS undertakes both public health and basic clinical care activities at the community level. The sub-district level is made up of health centres, health posts and clinics. The district level, through the district health administration supervises and coordinates the activities of the sub-districts with a district hospital acting as the first referral point for all the sub-districts. The district level includes both private and public health service providers. The district and sub-district levels

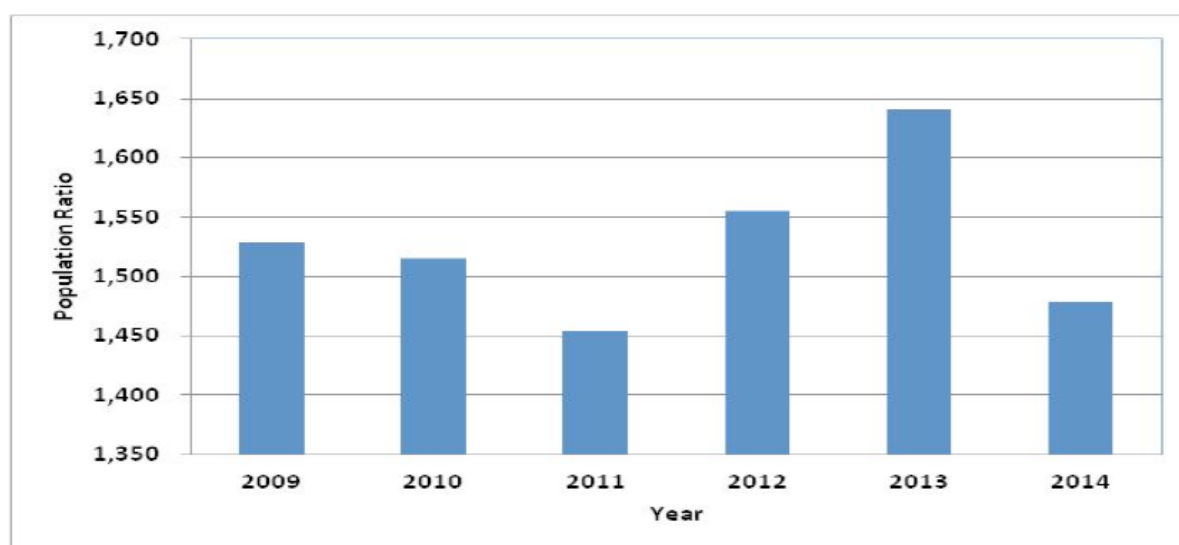
mainly provide primary level healthcare services of which basic maternal health (e.g antenatal, delivery and postnatal care) is a key component. The activities of the districts are also coordinated and supervised by the Regional Health Administration and the regional hospital acts as the secondary level and the referral point to support the districts. At the national level, the teaching hospitals, psychiatric hospitals and other tertiary level facilities act as referral centres (Ghana Health Service, n.d.-b). Varying degree of maternal health services are performed at all these levels. For example, the CHPS compounds are to provide basic maternal and reproductive health services including family planning, antenatal care (ANC), postnatal care (PNC) and also provide relevant information and motivate pregnant women to seek appropriate services including prevention of mother-to-child transmission (PMTCT) of HIV and ANC, and skilled delivery. The CHPS compounds are not allowed to supervise delivery services except in emergency situations (Ministry of Health, 2016). Pregnant women who seek ANC services from CHPS compounds will therefore have to seek delivery services elsewhere. Additionally, at the sub-district level, the health centres may supervise delivery services for facilities that have midwives. However, pregnant women at risk of suffering complications will also have to be referred to appropriate level facilities to seek specialized services. These are meant to ensure that pregnant women receive the appropriate care during pregnancy. However, they do not promote continuity of care and may also fragment the care if not well coordinated. Furthermore, inadequate staff, resources and previous experiences at some facilities may also result in some pregnant women seeking services elsewhere and spreading their care among several facilities, resulting in care fragmentation.

The health sector in Ghana has undergone broad reforms in the past in response to some of the numerous challenges that faced the sector (Saleh, 2013). These reforms sought to improve

access and quality of basic health care services. Key interventions taken included expanding and strengthening primary health services at the district and sub-district levels, strengthening secondary and tertiary services to support the district level and providing national level support through capacity development, monitoring and evaluation system, promoting private sector involvement and inter-sectoral collaboration (Ministry of Health, n.d.-a).

Despite these efforts, the health sector continues to encounter challenges regarding access to health services with wide variations in health outcomes across geographic locations (Ghana Statistical Service, Ghana Health Service, & IFC International, 2015). Doctor to population ratio (1:9043), midwives to Women in Fertile Age (WIFA) ratio (1:1374) (figure 1.1) (Ghana Health Service, 2015), nurse-population ratio (1:1251) (Ghana Health Service, 2012) etc are low and disproportionately distributed across the ten administrative regions of Ghana. Maternal and Child mortality remains high with differences across regions.

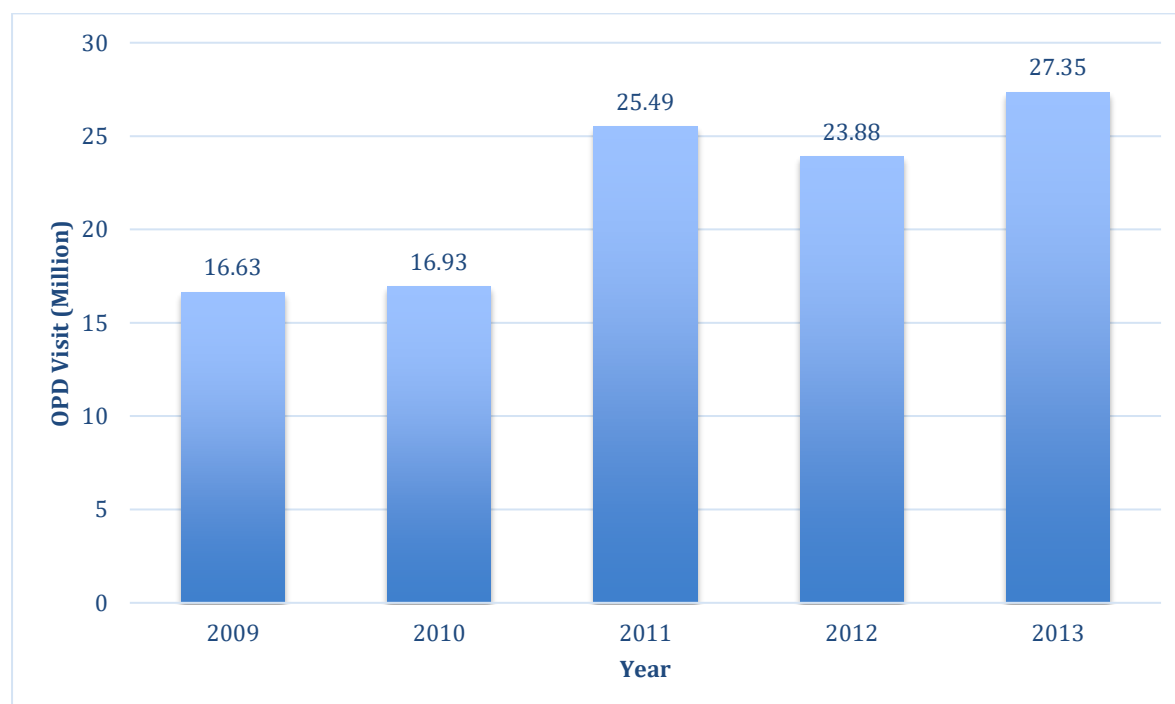
Figure 1.1: Trend of Midwives to WIFA Population Ratio, 2009-2014



Source: GHS 2015 Annual Report

Weak referral systems, provider shopping and poor emergency response systems have been noted as the key areas affecting the implementation of a seamless health service (Ministry of Health, 2012). Ghana in 2003 established the National Health Insurance Scheme (NHIS) to improve access and quality of basic health care services in Ghana. The NHIS has made significant achievements in coverage and utilization since it was launched in 2003. According to the 2011 Ghana Multiple Indicator Cluster Survey, about 60% of men and women aged 15-49 and 71% of children under five years hold valid NHIS membership card (Ghana Statistical Service, 2011). The NHIA annual report for 2013 also shows that about 38% of the population is covered by the NHIS (National Health Insurance Authority, 2013a). In addition, out-patient utilization of healthcare services according to the annual report, has also increased from 16.93 million in 2010 to 27.35 million in 2013 as shown in figure 1.2 (National Health Insurance Authority, 2013a).

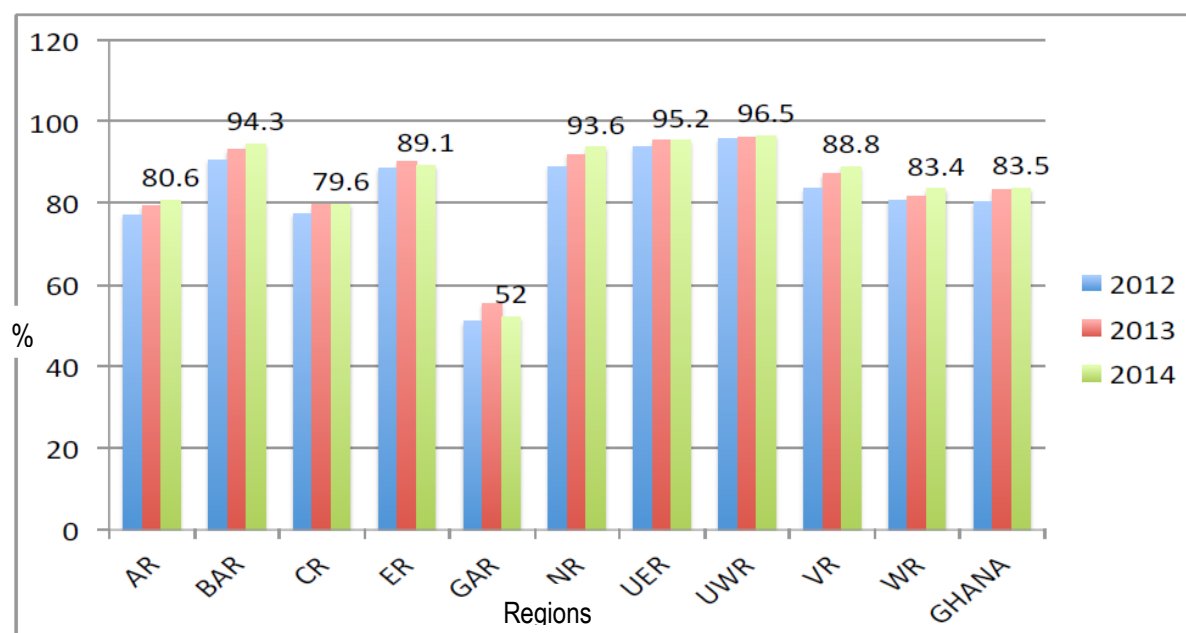
Figure 1.2: Out-patient utilization of healthcare services under NHIS



Source: NHIA 2013 Annual Report

Currently patients in Ghana access healthcare services in two ways: majority (84%) of the outpatient attendants in 2014 received care through the health insurance schemes and the remainder received care through fee-paying anytime they accessed healthcare services (figure 1.3).

Figure 1.3: Percent of OPD Attendants Insured by Region, 2012-2014



Source: GHS 2014 Annual Report

However, most patients in Ghana are not required to register with a service provider as their primary care provider as may be the case elsewhere. Patients in Ghana can choose to change primary providers regularly or can have any number of providers at one time. There are reports of patients moving regularly between different providers, a practice described as “provider shopping” (Aikins, 2005; Aryeetey, Aikins, Dako_Gyeke, & Adongo, 2015; Dako-Gyeke, Aikins, Aryeetey, McCough, & Adongo, 2013). Such behavior can have adverse impact on continuity of care if not well coordinated and managed.

1.1 Maternal and Child Health

According to the World Health Organization (WHO), “maternal health refers to the health of women during pregnancy, childbirth and the postpartum period” (World Health Organization, n.d.-c). “Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes” (World Health Organization, n.d.-b). High maternal mortality has for decades remained a major global health challenge (World Health Organization, n.d.-b). Between 1990 and 2015, the global maternal mortality ratio declined by only 2.3% per year (WHO, UNICEF, UNFPA, World Bank Group, & United Nations Population Division, 2015). The World Health Organization estimates that almost all maternal deaths (99%) occur in developing countries with more than half (66%) of these deaths occurring in sub-Saharan Africa. The maternal mortality ratio estimates in Sub-Saharan Africa and the developing countries in 2015 was very high compared to the developed countries (546 and 239 per 100 000 live births versus 12 per 100 000 live births respectively) (WHO et al., 2015). There are large disparities between countries, but also within countries, and between women with high and low income and those women living in rural versus urban areas (World Health Organization, 2016a).

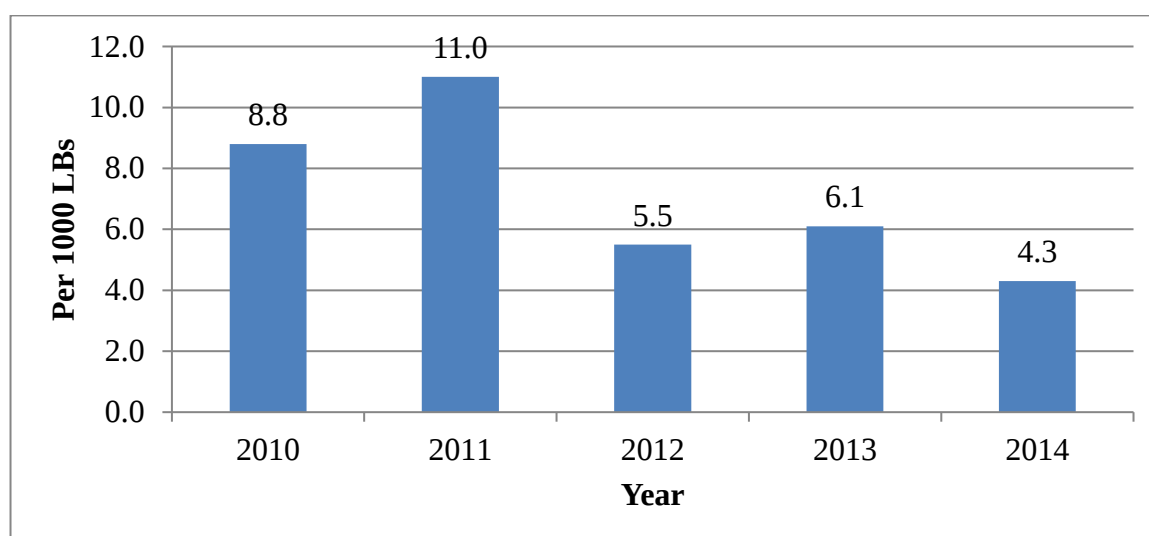
Complications during pregnancy and delivery account for most of the maternal deaths: severe bleeding after childbirth, infections after birth, pre-eclampsia and eclampsia, complications from delivery and unsafe abortion are responsible for nearly 75% of all maternal deaths (Say et al., 2014). However, many of the health problems in pregnant women can be prevented, detected and treated during antenatal care visits with trained health workers (Say et al., 2014).

Over the years, Ghana has adopted and implemented a number of policies and interventions aimed at improving maternal and child health in the country. Among these are the National Population Policy, Maternal and Child Health (MCH) and Family Planning (FP) services, the development of the national safe motherhood programme, the reproductive health service policy and standards, Prevention of Mother-To-Child transmission of HIV and Adolescent Reproductive Health (Odoi-Agyarko, 2003). Also, to help maintain informational continuity, Ghana introduced the antenatal record book, which contains the antenatal and delivery information including, information on services received and laboratory investigation results of the individual pregnant woman. This record book is given to the client to take home and carry with her to any health facility she visits during the antenatal and childbirth periods. The purpose of giving the book to the client is to ensure that if even she decides to visit a different provider for whatsoever reason, the basic information necessary for informed decision-making would be available to the healthcare providers.

As part of the response to the United Nation's Millennium Development Goals (MDGs), Ghana in 2008 also introduced the free maternal health care policy into the National Health Insurance Scheme (NHIS) to help improve maternal health and reduce maternal and child mortalities. The policy sought to remove barriers to accessing early antenatal care and skilled delivery services by waiving the health insurance premium for pregnant women (Hera & Health Partners Ghana, 2013). Evidence show that the policy has contributed to increase utilization of facility-based deliveries, reduction in institutional maternal mortality ratio (Hera & Health Partners Ghana, 2013) and removing barriers to accessing skilled maternity care (Ghana Statistical Service et al., 2015).

In recent times, Ghana's maternal mortality ratio decreased from 570 deaths per 100,000 live births in 2000 to 319 in 2015 (WHO et al., 2015). The under-five mortality rate also decreased from 111 per 1,000 live births in 2003 to 80 in 2008 and 60 in 2014 and infant mortality decreased from 64 per 1,000 live births in 2003 to 50 in 2008 and 41 in 2014 (Ghana Statistical Service et al., 2015). Although Ghana has made progress in these indicators, several challenges exist that need to be addressed regarding maternal care and child survival. Neonatal deaths still represent about 40% of child mortality (Ministry of Health, 2014b) with institutional neonatal mortality fluctuating between 8.8 in 2010 and 4.3 in 2014 (figure 1.4) (Ghana Health Service, 2015). Mortality varies across regions and by a number of other factors with the most deprived areas, having higher mortality rates.

Figure 1.4: Trend in Institutional Neonatal Mortality Rate, 2010-2014



Source: GHS 2014 Annual Report

Antenatal care constitutes a major component of comprehensive maternal and newborn health care (Ghana Statistical Service, Ghana Health Service, & Macro, 2009). The World Health Organization (WHO), as part of its oversight role recommends a minimum of 8 ANC visits for women whose pregnancies are progressing normally (World Health Organization, 2016b).

These visits should aid in the prevention, early detection and treatment of problems that may arise during pregnancy and delivery, promotes the use of skilled attendance at birth and breastfeeding, and helps a woman approach pregnancy and birth as positive experiences (Health Evidence Network, 2003; Lincetto, Mothebesoane-anoh, Gomez, & Munjanja, 2006). The WHO further recommends that, in settings with well-functioning midwifery programmes, “a known midwife or small group of known midwives” should support a pregnant woman throughout the pregnancy and delivery (World Health Organization, 2016b). Antenatal and delivery care in Ghana is mostly midwife-led as evidenced by the 2014 GDHS which shows that 97.3% of pregnant women received antenatal care at least once from a skilled provider with 21.7% from a doctor, 68.8% from a nurse/midwife, and 6.8% from a community health officer/nurse (Ghana Statistical Service et al., 2015). Even though Ghana may be practicing midwife-led ANC and delivery care, the WHO recommendation can only be applicable in healthcare systems with well-functioning ANC and delivery infrastructure and capacity across all levels of the healthcare system. Complications during delivery account for most of the maternal deaths in Ghana (Senah, 2003), requiring the need to place greater emphasis on labour and delivery as this period plays a critical role in the pregnancy and childbirth continuum of care (Ghana Statistical Service et al., 2015). Continuity of ANC with a skilled provider as recommended by the WHO is essential for safe delivery care. From the 2014 GDHS, 73% of births were delivered in health facilities, with the public sector accounting for 65% of the skilled births.

In response to some of these challenges, the MoH developed the Under-Five Child Health Policy (2007-2015) and the Ghana National Newborn Health Strategy and Action Plan (2014-2018). The Child Health Policy provided a “child-centred” framework for planning and improving child survival and well-being. It recognised the continuum of care for mother and

child from the pregnancy, birth and immediate newborn period, neonatal period, infants and children (Ministry of Health, 2010). The National Newborn Health Strategy and Action Plan on the other hand outlines a targeted strategy for accelerating the reduction of newborn deaths (Ministry of Health, 2014a).

1.2 Continuity of Care

Continuity of care (CoC) measures the extent to which an individual patient sees a given provider over a specified period of time (Katz et al., 2014). It implies that one patient experiences care over time as coherent and linked (Reid, Haggerty, & McKendry, 2002). Promoting CoC includes fostering continuous, caring relationships between patients and healthcare providers and ensuring the safe, coordinated transition of patients between health environments (Department of State, Rhode Island, n.d.).

A core principle in the delivery of comprehensive primary health care is the establishment and maintenance of continuity of care (Saultz & Lochner, 2005). Even though there is no single definition of continuity of care (Donaldson, 2001); there is agreement that it comprised of interrelated dimensions, including: informational continuity (availability of recorded information); longitudinal/chronological continuity (having a regular site of care); and relational or interpersonal continuity (development of a trusting relationship between provider and patient over time) (Donaldson, 2001; Saultz & Albedaiwi, 2004).

According to the Institute of Medicine (1994), “continuity can apply to an integrated delivery system, a primary care practice or team, and a single primary care clinician. Although the ideal may be an individual seeing the same clinician at each visit, there may be trade-offs between continuity and access. Continuity of clinician may be more important for some

people and in some circumstances than others”. For example, patients with chronic conditions who visit the healthcare provider at regular intervals, “clinician continuity is necessary to ensure that progress can be assessed. Continuity can also be a major source of satisfaction both to patients and clinicians as it fosters the long-term relationships that represent, for many clinicians, a significant reward of medical practice” (Institute of Medicine, 1994). It can be measured for one physician, physician groups or facility, depending on the focus and scope of the research (Manitoba Centre for Health Policy, 2015). This study focused on measuring continuity using the health facility as the provider and not an individual physician or midwife. This is because most health facilities in Ghana have few staff and do group practice by running shifts.

1.3 Fragmentation of Care

Just like continuity of care, there is no universally agreed definition of the term fragmentation of care. Elhauge, (2010) defined the term to mean, “having multiple decision makers make a set of health care decisions that would be made better through unified decision making”. According to Elhauge, (2010) “individual decision makers responsible for only one fragment of a relevant set of health care decisions may fail to understand the full picture, may lack the power to take all the appropriate actions given what they know, or may even have affirmative incentives to shift costs onto others”. According to the fragmentation postulation by Elhauge, “care delivery too often involves multiple providers and organizations with no single entity effectively coordinating different aspects of care”. Care that is poorly coordinated among various providers results in the fragmentation of the care (Agha, Frandsen, & Rebitzer, 2017). This is currently the situation in Ghana where patients are not required to have a primary care provider that coordinates the care across the various providers that the patient may encounter in the course of receiving care. The absence of this primary care provider to coordinate the

care means that the responsibility of care coordination has to be taken by the individual patients or the family members who may not have the required expertise to carry on that responsibility.

It must be noted that fragmentation can occur at the various levels of healthcare delivery system. At the individual level, care can be fragmented in the treatment for a particular condition of the individual. For example, if the care staffs treating a patient fail to share critical information about the patient at any given time, it can lead to adverse events. A study by the Institute of Medicine shows that ineffective data sharing among care professionals contributes to medical errors (Institute of Medicine, 1999). Care can also be fragmented across a number of care providers (facilities) or according to geographic areas or location where some geographic locations may have better quality of care compared to other areas. For example urban areas may have better access and quality of care compared to the rural areas.

1.4 NHIS and Continuity of Care

Ghana's National Health Insurance Scheme covers all the ten administrative regions and all Metropolitan, Municipal and Districts in the country. As at the end of 2013, active membership of the Scheme stood at 38% of the national population and ranges from 29.8% in Greater Accra region to 57.4% in the Upper East region as shown in table 1.1 (National Health Insurance Authority, 2013a).

Table 1.1: Regional Enrolment on NHIS, 2013

Region	Population	Health insurance coverage		Number of credentialed providers
		Number	Percent	
Ashanti	5,123,308	1,715,388	33.5%	619
Greater Accra	4,297,721	1,280,257	29.8%	440
Eastern	2,822,047	1,110,121	39.3%	514
Northern	2,657,329	880,517	33.1%	352
Western	2,546,468	961,873	37.8%	460
Brong Ahafo	2,476,765	1,353,840	54.7%	376
Central	2,359,817	866,936	36.7%	334
Volta	2,270,208	910,569	40.1%	321
Upper East	1,121,620	643,278	57.4%	211
Upper West	752,477	422,417	56.1%	195
National	26,427,760	10,145,196	38.4%	3,822

From 2009 to 2013, a cumulative number of 3,822 health providers (facilities) have been given full accreditation by the National Health Insurance Authority (NHIA). Accredited providers include Chemical Shops, CHPS Compounds, Clinics, Dental Clinics, Diagnostic Centres, Eye Clinics, Health Centres, Laboratories, Maternal Homes, Pharmacies, Physiotherapy, Polyclinics, Primary, Secondary and Tertiary Hospitals and Ultrasound providers. Out of these providers, 1,197 (31.3%) are CHPS compounds, 886 (23.2%) health centres and 339 (8.9%) primary hospitals. Government facilities account for 2,075 representing 54.3% of accredited providers followed by 1,511 private facilities representing 39.5% of accredited providers. Other accredited providers include the mission and quasi-government ownership (National Health Insurance Authority, 2013a).

As part of measures to improve cost containment, continuity and coordination of care for clients, the NHIA in 2011 piloted the implementation of capitation payment system for outpatient department (OPD) cases at the primary health care (PHC) level in the Ashanti Region of Ghana. The capitation system requires the client to choose and register with a primary provider that the client will be required to visit for all primary care services except in emergency cases. The NHIA believes that “by tying clients to a primary provider of their choice, it reduces fragmentation of care and introduces continuity of care for clients. In addition, it also enables proper implementation of a referral system” (Agyepong & Yankah, 2012).

A study by Agyei-Baffour, Oppong, & Boateng, (2013) indicated that 61.2% NHIS policy holders aged 18–69 years in Kumasi disclosed that capitation was not important to them as clients, and their reasons included “amount paid on behalf of clients is too small”, “service quality is low” and “capitation has a lot of problems”. The most cited reason according to the study was “the inability to access health care everywhere because one is restricted to one primary provider”. Trying to tie or restrict a client who is used to moving between providers to one primary provider would certainly be a challenge for most people.

A revised phased rollout of capitation has been extended to three more regions (Volta, Upper East and Upper West) with the initial phase where clients are required to select their preferred primary provider. Considering the fact that continuity of care is a quality of care indicator, there is the need to understand the behavior patterns of seeking healthcare to inform segmentation of clients for targeted education.

1.5 Problem Statement

Maternal mortality has for decades remained a major global health challenge (World Health Organization, n.d.-b) and efforts at reducing it are at the forefront of the global community. Globally, the number of women dying from maternal-related complications around the world annually is high with more than half (66%) of these deaths occurring in sub-Saharan Africa (WHO et al., 2015). According to Say et al., (2014), many of the health problems in pregnant women can be prevented, detected and treated with proper antenatal care with trained health workers. The World Health Organization (WHO), as part of its oversight role, had recommended a minimum of four antenatal care (ANC) visits for women whose pregnancies are progressing normally (World Health Organization, 2002). This has since been updated to a minimum of 8 ANC visits (World Health Organization, 2016b). These visits should aid in the prevention and detection of complications that may arise during pregnancy, health education and birth preparedness. Globally however, only 64% of pregnant women received the recommended minimum of four antenatal care visits, suggesting that large expansions in antenatal care coverage are still needed (World Health Organization, n.d.-a). Results from the 2014 Ghana Demographic and Health Survey (GDHS) show Ghana is performing above the global average with 87% of pregnant women receiving antenatal care (ANC) from skilled provider at least four times during the pregnancy (Ghana Statistical Service et al., 2015). However, a key question that remains unanswered by the GDHS, is “whether all the visits were made to the same healthcare provider or multiple providers”. One can only imagine the implications for a pregnant woman who visits three different facilities during her ANC and ends up delivering at a facility that she never visited during the ANC period, considering the fact that most maternal deaths occur during childbirth.

The key issue about ANC is not just only about the need for minimum number of visits, but also the need for continuity of care throughout pregnancy and childbirth (Dreier et al., 2012; Forster et al., 2016), where the woman is able to build a relationship of trust with her care providers. It must be noted that high levels of ANC and skilled delivery coverage are necessary but not sufficient to reduce maternal and neonatal morbidity and mortality. It is equally crucial that services are of high quality and continuity of care is a cornerstone of quality care. Continuity of maternity care has been shown to be beneficial to both patient and providers (Freeman & Hughes, 2010), with Jane Sandall, (2013) showing that women are more likely to mention concerns to someone they trust and that it is easier also for healthcare provider “to spot a problem in someone they have come to know”.

Currently in Ghana, there is no deliberate policy requiring pregnant women to have a primary care provider (facility) for antenatal care services. However, there is a deliberate effort to expand and make available and accessible basic antenatal and delivery care services up to the community level as demonstrated by the expansion in CHPS and health centres (Ministry of Health, 2016). This absence of the requirement to have a primary care provider means pregnant women in Ghana have a choice of where to access antenatal, delivery and postnatal care services. Evidence from Aryeetey et al, (2015) and Dako-Gyeke et al, (2013) show that some pregnant women in Ghana seek care from multiple healthcare providers during ANC leading to the fragmentation of care and patient information (considering the absence of integrated electronic health records system in Ghana) with severe implications for quality of care over time if not well coordinated and managed. Fragmented care can adversely affect the antenatal experience and outcomes for women and their families during pregnancy and labour (Department of Health, 2011). Though it is evident that some pregnant women receive care

from multiple providers, the problem is that, the extent of continuity and fragmentation of care during pregnancy and childbirth has not been quantified in Ghana.

In addition, lack of coordination is widely considered to be one of the key causes of poor quality healthcare (Bodenheimer, 2008; Øvretveit, 2009). Understanding how health facilities are connected through the sharing of patient is important for care coordination and identifying facilities that are central to the provision of antenatal and childbirth services. The purpose of this study therefore was to use health insurance claims data to measure the level of longitudinal continuity of care and to use social network analysis tools to visualize and determine the extent of care fragmentation (patient sharing) during pregnancy and childbirth in the Volta Region of Ghana.

1.6 General Objective

The general objective of the study was to measure the level of continuity and fragmentation of care during pregnancy and childbirth in the Volta Region of Ghana.

1.6.1 Specific objectives

The specific objectives were:

1. To determine the extent of continuity of care during pregnancy and childbirth in the Volta Region.
2. To estimate the extent of repeat visits to healthcare providers (provider continuity) by pregnant women during pregnancy and childbirth.
3. To determine the extent of care fragmentation among providers during pregnancy and childbirth.
4. To determine the extent of care fragmentation among districts during pregnancy and childbirth.

1.7 Research Questions

The key research questions addressed by the study include:

1. What is the level of continuity of care during pregnancy and childbirth in the Volta Region?
2. To what extent do the healthcare providers get repeat visits (provider continuity) to their facilities?
3. To what extent is antenatal and delivery care fragmented between healthcare providers in the Volta Region?
4. To what extent is antenatal and delivery care fragmented between districts in the Volta Region?

1.8 Justification

This study sought to fill the knowledge gap in continuity of care and fragmentation in Ghana. A search of the literature revealed that there is no published literature measuring the level of continuity of care in Ghana and Africa. In addition, there is also no published literature on the extent of care fragmentation and patient sharing during pregnancy and childbirth in Ghana and Africa. The result of the study will therefore inform the Ministry of Health and the Ghana Health Services on how to formulate policy for continuity of care and care coordination during pregnancy and childbirth in Ghana, since improving quality of maternal health care includes improving continuity of care for women before, during, and after delivery. In addition, the extent of multiple healthcare provider visits will assist NHIA monitor providers' services, primary provider selection and claims auditing.

In addition, the NHIS claims system has accumulated a vast amount of claims data over the years that can be used to understand the healthcare landscape and guide policy formulation and decision-making in the country. Research studies using claims data in Ghana to understand patient visits and utilization patterns, continuity and fragmentation of care are limited. There is the need to demonstrate that the claims data in Ghana have great potentials for understanding the health delivery landscape in Ghana. Developing methods to translate this claims data into meaningful formats to help measure continuity of care for other conditions and help visualize care fragmentation will contribute to strengthening the healthcare system in Ghana.

1.9 Conceptual framework for measuring continuity and fragmentation of care

Continuity and fragmentation of care have been shown to be influenced by a number of factors. These factors could be at various levels including the individual and the health system factors such as the availability of providers, the provider-patient interactions (consultations), the outcome of care received. Sturmberg, (2003) proposed a “system-based approach” to continuity of care. He conceptualized health system as a complex adaptive system consisting of five layers (the context of the care, the patient, the doctor as an individual, the consultation between the doctor and the patient, and the outcomes of the care provided or received). The patient factors that influence repeat visits to same provider include; demographics, belief, attitude and past experience of the patient (Alazri, Heywood, Neal, & Leese, 2007; Liu & Yeung, 2013; Sturmberg, 2003). The condition or illness factors that influence continuity or fragmentation include: the nature of the condition or illness, for example, a mental health condition will require that a patient visits a mental health professional while a malaria case may require a visit to a general doctor; and the severity of the illness (Sturmberg, 2003). Health systems factors have also been reported to contribute

either to continuity or fragmentation of care. These factors include healthcare policies, access (distance and cost), the availability of skilled staff, the availability of alternative providers, the attitude of staff, the interaction between the staff and the patient and the resulting relationships built, and the outcome of the care received in terms of patient satisfaction and improvement in health status (Agha et al., 2017; Stange, 2009; Sturmberg, 2003).

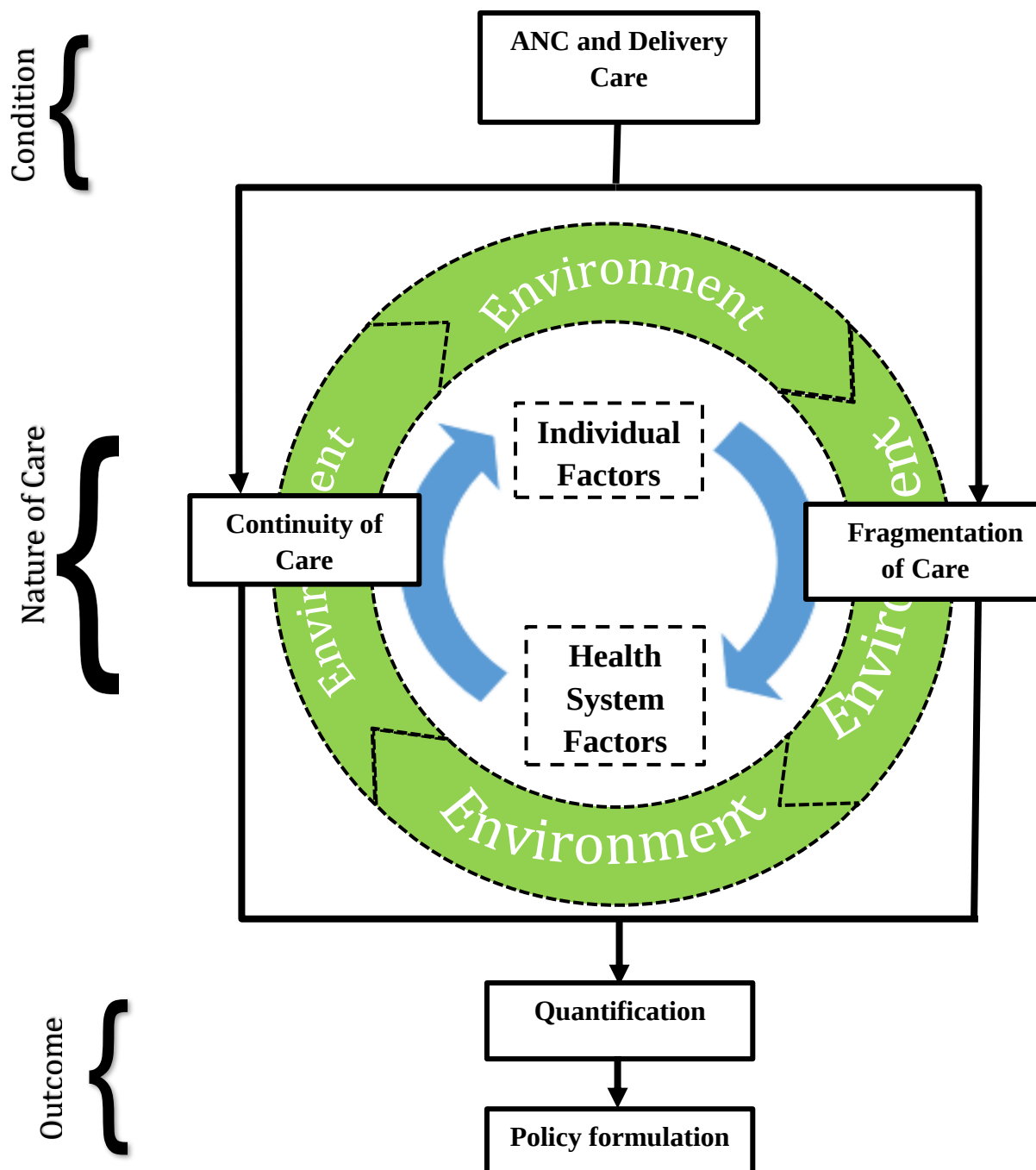
In addition, Beadles et al., (2014) through a review, proposed a framework for continuity of care by considering that continuity is influenced by the inter-personal relationship between the patient and the provider, the availability of comprehensive health information about the patient and the previous encounters of the patient, and the management of the patient by the different care providers treating the patient (Beadles et al., 2014). These three dimensions (inter-personal, information and consistent management) are not only in themselves inter-related but they also collectively influence the extent of continuity or fragmentation of care for a patient.

Based on the various dimensions and factors identified in the literature to be associated with continuity and fragmentation of care, the conceptual framework of this study was developed to measure the extent of continuity and fragmentation of care for a specific condition (antenatal and delivery) (figure 1.5). It is noted that the decision of an individual to continuously visit or change a provider, occurs within the broader context of the general socio-economic and political environment of the country and the health sector; including health insurance policies, regulatory environment, household income etc. A number of factors are likely to influence the extent of repeat visits or otherwise by a pregnant woman during ANC and delivery. These factors include the individual belief about ANC and skilled delivery, age, attitude, past experience of the woman or the clinician (midwife), the nature of

the pregnancy (progressing normally or complicated). These individual factors can either facilitate repeat visit to same facility (continuity) or visit to different facilities (fragmentation). Health systems factors such as the availability of midwives, doctors and nurses, experience with previous consultations, cost and distance could individually or collectively influence the woman's ability or decision to repeatedly visit same facility or not. The individual factors could influence health systems factors like healthcare policies and the way care is delivered. Likewise, the health system factors could also influence the belief, attitude and experiences of the individual. The individual and the health system factors in turn influence the extent of continuity and fragmentation of care. The nature of the delivery can also dictate as to whether the woman visits the same facility or moves to another facility. For example, a woman may repeatedly visit a health centre or a CHPS compound for ANC services but may require CS during delivery. The health centres and CHPS currently do not have the capacity to undertake CS delivery and so naturally this woman may be referred or decide to go to an appropriate hospital for delivery services.

Ideally, continuity and fragmentation of care are inversely related: the higher the level of continuity, the less fragmented the care would be. However, it is possible for a woman to have higher continuity of care and still have care fragmented at critical points in the pregnancy pathway particularly during labour and delivery. Measuring the extent of care continuity and fragmentation would facilitate policy formulation on healthcare services.

Figure 1.5: Conceptual framework for measuring continuity and fragmentation of care



Chapter 2: Literature Review

2.1 Review of NHIS Literature in Ghana.

Since the establishment of Ghana's National Health Insurance Scheme in 2003, a number of studies have been undertaken either using health insurance claims data or medical records or population based studies for which health insurance was the main focus. A comprehensive literature review of health insurance in Ghana was undertaken. A literature search was conducted in PubMed and Google Scholar from 2003 to August 2016 using the following keywords: 'health insurance' AND 'Ghana'; and 'Claims data' AND 'Ghana'. Peer reviewed journal articles that focused on health insurance in Ghana or used health insurance or medical claims data were included. In total, 69 articles were selected. Nine (9) articles were mainly focused on using claims data (13.0%) and sixty (60) used survey data. Of the articles using survey data, thirteen (13) articles were focused on maternal health (21.7%) and forty-seven articles (78.3%) were focused on the general issues. Sixteen (26.7%) articles used household surveys while 38 (63.3%) articles were focused on using individual level survey data for the analysis. The main issues raised in the review have been classified into three broad areas: (1) Claims data; (2) Maternal and Child Health; (3) General Studies.

2.1.1 Claims Data

Clinical data hold great potentials to transform healthcare system in any country if well used. It can provide greater insight to patients, healthcare providers, and policy makers into the appropriate application of interventions, and quality and costs of care services (Chandola, Sukumar, & Schryver, 2013). Understanding the extent of the potential and taking steps to utilize clinical claims data can help to improve healthcare delivery. Analysis of the articles that used health insurance claims data shows that most of the issues being investigated were

financial (Nsiah-boateng, Aikins, Asenso-boadi, & Andoh-Adjei, 2016; Odame, Akweongo, Yankah, Asenso-boadi, & Agyepong, 2013; Yevutsey & Aikins, 2010), sustainability (Amporfu, 2011; Aryeetey, Nonvignon, Amissah, Buckle, & Aikins, 2016; Odame et al., 2013) and claims management challenges (Carapinha, Ross-degnan, Desta, & Wagner, 2010; Sodzi-Tettey, Aikins, Awoonor-Williams, & Agyepong, 2012).

Using claims data to understand the profile of patients using or not using services; to understand the patient visits and utilization patterns, continuity or fragmentation of care; determine if appropriate services are provided to specific groups of patients; identify potential over utilization of services; provider shopping etc, are lacking. However, the ready availability of claims data in Ghana covering a large population of people throughout the country and almost all common medical conditions make health insurance claims data a very good source of inexpensive data for understanding the healthcare landscape in Ghana (Chandola et al., 2013).

Table 2.1: Claims data studies

Author	Type of data used	General objective	Key Findings/Conclusion
Yevutsey & Aikins, (2010)	Financial and claims data	Assess the financial viability of district schemes in the Upper West Region	The schemes major source of fund was NHIA. Regular support from NHIA, increasing coverage and reduction in administrative expenses would make scheme viable.
Odame et al., (2013)	Health insurance claims data	Examine claims expenditure under the free maternal care programme.	The rising financial demands from the programme on NHIS is becoming a threat to the sustainability of the NHIS fund.

Anko & Adetunde, (2011)	NHIS registration and claims data	Identify trends in registration and health facility utilization	Registration numbers increases in every first and fourth quarter while claims numbers and amount is on the rise.
Nsiah-Boateng et al., (2016)	Membership and medical claims data.	Assess the value of the benefit package to the insured.	NHIS is beneficial to subscribers but the scheme need to be more responsive to the financial needs of health services providers.
Sodzi-Tetty et al., (2012)	Claims data and interviews	Evaluate NHIS claims management for two Districts in the Upper East Region of Ghana.	“Claims processes in both districts were predominantly manual with administrative capacity, technical, human resource and working environment challenges contributing to delays in claims submission”.
(Amporfu, 2011)	Claims data	Test for the presence of supplier induced demand among private, for profit hospitals.	Supplier induced demand exist in the private sector among patients within the ages 18 and 60 years
Antwi & Zhao, (n.d.)	Membership and medical claims data	Examine factors that influence the NHIS claims.	Sex, age, marital status, distance and length of stay at the hospital are important factors of health insurance claims.
Carapinha et al., (2010)	Claims and routine data	Describe the structure of medicine benefits and routine data in 5 Sub-Saharan African Countries.	Basic data for performance monitoring were available, but key elements to aid the generation of useful information for management decisions were missing.

Aryeetey, Nonvignon, et al., (2016)	Claims data	Assess the effect of NHIS on health service delivery in mission health facilities in Ghana.	Result shows significant improvement in patient attendance, income, expenditure and access to medicines. However, non- reimbursement of claims, errors in claims, provision of feedback, and reporting procedures are challenges that need to be addressed.
--	-------------	---	---

2.1.2 Maternal and Child Health

Maternal and child health articles were mainly on NHIS and Maternal Health services utilization and the free maternal care policy introduced onto the NHIS in 2008. Six (46.2%) of the maternal health articles were focused on evaluation of the free maternal care policy while six (46.2%) were also focused on health insurance and utilization of maternal healthcare services. Findings showed that NHIS membership was associated with increased use of maternal healthcare service: antenatal services, facility delivery, neonatal and child health continuum of care service (Bosomprah, Ragno, Gros, & Banskota, 2015; Browne et al., 2016; Dzakpasu et al., 2012; Frimpong et al., 2013; Mensah, Oppong, & Schmidt, 2010; Singh et al., 2015). Only one paper used claims data to investigate maternal health issues (Odame et al., 2013). It was however, limited to looking at the financial sustainability of the free maternal health policy. No study was found that looked at using claims data to determine the uptake of maternal healthcare services and utilization patterns during antenatal and delivery.

Table 2.2: Studies on Maternal and Child Health

Author	Type of data used	Objectives	Key Findings/Conclusion
Mensah et al., (2010)	Survey data - individual	Examine the goal of NHIS regarding maternal and child health.	Women on NHIS were more likely to receive ANC, deliver at a hospital, have skilled birth, and experience less birth complications compared to those without NHIS.
Singh et al., (2015)	Quantitative and qualitative survey data	Describe the associations between insurance and skilled delivery, ANC and care for sick children.	• NHIS was associated with greater skilled delivery, early health seeking for children. • The poor and less educated were less likely to have NHIS compared to the wealthier and more educated.
Bosomprah et al., (2015)	MICS 2011	“Examine the association between NHIS membership and ANC, PNC and under-five mortality.	NHIS membership was associated with improved access to maternal and child health services but not associated with under-five mortality.
Koduah, Dijk, & Agyepong, (2016)	Qualitative data	Explore how and why primary care maternal services were dropped from NHIS capitation policy	Technical policy makers through their expertise and consensus got ANC, delivery and PNC services included in the capitation payment system, however, pressure and resistance from service providers forced their removal from the payment system.
Witter, Arhinful, Kusi, & Zakariah-akoto, (2007)	Qualitative data	Evaluate the free delivery policy for pregnant women in Ghana	The policy was well accepted, but increased staff workloads, disbursement and funding sustainability were key challenges that need to be addressed.

Arthur, (2012)	GDHS 2008	Examine the effect of wealth on ANC services usage	Wealth, education, age, number of living children, transportation, place of residence, geographic location and NHIS influence the use of ANC services in Ghana
Witter, Garshong, & Ridde, (2013)	Qualitative data	Explore how the free maternal health policy was developed and implemented.	Policy was seen primarily as a political initiative, with limited stakeholder consultation, no costing and no additional financial resources provided to the NHIS to support the policy.
Owoo & Lambon-quayefio, (2013)	GDHS 2008	Examine the effect of health insurance and social influence on the frequency of ANC visits.	Adjusting for socioeconomic and geographical factors, women who have NHIS use more ANC services than those that do not.
Frimpong et al., (2013)	Retrospective cohort data (2008-2010)	Examine NHIS registration following the introduction of the premium exemption for pregnant women.	NHIS registration among pregnant women increased significantly after the premium exemption policy.
Aikins, Aryeetey, Adongo, & Mcgough, (2014)	Survey data	“Examine socioeconomic differences in health services cost incurred by pregnant women”.	“Women socioeconomic differences play a critical role in access to health services”
Johnson, Frempong-anguah, & Padmadas, (2015)	GDHS 1990-2008	Investigate the impact of free maternal health policies on the uptake of skilled birth amongst the poor in Ghana.	“The benefits of skilled birth care during the ‘free delivery care’ and NHIS policy periods accrued more for the rich than the poor”.

Browne et al., (2016)	GDHS 2008	Evaluate the effect of NHIS status on the utilization of ANC, skilled delivery and PNC care.	Adjusting for socioeconomic, demographic and obstetric factors, insured women were more likely to have increased ANC, skilled delivery and PNC services.
Dzakpasu et al., (2012)	RCT	Assess the impact of the free delivery care policies for pregnant women.	Facility deliveries increased significantly particularly among the poorest over the policies periods.

2.1.3 General Studies

Forty-six papers focused on the general issues of health insurance in Ghana. Particularly client satisfaction, enrollment, utilization, financial protection for the poor and factors associated with NHIS membership and utilization, health seeking behavior of NHIS clients.

Table 2.3: General Studies

Author	Type of data used	Objectives	Key Findings/Conclusion
Agyemang, Adu-Gyamfi, & Afrakoma, (2013)	Survey data - individual	“Assess the contribution of the NHIS to health care delivery”.	“NHIS was associated with increasing Out-Patients-Department (OPD) attendance, reduction of self-medication and made health services more assessable to the poor”.
Aryeetey, Jehu-Appiah, Spaan, Agyepong, & Baltussen, (2012)	Household survey	Analyse costs, equity, efficiency and feasibility of strategies to identify poor households.	“Mean testing (MT) should be used as optimal strategy in low-poverty urban and rural settings and geographic targeting (GT) as optimal strategy in high-poverty semi-urban setting”.
Dixon, Tenkorang, & Luginaah, (2013)	Survey data - individual	Examine perceptions of NHIS members regarding services.	Wealth, education, gender and ethnicity are factors that influence members’ perceptions of services.
Dixon, Luginaah, & Mkandawire, (2014a)	Survey data - individual	Show gendered inequalities among people dropping out of NHIS.	Poor and food insecure women and women living with young children had higher chance of dropping out compared to men who were 50% more like to drop out for not being satisfied with the services provided.
Dixon, Luginaah, & Mkandawire, (2014b)	Survey data - individual	Examine factors associated with NHIS enrollment in the Upper West Region.	Wealth and desire for NHIS contribute to enrollment while education and being Muslim were contributing to non-enrollment and drop out.

Kusi, Enemark, Hansen, & Asante, (2015)	Household survey	Examine the extent of affordability on NHIS enrollment.	“Affordability of full insurance would be a burden on households with low socio-economic status and large household size”.
Kotoh & Van der Geest, (2016)	Survey data - individual	“Examine why the NHIS is not reaching the poor as envisaged”.	The general population had higher enrollment rates compared to the poor (17.6 % for the poorest compared to 44.4% for the richest). The inability of the poor to enroll was generally attributable to their poverty.
Adei, Mireku, & Sarfo, (2015)	Survey data – individual	Assess the implementation of NHIS in Sekyere South District	Majority of members were satisfied with NHIS. However, long waiting time, poor attitude of providers, prescription of inferior drugs are some issues affecting renewal.
Ama P. Fenny et al., (2016)	Household survey	Examine NHIS in improving access to healthcare services in Ghana.	• Greater proportion of insured accessed healthcare from formal service providers compared to the non-insured. • NHIS status, education and gender are key determinants of healthcare utilization.
Gobah & Zhang, (2011)	Qualitative and quantitative survey data	Assess effect of NHIS on access and utilization of healthcare services in the Akatsi District.	• NHIS promotes positive health seeking behaviour and utilization of services. • Age, education and occupation are key determinants of NHIS membership.
Alhassan, Nketiah-Amponsah, Spieker, Arhinful, & Rinke de Wit, (2016)	Survey Data (randomized cluster trial)	Examine frontline health workers’ perspectives on the NHIS and quality care delivery.	“Community engagement in quality service assessment is a potential useful strategy towards empowering communities while promoting frontline health workers’ interest, goodwill and active participation in Ghana’s NHIS”

G. C. Aryeetey, Westeneng, et al., (2016)	Household survey	“Analyze the effect health insurance on household out-of-pocket expenditure (OOPE), catastrophic expenditure (CE) and poverty”.	• 7–18 % of insured and 29–36% uninsured households incurred CE as a result of OOPE. • NHIS enrollment reduced OOPE by 86% while protecting households by 3.0% and 7.5% against CE and poverty respectively.
Witter & Garshong, (2009)	Data from Annual Reports	Provide a preliminary assessment of the NHIS	• NHIS has expanded coverage mainly as a result of exemptions. • Absence of copayments, wide-ranging benefits, limited gate-keeping, increasing cost and utilization and failure to reimburse on time are challenges to sustaining the scheme.
Sarpong et al., (2010)	Survey data - individual	Explore the association between socio-economic status and NHIS subscription	Socio-economic status was significantly associated with NHIS subscription
Jehu-appiah, Aryeetey, Spaan, Agyepong, & Baltussen, (2010)	Literature review and reports	Assesse feasibility, efficiency and equity of potential strategies to identify the poor	Useful strategies to identify the poor include: proxy means testing (PMT), participatory welfare ranking (PWR), and geographic targeting (GT). However, they vary in terms of their efficiency, equity and feasibility.
Agyepong & Nagai, (2011)	Survey and outpatients attendance data	Examine policy implementation gaps of user fees exemptions.	“Policies that do not take into account the incentives for frontline worker adherence and align them better with policy objectives may experience implementation gaps”.
Jehu-appiah et al., (2011)	Household survey	Evaluate equity in NHIS enrollment and determinants of demand	“There is evidence of inequity in NHIS enrollment and significant differences in determinants of current and previous enrollment across socio-economic quintiles”.

Nguyen, Rajkotia, & Wang, (2011)	Household survey	Evaluate impact of NHIS on households' out-of-pocket and catastrophic expenditures.	Though NHIS members still make out-of-pocket payment from informal sources and for drugs and tests not covered by NHIS, they incur significantly less cost than the uninsured.
Jehu-appiah, Aryeetey, Agyepong, Spaan, & Baltussen, (2012)	Household survey	Assess perceptions of the insured and uninsured households about providers.	Insured households had good perceptions of the quality of care, price, benefits and convenience with regards to NHIS
Akazili, Gyapong, & McIntyre, (2011)	Survey data (GLSS 2005/2006)	"Analyse the distribution of health care financing in relation to ability to pay in Ghana".	The healthcare financing system in Ghana is generally progressive while "out-of-pocket payments are regressive form of health payment to households".
Mills et al., (2012)	Household survey	Examine equity of healthcare financing and service use in three-countries	In all the three countries, health-care financing was progressive. However, the service benefits favoured richer people than the poor who had the greater burden of illness.
Dalinjong & Laar, (2012)	Survey data	Examine influence of the NHIS on providers' behavior.	"Providers preferred clients who make instant payments for health care services". "Most of the insured perceived and experienced long waiting times, verbal abuse, not being physically examined and discrimination in favor of the affluent and uninsured".
Derbile & Geest, (2013)	Qualitative and quantitative survey data	Examine how exemptions applied under the NHIS.	Administrative difficulties and challenges in identifying the poor account for inequity in exemptions (NHIS).
Macha et al., (2012)	Household survey and qualitative data	Explore factors influencing health care financing in the three countries	Inadequate enforcement of exemption and waiver policies results in regressivity of out-of-pocket payments

Goudge et al., (2012)	Household survey	Examine willingness to pre-pay and cross-subsidize the poor in three African countries.	62% of respondents in South Africa and 55% in Ghana favoured progressive financing system with only a smaller proportion of the rich favouring a progressive system.
Kumi-kyereme & Amo-Adjei, (2013)	GDHS 2008	Examine effect of spatial location and household wealth status.	Richer households were more likely to purchase health insurance compared to the poorest
Boateng & Awunyor-vitor, (2013)	Survey data	Assess attitude towards health insurance policy.	Factors that influence NHIS enrollment include: Gender, marital status, religion and perception of health status. Key reasons given for non-renewal: poor service quality and lack of money
Agyei-Baffour et al., (2013)	Survey data - individual	Explore the perceptions and understanding of capitation in Kumasi metropolis.	Ninety four (94) percent of providers believed people did not like capitation and 61.2% of respondent believed that capitation was not important to them.
Dwumoh, Essuman, & Afagbedzi, (2014)	MICS 2011	Determine the association between NHIS membership and child health service utilization.	NHIS membership was associated with higher odds of being fully immunized and lower odds of developing anemia
Amo, (2014)	Survey data - individual	Identify factors to enrolling on the NHIS.	Gender, education, number of children, place of residence, employment, premium level and income were significantly associated with NHIS enrollment.
Dalaba et al., (2014)	Household survey	Assess effects of NHIS on cost of treating malaria.	“Average direct medical cost of treating malaria was GH¢3.2 (US\$2.1) per case with the insured spending less (GH¢2.6/US\$1.7) per case than the uninsured (GH¢3.2/US\$2.1)”.

Fenny, Enemark, Asante, & Hansen, (2014)	Household survey	Examine satisfaction with health care among the insured and uninsured.	- Insured patients were more satisfied with overall quality of care compared to the uninsured. - Factors associated with satisfaction were waiting time, friendliness of staff and satisfaction with consultation.
Fenny, Hansen, Enemark, & Asante, (2014)	Individual survey data	Assess effect of NHIS on the quality of uncomplicated malaria case management.	- Assessments for identifying suspected malaria case was low in all the facilities. - The quality of treatment given to NHIS and non-NHIS members was not significantly different.
Akazili et al., (2015)	Survey data - individual	Explore extent of NHIS coverage for the poor.	“NHIS was yet to achieve its goal of addressing the need of the poor for insurance against health related financial risks”.
Boachie, (2016)	Survey data - individual	Investigate the factors associated with choosing primary healthcare provider.	Availability of doctor, drugs, proximity, provider reputation, waiting time, charges, and recommendations were the main criteria in selecting primary providers.
Fenny, Asante, Enemark, & Hansen, (2015)	Household survey data	Establish health-seeking behaviour of households.	NHIS and travel time to healthcare provider were key determinants of healthcare demand. The insured were more likely to choose formal healthcare provider compared to the uninsured.
Fenny, Asante, Enemark, & Hansen, (2015)	Individual survey data	Analyse malaria treatment seeking behaviour of households.	- The insured were more likely to choose public/formal provider over informal care. - Factors such as age, education and wealth influence choice of provider.

Kusi, Hansen, Asante, & Enemark, (2015)	Household survey	Examine effect of the NHIS on Out-of-pocket health expenditure and catastrophic health expenditures.	NHIS reduces out-of-pocket health expenditure and provides financial protection against catastrophic health expenditures.
Gyasi, (2015)	Survey data - individual	Examine the relationship between NHIS and traditional medicine use.	There is no significant association between NHIS status and traditional medicine utilization.
Alhassan, Duku, et al., (2015)	Survey data - individual	Examine perceptions of clients and health providers on quality of healthcare	“Increased efforts towards technical quality care alone will not necessarily translate into better client-perceived quality care and willingness to utilize health services in NHIS-accredited health facilities.”
Debpuur, Dalaba, Chatio, Adjuik, & Akweongo, (2015)	Qualitative	Document abuse of scheme among clients and service providers under the NHIS.	Abuse of the scheme identified included: frequent and ‘frivolous’ visits to providers, impersonation, feigning sickness, inappropriate charging and over prescription.
Fenenga et al., (2015)	Quantitative and qualitative data	Explore social relationships and decision to enroll onto NHIS.	Social capital can be a motivation factor for clients to enroll onto NHIS.
Kuure, Bisung, Rishworth, Dixon, & Luginaah, (2015)	Survey data - individual	Examine the factors influencing healthcare utilization.	Poor people enrolled in the NHIS were still less likely to utilize health services.”
Alhassan, Amponsah, et al., (2015)	Survey data - individual	Explore efficiency of NHIS accredited providers	There exist some level of wastage of resources among NHIS providers, particularly those in urban areas.
Amo-adjai, Anku, Amo, & Effah, (2016)	GDHS 2014	Investigate perception of service quality and NHIS enrollment	Some respondents felt that the quality of service provided to NHIS card holders was worse.

Amu & Dickson, (2016)	GDHS 2014	Examine factors associated with NHIS enrollment among women in Ghana.	Factors associated with NHIS enrollment include: education, age, religion, residential location, wealth status, marital status, birth parity and ecological zone.
Akazili, Garshong, Aikins, Gyapong, &McIntyre, (2012)	Ghana Living Standards Survey (2005/2006)	Measure progressivity of existing healthcare financing systems in Ghana.	Healthcare financing system in Ghana is progressive while the national health insurance levy contribution of the informal sector is repressive.

2.2 Continuity of Care

2.2.1 Dimensions of Continuity

The term “continuity of care” evolved around the late 1960s and is an ongoing concept. In the healthcare literature, evidence suggests that the term has been used to describe a number of relationships between patients and providers in the delivery of healthcare services. These definitions have evolved over time and overlap with relating concepts such as coordination, integration, patient-centred care etc. For example, Mindlin & Densen (1969), as part of the earliest definition of the term, considered “an infant to receive medical care with continuity if he had a single source of medical care during the year, or if, having had more than one, he got the subsequent sources only by referral from earlier sources”. Bass & Windle (1972) also defined continuity as “the relatedness between past and present care in conformity with the therapeutic needs of the client.” Starfield, Simborg, Horn, & Yourtee (1976) looked at continuity as a two dimensional concept: continuity of medical record: “having the patient seek care from the same facility,” and continuity of practitioner: “patients saw the same physician on repeated visits.” Bice & Boxerman (1977), who first proposed a quantitative measure for continuity of care, defined the concepts as “the extent to which a given individual’s total number of visits for an episode of illness of a specific time period are with a single or group of providers.”

Barbara Starfield (1982), expanded this definition by introducing two dimensions: longitudinality and continuity. Longitudinality refers to care over time from a regular source of care while continuity refers to “the way in which information about diagnosis and management of a problem is conveyed from one visit to the next”. Nassif, Garfink, & Greenfield (1982), also defined two dimensions of continuity: “Structural continuity” and “Process continuity”.

“Structural continuity” pertains to the site of medical encounter and assumes “that patients who receive all routine and non-emergent, non-routine care at one site are more likely to be seen by one physician or team of health care workers, and will, at least, have an integrated medical record.” “Process continuity” refer to “the coordinated delivery of care over a period of time or throughout an illness episode”.

The Institute of Medicine (1994), also referred to continuity of care as “a characteristic that refers to care over time by a single individual or team of health professionals (‘clinician continuity’) and to effective and timely communication of health information (about events, risks, advice, and patient preferences) (‘record continuity’). It applies to both space and time. It combines events and information about events occurring in disparate settings, at different levels of care, and over time, preferably throughout a person’s life span. Continuity encompasses patient and clinician knowledge of one another and the effective and timely communication of health information that should occur among patients, their families, other specialists, and primary care clinicians.” However, Saultz, (2003) provided a broad review of continuity of care measures and defined continuity of care using a hierarchical framework grounded on the healthcare provider having sufficient information about the patient (‘informational continuity’), which enables patients having repeated care setting over time (‘longitudinal continuity’) and results in a relationship of mutual trust and accountability between the patient and provider (interpersonal continuity) (Bentler, Morgan, Virnig, & Wolinsky, 2014a; Saultz, 2003).

Over the years, various authors have identified continuity as a multi-dimensional concept (Freeman, Shepperd, Robinson, Ehrich, & Richards, 2000; Haggerty, Reid, Freeman, Starfield,

& Adair, 2003; Reid et al., 2002; Roos et al., 1980; Saultz, 2003; Starfield, 1982; Starfield et al., 1976). Reid et al., (2002), identified two core elements and three types of continuity that bridge the domains of health care. These core elements include; “the experience of care by a single patient with his or her provider(s)”, longitudinality (the care continues over time). These, they argued, must be necessary but not sufficient for continuity to exist. The three types of continuity according to Reid et al (2002) include: informational continuity; relational (interpersonal) continuity; and management continuity. The fundamental idea from the various dimensions of continuity is that a patient develops an on-going mutual relationship with a healthcare provider. The development of this mutual relationship is further facilitated by repeat visits by the patient and the availability of relevant information about the patient and the care provided. The ability of the patient to see the same provider repeatedly allows the provider to have a care plan for the patient over time. However, when a patient moves from one provider to the other, this opportunity to develop a relationship and follow through a care plan is lost (Katz, Coster, Bogdanovic, Soodeen, & Chateau, 2004).

What is clear from the literature is that, there is no universally accepted definition of continuity but there is acceptance that it is a multi-dimensional concept and as a result, several authors have proposed a number of terms to describe the various dimensions involved (Haggerty et al., 2003; Salisbury, Sampson, Ridd, & Montgomery, 2009; Saultz, 2003). Table 2.4 summarizes the various dimensions that have been proposed.

Table 2.4: Dimensions of continuity of care

Dimension	Description
Longitudinal/ chronological continuity	Care from a regular site of care (G. Freeman et al., 2000; Reid et al., 2002; Roos et al., 1980; Salisbury et al., 2009; Saultz, 2003; B. Starfield, 1982; B. H. Starfield et al., 1976)
Relational/interper sonal continuity	Ongoing relationship between a patient and the healthcare providers (G. Freeman et al., 2000; Reid et al., 2002; Roos et al., 1980; Saultz, 2003)
Information continuity	Availability of and shared information between healthcare professionals (G. Freeman et al., 2000; Institute of Medicine, 1994; Reid et al., 2002; Salisbury et al., 2009; Saultz, 2003; B. Starfield, 1982; B. H. Starfield et al., 1976)
Team continuity -	Good communication across a team of professionals or services (Belling et al., 2011)
Management continuity	A consistent approach to the management of a patient from all those involved (Haggerty et al., 2003)
Geographic continuity	Care that is given or received in person on one site (office, home, hospital, etc) (Saultz, 2003)
Site continuity/ clinician continuity	Care from multiple but related physicians such as those practicing as a group (Institute of Medicine, 1994; Roos et al., 1980)
Referral continuity	Care linked by a referral (Roos et al., 1980)
Flexible continuity	Services that are flexible and adjusted to the needs of the individual over time (Belling et al., 2011).
Cross-boundary continuity	Care that follows the patient across settings (e.g. from primary care to hospital or vice versa) (Belling et al., 2011)
Structural continuity	"Site of medical encounter and the way in which the delivery of services is organized" Nassif, Garfink, & Greenfield (1982)
Process continuity	"The coordinated delivery of care over a period of time or throughout an illness episode" Nassif, Garfink, & Greenfield (1982)

2.2.2 Measuring Continuity of Care

In the healthcare literature, there are diverse concepts of continuity and various ways of measuring them. Most of the quantitative measures of CoC calculate the extent to which a patient had contact with a given healthcare provider over a specified period of time. Most of these CoC measures were established to measure single dimension of continuity. Most of the measures however, assess the chronology of a patient's visit with the healthcare providers over time. Continuity is determined from the duration of patient-provider relationship, the concentration and sequence of visits among the different providers. The basic assumption is that repeated contact with a single provider results in stronger patient-provider relationships, better availability of information, and more coherent approach to managing the patient. (Reid et al., 2002)

Over the past decades however, several authors have proposed different measures of the concept of CoC. In 2003, Saultz undertook a broad review of continuity of care measures and found 21 different measurement techniques used in measuring continuity of care (Saultz, 2003). In 2006, Jee and Cabana also undertook a review by examining claims-based CoC indices. They identified five main categories of CoC indices used in claims data: duration of provider relationship, density of visits, dispersion of providers, sequence of providers, and subjective estimates. Density measures require the identification of an index provider (e.g. usual/primary provider, most recent or frequent provider) for computing patient visit patterns. Dispersion measures extend the density indices by taking into consideration the various providers consulted by patients. Sequential indices go beyond these other measures by taking into consideration the order in which the visits were made to the different providers. However, duration indices which measure the aggregate length of the relationship a patient had with a provider were not

commonly used in continuity of care literature (Bentler et al., 2014a)

One prominent approach in measuring continuity and coordination involves the use of health insurance claims data to measure care “continuity” or “fragmentation” (Bentler et al., 2014a; Jee & Cabana, 2006). However, claims-based CoC measures cannot determine the quality of the provider-patient relationship and does not also take into consideration the experience of the patient. While these claims-based measures have important limitations as measures of care continuity (Saultz, 2003), claims data have several advantages including the fact that claims data contains large numbers of beneficiaries, provide comprehensive record of services provided and relatively inexpensive to collect as compared to primary data collection or interviews (Pollack et al., 2015).

According to the healthcare literature, the most commonly used category of indices to measure continuity of care were density measures, with usual provider of care (UPC) as the most common index within this category (Jee & Cabana, 2006; Saultz, 2003). Other variants of UPC include “most recently seen provider” and “most frequently seen provider” continuity. Density measures are applicable to various groups of patient using medical record, claims data and surveys (Jee & Cabana, 2006).

The second most regularly used index category was dispersion measures with the Bice and Boxerman continuity of care index (CoCI) (Bice & Boxerman, 1977) as the most frequently applied dispersion measure (Jee & Cabana, 2006; Saultz, 2003). The dispersion index, takes into account the fact that patients may consult more than a single care provider and therefore

continuity measure ought to reflect the extent of care sought from other providers (Jee & Cabana, 2006). Other common dispersion measures include the Modified, Modified Continuity Index (MMCI) (Magill & Senf, 1987). These dispersion indices are mostly applied to claims data. Dispersion indices are more challenging to calculate and require at least several consultations (Jee & Cabana, 2006).

The third category of measures used is the sequential continuity index (SECON) (Jee & Cabana, 2006; Saultz, 2003). This category of index, takes into consideration the order in which care providers are consulted. Sequential continuity is not as frequently used as compared to the density and dispersion measures, as it is challenging to compute. In theory, patients who require regular follow up with care providers may benefit from the index. Consistent follow-up consultations with a care provider will result in higher sequential index score. However, if a patient alternates between a primary care provider and specialist as a result of referral, this index is not able to take this back and forth movement between the two providers into consideration. This index is most useful in situation where it is important to take into consideration the need for follow-up consultation with the same care provider (Jee & Cabana, 2006) as may be the case in normal antenatal care.

2.2.3 Health Facility Level Continuity of Care

In the report “*Physician Integrated Network: A Second Look*”, Katz et al., (2014) measured continuity of care by using health facilities (Physician Integrated Network clinic) instead of the usual individual physician used by most authors. Using this approach, continuity of care indices can be calculated at the health facility level. A Continuity of care index value of zero (0) means

that all visits made to different health facilities and a value of one (1) means all visits made to the same health facility.

In another report “*Using Administrative Data to Develop Indicators of Quality in Family Practice*”, Katz et al., (2004) developed a continuity of care measure that took into account the number of ambulatory visits for a patient to each provider. They measured continuity of care to reflect “the proportion of ambulatory care provided by primary care physicians to a patient by any one particular physician”. They calculated the continuity of care score for each physician which represents “an average of the proportion of care (measured by visits) that a physician provided to all the patients who accessed them for care compared to other physicians who provided care for those same patients. Possible scores range from just greater than zero (0) to 1; thus, a practitioner who was a patient's only primary care physician (and who provided care during the study year) was allocated a score of 1 for that patient. If a patient accessed two physicians for equal proportions of their care, each of those physicians were allocated a score of 0.5”. Averages of all scores were calculated for each physician and then for all physicians overall. The overall average score served as the standard of comparison. Individual physicians who scored less than the standard were considered “below average” and those who scored higher than the standard were deemed “above average” compared to their colleagues (Katz et al., 2004).

2.2.4 Continuity of Maternal Care

There are several ‘models of care’ during pregnancy, labour and delivery, and the postnatal periods (Sandall, Soltani, Gates, Shennan, & Devane, 2016). Sometimes, an obstetrician or another doctor is the lead healthcare professional and at other times it is a midwife. ‘Midwife-

led continuity model' is where the midwife is the lead care professional from the initial antenatal period to the early days of the postnatal period (Sandall et al., 2016). In this model, the woman is encouraged to have the same carer or small group of carers throughout the pregnancy, labour and delivery and occasionally up to six weeks of the postnatal period. This is sometimes called caseload' or 'midwifery group practice' or team midwifery (The Royal Women's Hospital, n.d.). With this model of care, a woman is less likely to see the same midwife at each visit but each midwife in the team may be more familiar with the woman and her pregnancy. She is placed in the care of a team of midwives so that she is more likely to develop a relationship with them (The Royal Women's Hospital, n.d.).

In Ghana, the main providers of care during pregnancy, labour and child-birth are the midwives (Ghana Statistical Service et al., 2015). Midwife-led model package of care includes: "continuity of care throughout pregnancy, birth and the postnatal period; providing the woman with individualized education and counseling; being cared for by a known and trusted midwife during labour; and the immediate postpartum period; and identifying and referring women who require obstetric or other specialist attention" (Sandall, 2013). The emphasis in midwife-led care, is on continuity of care and feeling of being taken care of during labour by a midwife whom the pregnant woman has come to know and trust (Sandall et al., 2016).

Research shows that women who had continuity of care during and after pregnancy were less likely to give birth prematurely and have fewer complications than those receiving standard care (Sandall, 2013). Continuity of midwifery care has also been demonstrated to be associated with positive care outcomes and improved satisfaction with maternity care, (Sandall, Soltani, Gates,

Shennan, & Devane, 2013) and it has been recommended by the World Health Organization as having an important role in improving maternal and child health (World Health Organization, 2005). Continuity of maternity care from a skilled provider is especially important in ensuring that the risks associated with a pregnancy are avoided or minimized. According to Sandall, “Women’s access to quality midwifery services has become a part of the global effort in achieving the right of every woman to the best possible health care during pregnancy and childbirth” (Sandall, 2013). Evidence from the Ghana Maternal Health Survey shows that a little below 50% (48) of women access all major maternity care components (antenatal care, delivery care, and postnatal care) from skilled providers (Ghana Statistical Service et al., 2009).

2.2.5 Continuity of Care and Health Outcomes

Continuity of care (CoC) is generally considered to be an essential component of high-quality patient care, especially for people with multiple chronic conditions which requires consistent treatment and follow-up (Bentler, Morgan, Virnig, & Wolinsky, 2014b; B. Starfield, Shi, & Macinko, 2005). Several studies have suggested that interpersonal or relational continuity is associated with “less hospitalization and emergency department use”, “better preventive care” and lower costs (Bentler et al., 2014b; Cabana & Jee, 2004; Weiss & Blustein, 1996; Wolff, Starfield, & Anderson, 2002). A study by Cheng, Hou, & Chen, (2011) reveal that “lower CoC is associated with increased hospital admissions and emergency department visits, even in a health care system that lacks a referral arrangement framework”. They suggested that improving the CoC is useful to both patients and the health care system overall. Longitudinal continuity of care between care provider and patient has been found also to improve satisfaction of both patients

and providers, and ensure medication compliance by patients (Dietrich & Marton, 1982).

A systematic review by Sandall et al., (2013) published in the Cochrane Library revealed that “women who had midwife-led continuity models of care were less likely to experience regional analgesia (average risk ratio (RR) 0.83, 95% CI 0.76 to 0.90), episiotomy (average RR 0.84, 95% CI 0.76 to 0.92), and instrumental birth (average RR 0.88, 95% CI 0.81 to 0.96), and were more likely to experience no intrapartum analgesia/anaesthesia (average RR 1.16, 95% CI 1.04 to 1.31), spontaneous vaginal birth (average RR 1.05, 95% CI 1.03 to 1.08), attendance at birth by a known midwife (average RR 7.83, 95% CI 4.15 to 14.80), and a longer mean length of labour (hours) (mean difference (hours) 0.50, 95% CI 0.27 to 0.74). There were no differences between groups for caesarean births (average RR 0.93, 95% CI 0.84 to 1.02). Women who were randomised to receive midwife-led continuity models of care were less likely to experience preterm birth (average RR 0.77, 95% CI 0.62 to 0.94) and fetal loss before 24 weeks’ gestation (average RR 0.81, 95% CI 0.66 to 0.99).”

A similar review by Sandall et al (2016) also revealed that “women who received care led by a midwife during pregnancy, were less likely to give birth prematurely or lose their babies before 24 weeks of gestation”. These women were reported to be “happier with the care they received, had fewer epidurals, fewer assisted births, and fewer episiotomies – or surgical incisions to reduce the risk of a tear”. In addition, women in midwife-led settings “were no more likely to have caesarean births, but they tended to be in labour for about half an hour longer on average” (Sandall et al., 2016).

In a study that used claims data to determine the association between continuity of care and health outcomes, Dreier et al., (2012) found that continuity of care indices were: “UPC: 0.75 ± 0.25 ; MMCI: 0.81 ± 0.21 ; COC: 0.67 ± 0.30 ; SECON: 0.70 ± 0.31 ”. Thirty-six (36.1) percent of the participants had continuity of care value of 1.0 on all CoC indices, which is described as “perfect” continuity. They also found significant association between higher values of UPC, COC, and SECON and a decrease in the number and cost of emergency department (ED) visits after controlling for patient characteristics in a multivariate analysis. “Higher MMCI values were associated with a greater number and higher costs of medical consultation visits” (Dreier et al., 2012).

Also, a systematic review of randomised controlled trials by Waldenström & Turnbull (1998) found “continuity of midwifery care was associated with less use of obstetric interventions during labour (eg, induction, augmentation of labour, electronic fetal monitoring, obstetric analgesia, instrumental vaginal delivery and episiotomy)”. Similar results were also found by Wong et al (2015) that showed increased rates of normal vaginal birth, spontaneous vaginal birth, decreased rates of instrumental birth and caesarean sections in the midwifery continuity cohort (Wong et al., 2015).

In another systematic review and meta-analysis by Turienzo, Sandall, & Peacock (2016) to evaluate the efficacy and safety of existing models of antenatal care as a means of reducing preterm birth (PTB) rates in all pregnant women, it was shown that “compared to routine care, midwife-led continuity models of antenatal care were less likely to experience PTB (0.78, 0.66 to 0.91)”. Hoang, Lê, Terry, Kilpatrick, & Stuart (2013) in a systematic review revealed, care

providers and rural women in Tasmanian believed that continuity of care with a provider would facilitate the development of provider-patient relationship and contribute to their satisfaction with care. “However, both maternity health providers and rural consumers recognised the challenges of providing continuity of carer in the public health system due to the constraints of human resources”. They concluded that “given the human resource constraints in the public hospital system, women would be happy with the quality of care provided by the team of health professionals” (Hoang et al., 2013).

In another study that tried to measure the relationship between continuity and quality of care, Shear, Gipe, Mattheis, & Levy (1983) compared the outcome of care among pregnant women cared for by family practice and those by obstetric clinics. They found that sequential continuity of care was much higher in the family practice group, and was highly associated with the presence of an "attitudinal contract" between patient and provider. Their results suggested that continuity of care was associated with improved patient health outcomes and satisfaction (Shear et al., 1983).

Williams, Lago, Lainchbury, & Eagar, (2010) in a study on *“mothers’ views of caseload midwifery and the value of continuity of care”*, found that midwifery group practice (MGP) achieved high levels of continuity of care, both objectively (based on birth records) and from mothers’ perspectives. The women evaluated the care they received as very positive and indicated that “their relationships with their midwives were genuinely caring and a valued source of reassurance and comfort during pregnancy, labour and early motherhood”. They concluded by reaffirming the view that “continuous care appears to facilitate the development of supportive

relationships between women and their midwives. Women's perceptions about continuous and respectful treatment were related to objectively measured continuity of care" (Williams et al., 2010).

In a study titled "*Determinants of the number of antenatal visits in a metropolitan region*" Beeckman, Louckx, & Putman (2010) after adjusting for explanatory variables found that "women with a CoC index greater than 50% had 12% less antenatal visits compared with women with less continuity of care in their antenatal care trajectory (adjusted visit ratio 0.88, 95% CI 0.82 - 0.94)". Vanden Broeck, Feijen-de Jong, Klomp, Putman, & Beeckman (2016) in examining pregnancy-related determinants and ANC utilization in Belgium and the Netherlands found that "women with a CoC index < 50% (OR: 0.60; 95% CI 0.42 - 0.84) and women who did not attend antenatal information classes (OR: 0.67; 95% CI 0.47 - 0.94) had lower odds of obtaining a higher content and timing of care during pregnancy (CTP) classification compared with women with a CoC index $\geq$ 50% and those attending antenatal information classes respectively".

A study conducted among women who had live births between January 2011 and April 2013 in three regions of Ghana by Yeji et al., (2015) measured the extent of continuum of care completion among Ghanaian women aged 15–49. The results shows, 95% women had 4+ ANC visits, 75% skilled delivery and 25% postnatal care within 48 hours with only 8.0% of the women having continuum of care completion. The greatest contributor to the low continuum of care was accessing postnatal care services within 48 hours after delivery. Factors associated with continuum of care completion were "geographical location (OR = 0.35, CI 0.13 - 0.39), marital

status (OR = 0.45; CI 0.22 - 0.95), education (OR = 2.71; CI 1.11 - 6.57), transportation (OR = 1.97; CI 1.07 - 3.62), and beliefs about childhood illnesses (OR = 0.34; CI 0.21 - 0.61)” (Yeji et al., 2015).

In a study titled “*Mining care trajectories using health administrative information systems: the use of state sequence analysis to assess disparities in prenatal care consumption*”, Meur, Gao, & Bayat (2015) extracted trajectories of prenatal care from the French health insurance database. They computed continuity of care index to determine whether the care quality and efficiency were affected by the coordination of care within and between healthcare organizations and the interaction among healthcare professionals. They found that continuity of care during pregnancy was low (mean CoC index: 43.13 % and median: 36.4 %) (Meur et al., 2015).

Banfield et al., (2013) in trying to explore the power of information for care coordination, undertook a qualitative study of information continuity in four primary health care models in Australia. They found that though “accessibility and continuity of information underpin effective care, they are not sufficient for coordination of care for complex conditions”. Participants preferred “coordination in terms of the active involvement of a person in care rather than the passive availability of information”.

2.2.6 Limitations of Continuity of Care

Despite the many benefits of CoC, there exist some limitations as well. In a study to determine whether, “claims-based continuity of care measures reflect the patient perspective”, Bentler et al., (2014), compared claims-based CoC indices and participants’ self-reported continuity

experiences among Medicare recipients. They found that for older adults, most claims-based CoC measures do not reflect the perceptions of continuous interpersonal relationships with the provider. The results is an indication that claims-based CoC evaluations should be used with patient reports in evaluating patient-provider relationship (Bentler et al., 2014a).

There are also suggestions that “when an illness has progressed slowly, a doctor who has seen the patient regularly may miss a diagnosis that is obvious to a newcomer. Continuity may also lessen the doctor’s objectivity, adversely affecting decisions on investigation, and generating reluctance to avoid confrontation. Paternalism/maternalism can develop, with loss of autonomy, especially in vulnerable patients. A patient may become ‘stuck’ with a doctor in whom he or she lacks confidence, and adherence to medical advice suffers as a result” (Gray et al., 2003). Evidence exists that doctors who are familiar with their patients can have special challenges in strict application of evidence-based care (Freeman & Sweeney, 2001; Summerskill & Pope, 2002). Another school of thought says “patients with insoluble problems” can have their doctors “feeling frustrated” as a result of their prolonged situation. This frustration is even made worse by long-term continuity with the provider. “Eventually, the patient rather than the illness may come to be seen as the issue” (Gray et al., 2003).

2.3 Using Claims Data for Healthcare Analytics

The healthcare industry is information intensive and generates huge volumes of multifaceted data about services, medications, investigations among others provided to patients. This huge volumes of data is a key resource for knowledge extraction that supports decision-making in the health sector (Desikan, Hsu, & Srivastava, 2011). Big data analytics is the use of advanced

analytic techniques (such as text analytics, machine learning, predictive analytics, data mining, statistics, natural language processing etc.) against very large, diverse datasets that include different types such as structured/unstructured and different sizes (IBM, n.d.). In recent years, several experts (Chandola et al., 2013; Manyika et al., 2011; Raghupathi & Raghupathi, 2014) have stressed on the role of big data analytics in addressing the issues with healthcare. It is said that by discovering associations and understanding patterns and trends within healthcare data, big data analytics has the potential to improve healthcare, save lives and lower costs (Raghupathi & Raghupathi, 2014). Several areas within the healthcare sector can benefit from using big data analytics including segmentation of patients based on their health profiles to identify target groups for proactive care or lifestyle changes and conducting comparative effectiveness research across providers, patients, and geographical locations (Manyika et al., 2011).

Even though Ghana currently does not have an integrated electronic health record system, Ghana since 2003 has been operating a national health insurance scheme nationwide and all NHIA accredited health facilities that provide services, submit monthly individual level claims data to the NHIA for re-imburement. Through big data analytics, the healthcare insurance claims data have the potential to facilitate understanding of the current healthcare landscape, from conditions, care, cost (Chandola et al., 2013), and client behavior perspectives. It has been argued by Chandola et al. (2013) that until shareable electronic health records become a reality, healthcare insurance claims data, especially from organizations with a large spatial and demographic coverage are the most reliable resource for understanding the current healthcare landscape. While, in the future, it may be possible to use interoperable cross-provider electronic health records to measure coordination and longitudinal continuity, health insurance claims are

currently the only source of digital data that can practically be used for this purpose on a large scale (Pollack, Weissman, Lemke, Hussey, & Weiner, 2011).

Claims data have been argued to have many advantages: help researchers and policy makers to understand the cost and quality of health care, identify patients at risk of developing chronic conditions, pinpoint billing fraud, and improve patient care, point to gaps in care, offer the ability to assess disparities etc (Wilson & Bock, 2012). “Additionally, since all health care providers want to be paid for their services, nearly every encounter that a patient has with the medical system will lead to the generation of a claim, creating an abundant and standardized source of patient information”. Even with the advent of electronic medical records (EMR), claims data provide a holistic view of the patient’s interactions with the health care system over EMR (Stanek & Takach, 2010; Shahadat Uddin, Hossain, Hamra, & Alam, 2013; Wilson & Bock, 2012). Consider, for example, a patient who visits four different health facilities consisting of two clinics, a hospital and a tertiary health facility across two geographic regions of Ghana within a period of three months. Without an integrated EHR, it will be difficult to track the record of this patient. This is however possible with claims data if all the facilities are accredited by the NHIA.

Despite the many advantages of claims data, they also have some limitations. These include incomplete recording of the claims detail due to the fact that healthcare workers are constantly pressed for time, and so every time used in recording billing codes is a time that takes them away from direct patient care. Additionally, in a fee-for-service setting, the reimbursement that a health facility receives for primary care may not directly be related to the number or types of conditions for which the facility codes, making claims data an imperfect reflection of the actual

status of a patient (Stanek & Takach, 2010; Tyree, Lind, & Lafferty, 2006; Wilson & Bock, 2012). The time lag between the provision of care services and the availability of claims data has also been pointed as a limitation of claims data. This time lag results from the accumulation of the time it takes a provider to submit a claim for a service and a payer to process, pay and prepare the data from the claim for addition to claims data that can be used for analysis (Stanek & Takach, 2010).

Although in Ghana, health insurance claim data are mainly maintained for billing purposes, they are found useful in a wide range of healthcare research areas including analysing healthcare utilisation (Aryeetey et al., 2016; Uddin, Hossain, & Kelaher, 2012), financial sustainability (Odame et al., 2013; Yevutsey & Aikins, 2010), care and cost of services (Nsiah-boateng et al., 2016; Odame et al., 2013), provider inducement (Amporfu, 2011), determining risk factors (Antwi & Zhao, 2012), predicting claims volumes (Anko & Adetunde, 2011) and medicine benefits (Eghan et al., 2015). Elsewhere, claims data have been used in measuring coordination performance of the hospital care network, (Srinivasan & Uddin, 2015; S Uddin & Hossain, 2012; S Uddin et al., 2012; Shahadat Uddin, Khan, & Piraveenan, 2015), measuring disease prevalence (Boehme et al., 2015; Cragin et al., 2009; Jones, Coulter, & Conner, 2013; Kim, Thurman, Durgin, Faught, & Helmers, 2015; Riedel, Bitters, Amann, Garbe, & Langner, 2016), and identifying networks (Landon et al., 2013; Lee et al., 2011) etc.

Uddin, Khan, & Piraveenan, (2015) proposed a research framework to explore coordination among different hospital units during the course of providing care to hospitalised patients. In accordance with the proposed research framework, they used health insurance claim dataset, to

explore physician collaborations that evolve among physicians during the course of providing healthcare to hospitalised patients. They found positive correlation between degree centrality and length of stay (LoS) ($\rho = 0.763$, $p < 0.01$ at 2-tailed) and between tie strength (the quality of the relationship between physicians) and LoS ($\rho = 0.295$, $p < 0.01$ at 2-tailed). The finding regarding the degree centrality suggests that patients need to have less physician-visit during their hospitalisation periods in order to make their hospital LoS shorter and the positive correlation between tie strength and LoS also suggest that less cost for services provided by hospitals makes LoS shorter.

The health insurance claim datasets in Ghana contain a large number of claims covering the entire country on a wide selection of medical services provided and over a long period of time. Apart from calculating utilisation statistics of the various medical services, conditions and procedures, the health insurance claims data can reveal a lot of information about patient movements or interactions with different care providers (either through referrals or patient deciding to visit a different provider) in their quest to seek healthcare. These patients' interactions with the different health facilities can serve as a useful source of data in understanding the relationship among different health facilities.

For conditions that require regular visits to care providers, there is the need for the care to be coordinated to ensure continuity and continuum of care. This is particularly the case for maternity care and chronic conditions. Antenatal care for example requires coordinated care to aid prevention, early identification and treatment of conditions that may arise in the course of the pregnancy and delivery. The health insurance claims data can provide details of the care of

pregnant women who have been provided care by multiple health facilities in the course of the pregnancy and childbirth. These claims data can be used to calculate various continuity of care measures for various conditions, construct provider collaboration network that evolves as a result of patient sharing etc. For example, a social network of facility collaboration during the care of pregnant women can reveal the central facilities at the core of the antenatal and delivery services. It can also help determine key facilities that are influencing others or being influenced by other facilities.

2.4 Health Care Fragmentation

Care seeking from multiple providers has become a challenge to the health systems in many countries. For example, studies in the United States have shown the presence of multiple provider consultation across the population. Bourgeois, Olson, & Mandl, (2010) in a study revealed that (31%) adult patients in Massachusetts visited 2 or more hospitals, 1% visited 5 or more hospitals, during the period October 1, 2002, to September 30, 2007. In Ghana healthcare provider shopping has been a concern to the NHIA, and that is one of the reasons for the introduction of capitation in Ghana. Poorly coordinated delivery of healthcare services across various providers have been shown to result in fragmentation of care (Agha et al., 2017). According to evidence from the US, health insurance tends to contribute to fragmentation. For example, the average US Medicare member visits two general practitioners and five specialists a year. This increases for those with chronic conditions (Hyman, 2010). Other studies show that the median Medicare clients consults eight physicians in five separate practices (Cebul, Rebitzer, Taylor, & Votruba, 2008).

According to the Institute of Medicine, (1999), fragmentation contributes to medical errors because when patients visits multiple care providers in different situations, with none having access to the complete health information, it is easier to get things wrong. “Poor coordination across providers may lead to suboptimal care, including important healthcare issues being inadequately addressed, poor patient outcomes, and unnecessary or even harmful services that ultimately both raise costs and degrade quality” (Elhauge, 2010; Frandsen, Joynt, Rebitzer, & Jha, 2015). Evidence exist that fragmentation of care has negative effect on care delivery. For example, Frandsen et al., (2015) found that “more fragmented care is associated with lower quality and higher costs among non-elderly, chronically ill patients”. Postsurgical care fragmentation according to Tsai, Orav, & Jha, (2015) is associated with a substantially higher risk of death.

2.5 Social Network Analysis in Health Care Setting

2.5.1 Social Network

A network consists of entities (actors, nodes, vertices) connected by a type of relationship (links, edges) (O’Malley & Marsden, 2009). A social network is a set of social entities linked by a set of social relationships, such as friendship, communications etc (Luke & Harris, 2007). In the health sector, the actors or nodes may usually be individual persons (e.g. patients or clinicians), other social units (such as hospitals, clinics etc), objects (e.g. drugs), conditions (e.g. diseases) etc. while the links show interactions or flow between the nodes (e.g. exchange of information, frequency of interaction, patient transfer etc). The link is said to be directed if the interaction is from one entity to the other and is not reciprocated by the other entity (Figure b) and is undirected if the interaction is reciprocated (Figure a). Example of a directed link is a health

facility (A) referring a patient to another health facility (B) and example of undirected link is a drug (A) being prescribed with another drug (B).

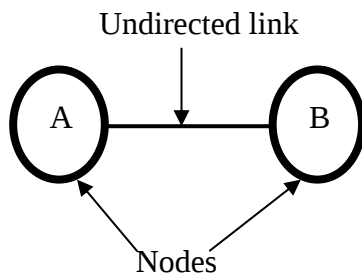


Figure a

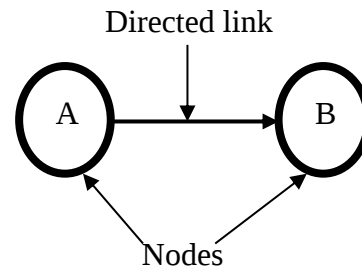


Figure b

Health facilities can be linked to each other through patients-sharing either by referrals or provider shopping by the patients (Lee et al., 2011). Social network analysis have been applied as a tool to comprehend the diffusion of behaviors and spread of diseases (Drewe, 2010; Lee et al., 2011).

In recent times, there has been growing interest in social network analysis (Dunn & Westbrook, 2011), with many related disciplines like computer science, artificial intelligence, web, transport, informatics, healthcare etc applying it in their field (Garton, Haythornthwaite, & Wellman, 1997; Otte & Rousseau, 2002). Social network analysis uses quantitative approaches to assess interactions within a network and compares network characteristics (Scott et al., 2005). It is usually employed to help understand the elements, structure, and results of relationships between actors. Helping us to understand how relationships are formed, the kinds of relational structures that emerge from the building blocks of individual relationships between pairs of actors, and the outcome of these relationships on actors (Grunspan, Wiggins, & Goodreau, 2014).

2.5.2 Network Data Representation

2.5.2.1 Adjacency Matrix Representation

Analysing a network entails the collection of relational, positional, or spatial data (Anderson, 2002). The relational data are then organized into an adjacency matrix with rows and columns representing individuals, units, or organizations. Matrix format is the basic way to represent a social network mathematically. Values in a cell are used to represent the existence or absence of a direct relation or the frequency or strength of the relation (Anderson, 2002) as shown in table 2.5. A value of 1 in cell AB, for example, indicates a relationship between nodes A and B and 0 denotes no relation between the two nodes (Scott et al., 2005). Generally, any real number can be used as an indication of the strength of the relationship (such as the frequency of interaction) between any two nodes. In the adjacency matrix, diagonal entries represent self-links or loops. Adjacency matrices can be commonly formalized as:

$$A_{i,j} = \begin{cases} 1 & \text{if } v_i \text{ is connected to } v_j \\ 0 & \text{otherwise} \end{cases} \quad (\text{Zafarani, Abbasi, \& Liu, 2014})$$

Table 2.5: Adjacency matrix representation

	A	B	C	D	E
A	-	1	1	1	0
B	1	-	0	1	1
C	1	0	-	1	0
D	1	1	1	-	1
E	0	1	0	1	-

2.5.2.2 Edge list representation

The major downside of adjacency matrices is that of zeros. This arises because of the relatively small number of interactions in social networks, leading to many cells containing zeros. This creates a large sparse matrix. The solution to the sparse matrix problem above is to represent networks as edge-lists. This is another simple and common approach where all edges in a large network are stored. In this edge list representation, each element is an edge and is represented as (v_i, v_j) , where node v_i is connected to node v_j (Zafarani et al., 2014). The edge list representation of the adjacency matrix is shown in the table 2.6.

Table 2.6: Edge list representation

Node 1	Node 2	Node 1	Node 2
A	B	C	D
A	C	D	A
A	D	D	B
B	A	D	C
B	D	D	E
B	E	E	B
C	A	E	D

2.5.2.3 Adjacency list representation

Another way to overcome the sparse matrix problem indicated in table 2.5, is to use an adjacency list. In an adjacency list, every node is linked with a list of all the other nodes that are connected to it. The adjacency list representation of the adjacency matrix is shown in table 2.7.

Table 2.7: Adjacency list representation

Node	Connected to
A	B, C, D
B	A, D, E
C	A, D
D	A, B, C, E
E	B, D

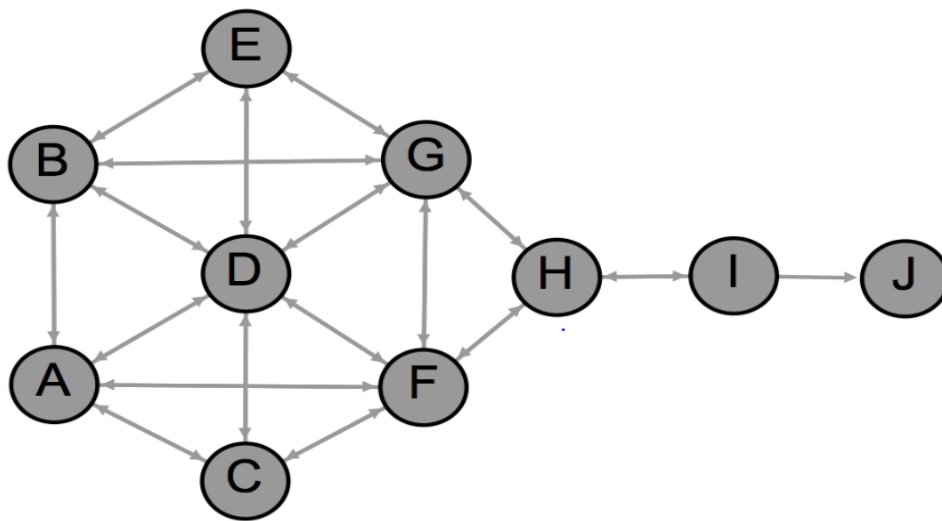
2.5.3 Network Measures

Network metrics include indicators of the aggregate properties of networks as well as indicators based on the locations of individuals within networks (Dunn & Westbrook, 2011). Measures based on an individual's location include centrality measures while the simplest aggregate network measures include size (N) and density of the network. The network size is given by the number of nodes while the density is given by the number of connections as a proportion of the total number of all possible connections (Dunn & Westbrook, 2011; O'Malley & Marsden, 2009). Centrality measures address the question of "what/who is the most important or central node in a network?" (Du, n.d.). The concept on centrality was first described by Bavelas, (1950) which showed that centrality play a role in efficiency in solving problems. According to Bavelas, centralised structures such as the star or wheel are far more encouraging for performance than the decentralised or flattened structures, such as a circle structure. The reason is that in a decentralised network structure, information floats around inefficiently, thus less encouraging for performance (Bavelas, 1950).

The concept was expanded in the 1970s in an article by Freeman, (1978) for measures of structural centrality. Since then, centrality has become a core concept in social network analysis.

Freeman expanded the concept of centrality by uncovering three distinct intuitive conception of centrality: (a) degree, (b) betweenness, and (c) closeness (Freeman, 1978). Degree is the number of links to and from a node in a network. Closeness centrality indicates the extent to which a node is close to all other nodes in the network, and betweenness centrality reflects the extent to which a node lies in the shortest path to all other nodes in the network (Srinivasan & Uddin, 2015) as explained in figure 2.1 using the example of the kite network developed by Krackhardt, (1990).

Figure 2.1: Network Kite by Krackhardt (1990)



2.5.3.1 Degree Centrality

Degree centrality shows the number of direct links a node has. In a directed network, this measure is further broken down into in-degree which indicates the number of incoming connections to a node and out-degree which shows the number of outgoing connections from a node. Degree provides the relative importance and location of a particular node in a network.

With respect to patient sharing or referrals, a node with relatively high degree looks important. A node that is directly connected with many other nodes is seen as indispensable in the network (Hussain, 2007). Conversely, a node with low degree is seen to be isolated and not a key stakeholder. In figure 2.1, node D has the most direct connections in the network, showing it is the most active member in the network.

2.5.3.2 Betweenness Centrality

Betweenness measures the extent to which a node can play the role of intermediary in the interaction between other nodes. In figure 2.1, node D has many direct links while H has few direct connections in the network. However, H, has one of the best locations in the network. It is a 'bridge' or 'broker' between two important constituencies. Without H, nodes I and J would be cut off from information in D's cluster. A node with high betweenness has great influence over what flows, and what does not in the network. Node H therefore may control the outcomes in the network.

2.5.3.3 Closeness Centrality

In closeness centrality, the intuition is that the more central a node is, the more quickly it can reach other nodes (Zafarani et al., 2014). Nodes F and G in figure 2.1 have fewer connections than node D, however, the pattern of their direct and indirect links allow them to access all the nodes in the network more rapidly than any other node. They have the shortest paths to all others nodes.

2.5.4 Application of Social Network Analysis in Health

Social network analysis (SNA) has been applied in health care setting. A systematic review by Chambers et al of the application of SNA in healthcare identified 52 published literature between 1950 and 2011 (Chambers, Wilson, Thompson, & Harden, 2012). However, only few of the studies examined linkages across healthcare settings (9 of 52 studies) (McDonald et al., 2014). In another systematic review on the effectiveness of SNA in the health care setting and contributions to care quality and patient safety, Bae, Nikolaev, Seo, & Castner, (2015) examined studies using SNA in the health care workforce and assess factors contributing to social network and their relationships with care processes and patient outcomes. They found few studies that showed the effects of social network adoption and the use of a health information system, patient outcomes, and coordination. They concluded that the level of technical sophistication in these studies were low and called for more enhanced sophistication in study design, analysis, and patient outcome to fully leverage the potential of SNA in health care studies.

Social network analysis methods have been shown to offer understanding into coordination practices at the level of health organizations and patients. In a study that used SNA to examine care coordination, Nageswaran et al examined health facilities partnership in the care of children with complicated chronic conditions (Nageswaran, Ip, Golden, O'Shea, & Easterling, 2012). They found that “pediatric practices reported the greatest degree of collaboration with other agencies with respect to both referrals out to and in from other organizations”.

According to Hilton, Serban, & Zheng, (2016), network analysis can be used to investigate the structure and relationships between different actors in the healthcare space, for example

healthcare providers, patients, supplier, drugs etc to determine the extent of relationships between different actor and group of actors. Network analysis is often applied in healthcare analytics to help visualize large healthcare datasets and to detect the strength of the linkages between different actors (Hilton et al., 2016).

Several other articles have been published in the area of healthcare using social networking analysis. For example Creswick & Westbrook, (2010) use social networking analysis to examine the medication advice-seeking interactions among staff in a hospital ward in Australia. They found that hospital clinical staff sought medication advice among themselves and staff tends to seek them from those in their profession. They also found that there were key persons in the ward that were relied upon for providing medication advice by staff from all professions (Creswick & Westbrook, 2010). Again Fattore, Frosini, Salvatore, & Tozzi, (2009) used SNA to examine the effect of a doctor network on their prescribing behavior and discovered doctors working in a “collaborative arrangement” have like prescription behaviour (Fattore et al., 2009).

Using SNA for physician collaboration and coordination has been extensively studied. In determining the amount of patient sharing occurring among different hospitals and how patient sharing correlated with geographic distance, Lee et al., (2011) used SNA to construct patient-sharing networks. The results showed that geographically proximate hospitals were somewhat more likely to share patients, even though many distant hospitals shared patients. A similar study by Landon et al., (2012) shows doctors were inclined to share patients with other doctors with “similar physician-level and patient-panel characteristics” and that network properties vary across geographic locations. Barnett et al., (2012) in a study “to assess how the structure of

patient-sharing networks of physicians affiliated with hospitals might contribute to variation in the cost and intensity of care delivered by US Hospitals”, found significant association between network structure and organization’s care patterns for patients. Doctors with higher degree centrality had higher costs and more intensive care.

Using retrospective commercial healthcare claims data for patients that received two or more benzodiazepine prescriptions from more than one provider, with overlapping coverage, Ong et al., (2016) modelled provider patient-sharing using SNA. The results showed that for providers who hardly shared patients, their patients had “higher risk of being prescribed overlapping benzodiazepines”. Provider pairs who collaborate and share patients were less likely to co-prescribe overlapping drugs (Ong et al., 2016). Again, Hamra, Uddin and colleagues used claims data to show positive correlation between betweenness centrality, hospitalization cost and readmission rate and negative correlation between degree centrality, network density, and hospitalization cost and readmission rate (Hamra, Uddin, & Hossain, 2011; S Uddin et al., 2012; Shahadat Uddin et al., 2013).

A number of studies using SNA in healthcare in Africa have been published in the literature. Chami, Ahnert, Voors, & Kontoleon, (2014) use SNA to predict “health behaviours and self-reported health”. Using data from remote, post-conflict villages in Liberia they compared in-degree and betweenness centralities of the network and found that both in-degree and betweenness centralities independently explained “self-reported health and behavior”. They suggested, “targeting households based on network measures rather than health status may be effective for promoting the uptake of health interventions in rural poor villages”. Kawonga, Blaauw, & Fonn, (2015) also used SNA to measure the extent of communication between HIV

monitoring and evaluation staff in South Africa. The results showed that “HIV programme managers located at higher level communicated largely amongst themselves as a group (homophily), seldom talked to the district managers to whom they are supposed to provide specialist HIV M&E support, and rarely participated with them in management committees”.

Using SNA to understand Ghanaian mobile health teams has also been explored. Using mobile communication between groups consisting of the “Bonsaaso Millennium Villages Project Health Team”, Kaonga et al., (2013) showed that the Health Management Team members were more central players in the network than Community Health Nurses as many would have expected.

Despite all these applications of SNA to healthcare, there is no published literature that have applied social network analysis and measures to health providers to understand how providers are interconnected by patient sharing in Ghana and Africa to understand the extent of care fragmentation.

2.6 Summary of the Key Issues from the Literature

The health insurance scheme in Ghana generates large volumes of data about patients, diagnosis, procedures, conditions, services, medication, cost etc. This large expanse of data is an asset for knowledge extraction that supports decision-making in the health sector. The healthcare insurance claims data in Ghana has the potential to facilitate our understanding of the current healthcare landscape, from conditions, service delivery, cost etc. Chandola et al.(2013) have argued that until shareable electronic health records becomes a reality, healthcare insurance claims data, especially from organizations with a large spatial and demographic coverage (as in

the case of Ghana) are the most reliable resource for understanding the current healthcare landscape.

However, the use of the health insurance claims data in Ghana for research has been grossly under explored. About 13% of peer reviewed journal articles on health insurance in Ghana made use of health insurance claims data. Analysis of these articles shows that most of the issues being investigated were financial (Nsiah-boateng et al., 2016; Odame et al., 2013; Yevutsey & Aikins, 2010), sustainability (Amporfufu, 2011; Aryeetey et al., 2016; Eghan et al., 2015; Odame et al., 2013) and claims management challenges (Carapinha et al., 2010; Sodzi-Tettey et al., 2012).

Using the claims data to understand the profile of patients, understand patient visits and utilization patterns, continuity and fragmentation of care, determine appropriate services provided to specific groups of patients, identify potential over utilization of services, provider shopping etc, are limited. However, the ready availability of claims data in Ghana covering a large population of people and almost all common medical conditions make health insurance claims data a very good source of inexpensive data for understanding the healthcare landscape in Ghana. The low utilization of claims data for research could be due to inadequate awareness of the availability of the claims data for research, the perception that claims data may have quality constraints or the inability to transform claims data into formats that make it possible to answer research questions among other reasons. Whatever the reasons may be, there is the need to demonstrate that claims data have great potentials for understanding the health delivery landscape in Ghana.

In addition, Ghana's healthcare system does not require a patient to have a primary provider of care. As a result, patients can choose to visit any number of care providers they wish when seeking care. This behavior of seeking care from multiple providers leads to the fragmentation of care. This situation is particularly of serious concern considering the absence of an integrated electronic health record system for the country. The need for understanding continuity of care is becoming greater to facilitate better quality of care and improved patient outcomes. This need becomes even profound for conditions that require regular follow up visits, as is the case for maternity care and chronic conditions. Continuity of care is valued by both patient and providers (Freeman & Hughes, 2010) and has been found to contribute to both better healthcare delivery and improved patient outcomes (Van Walraven, Oake, Jennings, & Forster, 2010), development of therapeutic relationship between patients and providers (Saultz, 2003; Scholl, Zill, Härter, & Dirmaier, 2014), better coordination of patients care (Barach & Lipshultz, 2016; Gardner, Banfield, McRae, Gillespie, & Yen, 2014) and reduction in hospitalization and cost (Van Walraven et al., 2010). It has been found to be important to patients leading to higher satisfaction with care received (Saultz & Lochner, 2005) and contribute to greater trust (Rolfe, Cash-Gibson, Car, Sheikh, & McKinsty, 2014).

To help improve continuity of care and derive the needed benefits, there is the need to increase patients' awareness of the value and importance of continuity and what they stand to benefit with greater continuity of care (Barnet & Shaw, 2013). This calls for a greater understanding of continuity of care in Ghana. However, there is a gap in the literature as there is no published literature on continuity of care in Ghana. Though findings from Ghana revealed that pregnant women receive pregnancy-related care from multiple sources during pregnancy (Aryeetey et al.,

2015; Dako-Gyeke et al., 2013), the extent to which a pregnant woman repeatedly visits the same provider (longitudinal continuity) or fragments the care among different providers during pregnancy and delivery has not been quantified and documented.

The fragmentation of the delivery of care services for patients has serious implication for quality care. It goes contrary to all the benefits of continuity of care enumerated above. Addressing care fragmentation requires the ability to visualize and understand the structure and relationship between health facilities in the patient sharing network. Social networking analysis tools and methods have been used to investigate the structure and relationships between different actors in the healthcare space, for example healthcare providers, patients, etc to determine the extent of relationships between different actors and group of actors or the extent of fragmentation of care between providers (Creswick & Westbrook, 2010; Fattore et al., 2009; Hilton et al., 2016; Lee et al., 2011; Ong et al., 2016; Srinivasan & Uddin, 2015). Network analysis is often applied in healthcare analytics to help visualize large healthcare datasets and to detect the strength of the link between different actors (Hilton et al., 2016).

Chapter 3: Method

3.1 Research Philosophy

This study embraces the positivist approach to research. Positivists believe that there is a single reality, which can be measured and known and prefer to work with observable phenomena that can lead to the production of credible data (Remenyi, Williams, Money, & Swartz, 2013; Saunders, Lewis, & Thornhill, 2009). This is done using existing theory to develop a hypothesis, data is then collected to test and confirm or reject the hypothesis, leading to the further development of theory which then may be tested by further research (Saunders et al., 2009). Another important assumption underpinning the positivist approach to research is that the research is undertaken, as far as possible, in a value-free way and that the researcher is independent of the data and maintains an objective stance. Positivist researcher lean towards using a highly structured methodology in order to facilitate replication (Gill, Johnson, & Clark, 2010). Furthermore, the emphasis is placed on quantifiable observations that can be analysed using statistical techniques and tools (Saunders et al., 2009). The research framework used for the study (see section 3.3) and the conceptual framework (see section 1.9) developed for the study were informed by the research philosophy used for the study.

3.2 Study Design

The study was a retrospective cohort study that used national health insurance claims data for pregnant women who sought antenatal care (ANC) and skilled delivery services from January to December 2013 in the Volta Region of Ghana. As a requirement in Ghana, all health providers accredited by the National Health Insurance Authority (NHIA) are to provide healthcare services to insured patients, and submit individual patient level monthly claims to the NHIA for re-

imbursement. These monthly claims datasets for the Volta Region were obtained from the NHIA after confidentiality and data use agreement was signed with the authority. Pregnant women were selected for the study because pregnancy is a condition that requires a number of follow up visits to the healthcare providers during the antenatal and delivery periods. Knowing the extent of repeated follow up visits to the same or different care providers will therefore contribute to our understanding of the dynamics of health seeking behaviour during pregnancy and childbirth. Women that delivered at a health facility and had at least two other ANC visits to the health facilities (a total of at least 3 visits) were included in the study. The cutoff of 3 visits was necessary because “continuity of care is always perfect for patients with one visit, and even among patients with two visits, values of indices could shift from 0 to 1 with minute changes in the patterns of visits” (Dreiherr et al., 2012). In all, 14,474 pregnant women that attended an NHIA accredited health facility using their NHIS health insurance card in the Volta region and met the inclusion criteria were included in the study.

3.3 Research framework for measuring continuity and fragmentation

The research framework proposed by Shahadat Uddin, Kelaher, & Srinivasan, (2015) was adapted for this study (figure 3.1). The proposed framework was developed to help in the use of administrative health insurance claim data to explore care coordination and collaboration among healthcare service providers in the cause of providing health care services to patients. The framework was adapted to measure continuity and the fragmentation of care by looking at the extent to which patients move from one care provider to the other or remain with a provider during the antenatal and delivery period. This framework was adopted because the application of social network analytics in exploring health care fragmentation and coordination is a relatively

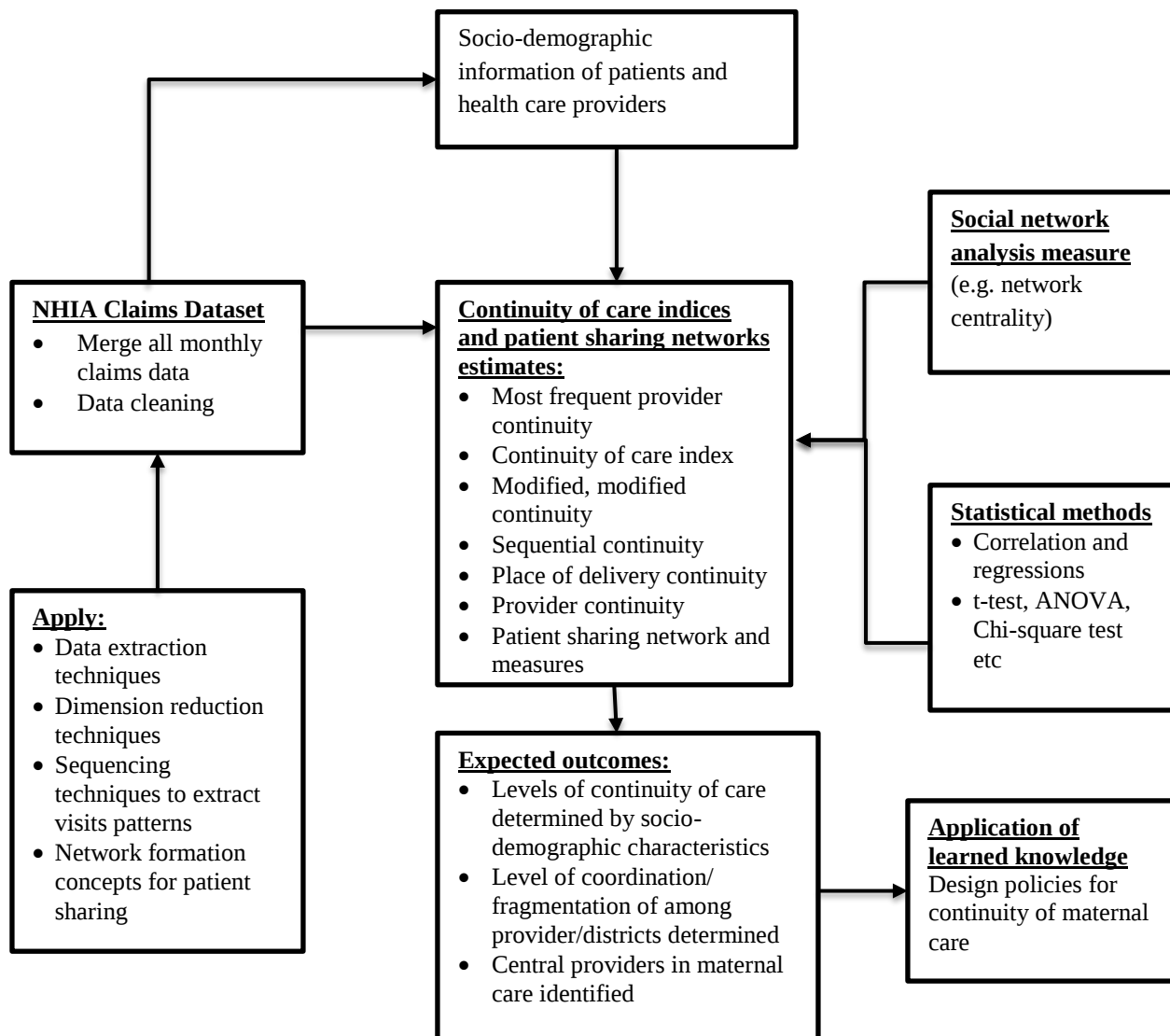
new research area. This framework therefore provides the needed methods and approaches in the application of social network analysis in this area in healthcare.

Health insurance claims data from Ghana's National Health Insurance Scheme was used. Health insurance claims data reveals essential information concerning the various care providers that an individual patient has visited either for a single episode of a condition, a period of time, or the entire lifetime of a patient. In addition, it can also reveal details about healthcare provider interactions or sharing of patients and the extent to which care coordination is either present or absent as a patient moves from one provider to the other. Since care delivery often involves various care providers, it is believed that this has the potential to lead to care fragmentation if no one is responsible for coordinating the care that an individual receives. This framework therefore helps to measure the extent of repeat visits to a provider by a patient and the extent to which care is fragmented among the various providers and districts in the Volta region of Ghana.

Health insurance claims data for the Volta region were obtained from the NHIA for the period January to December 2013. Antenatal and pregnancy related data were extracted and merged into a single file. Using dimension reduction, data transformation and sequencing techniques, the claims data were presented in formats that allow the determination of the various continuity of care indices and care fragmentation. Network data representation concepts were also applied to the claims data using patient sharing between providers to determine the extent of care fragmentation. Continuity of care indices and network centrality measure were calculated using social network analysis and statistical methods. In addition, the extent of care fragmentation was also visualized with the help of the social network analysis tools. Analysis of these indices and

measures were done and presented according to the socio-demographic characteristics of patients and care providers. The expected result is the determination of the level of continuity and fragmentation of care during antenatal and childbirth, and this hopefully will lead to improved knowledge of care continuity and fragmentation.

Figure 3.1: Research framework to learn about healthcare continuity and fragmentation



Source: Adapted from Shahadat Uddin, Kelaher, & Srinivasan, (2015)

3.4 Study Area

The study was undertaken in the Volta Region of Ghana. The region was selected in consultation with the NHIA based on the availability of comprehensive data covering the region as compared to the other regions.

Volta Region is one of the ten administrative regions in Ghana. It has all the ecological zones and ethnic groups found in Ghana living in it. The population of the region according to the 2010 Population and Housing Census was 2,118,252 with 1,019,398 male and 1,098,854 female (table 3.1). The region shares boundaries with the Republic of Togo to the east, Greater Accra, Eastern and Brong Ahafo regions to the west, Northern Region to the north and to the south, the Gulf of Guinea. The region has a total land area of 20,570 square kilometres, representing 8.7 percent of the total land area of Ghana. As in the other regions in Ghana, the region has a decentralized political and administrative system. It is divided into 25 administrative municipal and districts.

Figure 3.2: District Map of Volta Region



Table 3.1: Distribution of population by districts

District	Population		
	Male	Female	Total
South Tongu	40,019	47,931	87,950
Keta Municipal	68,556	79,062	147,618
Ketu South	75,648	85,108	160,756
Ketu North	46,551	53,362	99,913
Akatsi	59,165	69,296	128,461
North Tongu	70,282	78,906	149,188
Adaklu Anyigbe	31,298	33,106	64,404
Ho Municipal	129,180	142,701	271,881
South Dayi	22,132	24,529	46,661
North Dayi	44,553	49,096	93,649
Hohoe Municipal	126,239	135,807	262,046
Biakoye	33,057	32,844	65,901
Jasikan	29,142	30,039	59,181
Kadjebi	29,951	29,352	59,303
Krachi East	60,730	56,074	116,804
Krachi West	62,019	60,086	122,105
Nkwanta South	58,482	59,396	117,878
Nkwanta North	32,394	32,159	64,553
Total	1,019,398	1,098,854	2,118,252

Source: 2010 population and Housing Census

In the area of health, the region has a total of 513 health institutions out of which 451 are managed by Ghana Health Service (GHS), 18 are Mission owned, one facility is quasi-government, and 42 privately owned (table 3.2). The Government facilities are evenly distributed across the region but the private facilities are more concentrated in the southern part of the region compared to the other parts (table 3.3).

Table 3.2: Health facility ownership, Volta Region

Facility Type	Ownership					
	CHAG	Government	NGO	Private	Quasi-Government	Total
CHPS	-	270	-	-	-	270
Clinic	5	15	1	18	1	40
District Hospital	5	12	-	-	-	17
Health Centre	5	150	-	1	-	156
Hospital	3	-	-	8	-	11
Midwife / Maternity	-	1	-	15	-	16
Polyclinic	-	2	-	-	-	2
Regional Hospital	-	1	-	-	-	1
Grand Total	18	451	1	42	1	513

Source: DHIMS II, Ghana

Table 3.3: Distribution of health facilities by districts, Volta Region

Districts	Ownership					
	CHAG	Government	NGO	Private	Quasi-Government	Total
Adaklu	1	12	-		-	13
Afadjato South	1	18	-	2	-	21
Agortime-Ziope	-	13	-	1	-	14
Akatsi North	-	10	-	-	-	10
Akatsi South	-	33	-	5	-	38
Biakoye	-	16	-	-	-	16
Central Tongu	-	12	-	2	-	14
Ho	2	21	-	3	1	27
Ho West	-	23	-	3	-	26
Hohoe	-	47	-	-	-	47
Jasikan	-	16	-	-	-	16
Kadjebi	1	10	-	1	-	12
Keta	2	18	-	7	-	27
Ketu North	1	12	-	2	-	15
Ketu South	-	20	-	6	-	26
Kpando	1	14	-	3	-	18
Krachi East	1	19	-	-	-	20
Krachi Nchumuru	1	12	-	-	-	13
Krachi West	-	12	-	-	-	12
Nkwanta North	2	13	-	2	-	17
Nkwanta South	1	22	-	-	-	23
North Dayi	1	15	-	-	-	16
North Tongu	1	13	-	1	-	15
South Dayi	1	10	-	2	-	13
South Tongu	1	40	1	2	-	44
Grand Total	18	451	1	42	1	513

Source: DHIMS II, Ghana

In 2012 there were 73,038 ANC registrants in the region with 39,675 health facility deliveries. In 2013 there were 71,409 ANC registrants with 39,358 deliveries compared to 72,115 registrants and 42,028 deliveries in 2014 as shown in table 3.4.

Table 3.4: ANC and delivery statistics for Volta Region, 2012-2014

District	2012						2013						2014					
	ANC		Deliveries				ANC		Deliveries				ANC		Deliveries			
	Registrants	Visits	CS	Vaginal	Vacuum	Forceps	Registrants	Visits	CS	Vaginal	Vacuum	Forceps	Registrants	Visits	CS	Vaginal	Vacuum	Forceps
Adaklu	441	1163	0	280	0	0	351	1008	0	239	0	0	401	1081	4	382	0	0
Afadjato South	1337	2974	0	296	0	0	1366	3436	0	258	0	0	1232	3486	0	303	0	0
Agortime-Ziope	1281	4191	0	353	0	0	1369	4158	0	430	0	0	1316	4614	0	471	0	0
Akatsi North	593	1862	0	167	0	0	546	1801	0	133	0	0	476	1527	0	43	0	0
Akatsi South	2966	12747	128	1437	0	0	2510	13760	179	1344	0	2	2857	14737	206	1505	0	0
Biakoye	2888	9826	76	1262	0	0	2835	10661	144	1348	1	0	3822	10487	224	1393	5	0
Central Tongu	2221	9611	73	707	1	0	2192	8990	57	811	0	2	2260	9511	183	930	0	0
Ho	4266	24241	902	3227	0	0	4395	22672	1000	3414	1	0	4848	24442	943	3650	1	0
Ho West	1513	5315	0	597	0	0	1365	4675	0	594	0	0	1362	4726	0	692	0	0
Hohoe	3105	14705	292	2113	0	0	3097	14194	335	2182	0	0	3131	13263	490	2137	1	0
Jasikan	2019	9342	121	887	0	0	1894	9129	159	925	0	0	2005	9477	154	890	0	0
Kadjebi	2734	8682	95	1393	6	0	2891	8558	140	1393	4	0	2536	7905	150	1496	4	0
Keta	5729	30069	727	3724	27	0	5359	27532	626	3761	0	0	5078	27844	691	3744	8	0
Ketu North	2492	11295	247	1155	0	0	2454	13052	293	1212	2	0	2632	20227	324	1432	0	0
Ketu South	7089	27486	436	3539	1	1	6672	26373	465	3312	0	3	6230	22796	616	3727	0	0
Kpando	3083	11818	465	1910	0	1	3006	10621	556	1803	8	14	3126	10271	550	1695	1	1
Krachi East	4547	12597	0	1144	0	0	4632	12538	0	1071	0	0	5173	13496	0	1239	0	0
Krachi Nchumuru	2184	7118	0	866	0	0	2220	6741	0	917	0	0	2048	6785	0	947	0	0
Krachi West	2654	9976	198	860	9	0	2042	9876	212	782	0	0	1867	13994	178	839	1	0
Nkwanta North	3970	11432	0	606	0	0	4664	11827	0	749	0	3	4905	13608	0	850	0	0
Nkwanta South	6255	23449	491	1938	1	0	5222	16850	254	1488	1	0	5243	16300	264	1539	0	1
North Dayi	957	4189	93	813	15	0	1073	4449	66	763	27	0	1285	5716	99	830	16	1
North Tongu	3060	14323	485	2117	17	0	2773	14102	428	2162	19	0	2644	13058	433	2056	3	0
South Dayi	2698	8119	63	1082	0	0	2688	8511	66	974	0	0	2183	9445	155	1131	0	0
South Tongu	2956	13668	358	1873	0	0	3793	15010	413	1813	0	0	3455	16588	434	1960	0	6
Grand Total	73038	290198	5250	34346	77	2	71409	280524	5393	33878	63	24	72115	295384	6098	35881	40	9

Source: DHIMS II, Ghana

3.5 Study Variables

Variables used in this study were derived from Ghana's NHIA claims dataset. For each visit to a health facility, the data collected for the claims include; name of facility, NHIS ID, age, date of visit, folder No, procedure, diagnosis, G-DRG code, ICD10 code, cost of service, cost of drug, total cost, type of visit, month and district. The outcome variables for the study included the type of delivery, continuity of care indices (MFPC, MMCI, COC, SECON, PDC) and the facility continuity of care index (table 3.5). The explanatory variables included; NHIS ID, age, facility name, date of visit, procedure, diagnosis, G-DRG, ICD10, cost of service, cost of drug, type of visit, month, district, sequential pattern, delivery details, ownership of facility, type of facility, degree centrality, closeness centrality and betweenness centrality.

Table 3.5: List of variables for the study

#	Variable Name	Scale	Explanation
<i>Outcome Variables</i>			
1	Type of delivery	Nominal	Indicate the type of delivery. E.g CS, SVD etc
2	Facility (provider) continuity	Ratio	Average proportion of visits to a provider by all the patients who visited the provider compared to other providers who provided care for those same patients.
3	MFPC	Ratio	Proportion of visits to the frequently visited provider
4	MMCI	Ratio	Measure of dispersion that takes into consideration the number of caretakers and number of visits
5	COC	Ratio	Measure of dispersion that weights both the frequency of visits to each caretaker and the dispersion of visits between caretakers
6	SCON	Ratio	Measure short-term sequence of visit to providers
7	PDC	Ratio	Proportion of visit made to the place (facility) the woman delivered
<i>Explanatory Variables</i>			
8	Delivery details	Nominal	Indicate the detail of the delivery or interventions made during delivery. E.g emergency, assisted, instrumental, etc
9	NHIS ID	Nominal	Unique ID given to each patient
10	Maternal Age	Ratio	Age of the woman
11	Facility	Nominal	Health facility name
12	Date of visit	Interval	Date of visit to the facility
13	Procedure	Nominal	Procedure performed for the patient
14	Diagnosis	Nominal	Diagnosis of the patient condition
15	G-DRG	Nominal	Ghana Diagnostic Related Group
16	ICD10	Nominal	ICD10 Code
17	Cost of service	Ratio	Cost of medical services provided
18	Cost of drug	Ratio	Cost of drugs provided
19	Total Cost	Ratio	Cost of services + cost of drugs
20	District,	Nominal	Name of district where facility is located
21	Visit type	Nominal	Indicate the type of visit made, either ANC or OBGY
22	Sequential pattern	Nominal	Derived sequence of facility visited
23	Ownership	Nominal	Ownership type of the health facility. E.g Gov't
24	Facility Level	Nominal	Level of the health facility. E.g CHPS, Hospital, etc
25	Degree	Ratio	Degree centrality of the facility
26	Closeness	Ratio	Closeness centrality of the facility
27	Betweenness	Ratio	Betweenness centrality of the facility
28	Eigenvector	Ratio	Eigenvector centrality of the facility

3.6 Data Compilation and Processing

Soft copies (in Microsoft Excel) of the monthly claims datasets from all accredited health facilities were obtained from the National Health Insurance Authority (NHIA) after confidentiality and data use agreement was signed with the authority. Two research assistants were recruited to go through the monthly claims datasets to, as a first step, correct all dates to the same formats (dd/mm/yyyy). This alignment of dates to the same format was necessary because facilities used different date formats either in the same excel sheet or different sheets, and there was no standard date format used for all the claims data. Most facilities used British (day/month/year) or American (month/day/year) formats interchangeably. In addition, a standard template containing all the fields was developed based on the various templates that were used. The research assistants formatted all the sheets to have uniform alignment of the variables according the standard template. This was again necessary because some facilities used different reporting templates. Variables (columns) positions varied from one facility to the other and even varied within months in some cases for the same facility. For example, NHIS ID could be column 5 in one claim submission and column 7 in another. Monthly claims data for ANC and OBGY related visits were merged into a single sheet (using the standard template) for each facility with the facility name, month, and type of visit (ANC or OBGY) filled as additional variables. Facility data were subsequently merged into a district file (with each facility as a separate sheet and a final sheet that contain the merged data from all the facilities) with the name of the district as an additional variable. District files were also subsequently merged into a regional file with each district as a separate sheet. Microsoft Access was used to develop a database where the final merged data were loaded. Districts tables (files) were subsequently merged in Microsoft Access to form a region file.

3.6.1 Identification of Deliveries

Following the inclusion criteria, which required delivery at a health facility as a necessary condition for inclusion in the study, a system was developed to identify deliveries and the visits that resulted in the deliveries. The Ghana Diagnosis Related Groups (GDRG) is a patient classification system that provides a way of relating the types of patient a provider treats to the cost incurred by the provider based on the grouping of the diagnosis. It uses codes to uniquely identify each of the related diagnosis. The GDRG code ideally could have been the easiest way of determining visits that resulted in deliveries since they had unique code for deliveries. However, GDRG codes in the dataset had some challenges and could not be used because some providers did not specify the GDRG codes all the times. In addition, some providers did not appropriately use some of the codes. For example the GDRG code for spontaneous vaginal delivery (SVD) - OBGY34 was not used by some providers (especially lower level facilities) to indicate SVD and also, some of the codes specified did not match the type of services provided. Based on these challenges, a scheme was developed that used a combination of the procedure performed and diagnosis to identify deliveries. The use of the procedure and diagnosis combined helped identify more deliveries as compared to using the GDRG codes. The algorithms for identifying deliveries using procedure and the diagnosis that were developed are shown in figures 3.3 and 3.4.

For visits that resulted in Cesarean Section deliveries, they were identified first, through the procedure performed and then the diagnosis. If the procedure indicated for a visit was cesarean section or any variant of cesarean section such “CS”, “C/S”, “C-section”, “Cesar” etc, then the type of delivery was indicated to be Cesarean Section. If, however, the procedure indicated was

not cesarean section or related to cesarean section, the next option used was the diagnosis indicated for the visit. If the diagnosis indicated the following key words; “Cesarean-Section”, “Obstructed or Prolong labour”, “Cephalo Pelvic Disproportion”, “Fetal distress/stress”, “Placenta previa”, “Failure of labor to progress”, or variants of these, then the type of delivery was indicated to be Cesarean Section.

For visits that resulted in normal or spontaneous vaginal deliveries, they were also identified first, through the procedure performed and then the diagnosis. If the procedure indicated for a visit was spontaneous vaginal delivery or normal delivery or any variant such as “SVD”, “Vaginal delivery”, “Spont delivery” etc, then the type of delivery was indicated to be spontaneous vaginal delivery (SVD). If, however, the procedure indicated was not SVD or related to normal delivery, the next option used was the diagnosis indicated for the visit. If the diagnosis indicated the following; “SVD”, “delivery”, “Labour”, “postpartum” or variants of these, then the type of delivery was indicated to be spontaneous vaginal delivery. This last option had the potential of including false deliveries. It was however necessary to include false positive than miss out some true positives completely. With the full knowledge of the potential for false positives, a scheme was devised that removed all deliveries where the diagnosis included terms like “false labour”, “false delivery” etc.

For visits that resulted in vaginal deliveries with episiotomy, they were also first identified through the procedure performed, and second, the diagnosis. If the procedure indicated that an episiotomy was performed, or any variant such as “SVD+Epis”, “normal delivery with epis” etc, then the type of delivery was indicated to be vaginal delivery with episiotomy. If however, the

procedure indicated was not episiotomy or related to episiotomy and the diagnosis indicated episiotomy then the type of delivery was indicated to be vaginal delivery with episiotomy.

Figure 3.3: Flowchart for identifying Cesarean Section deliveries

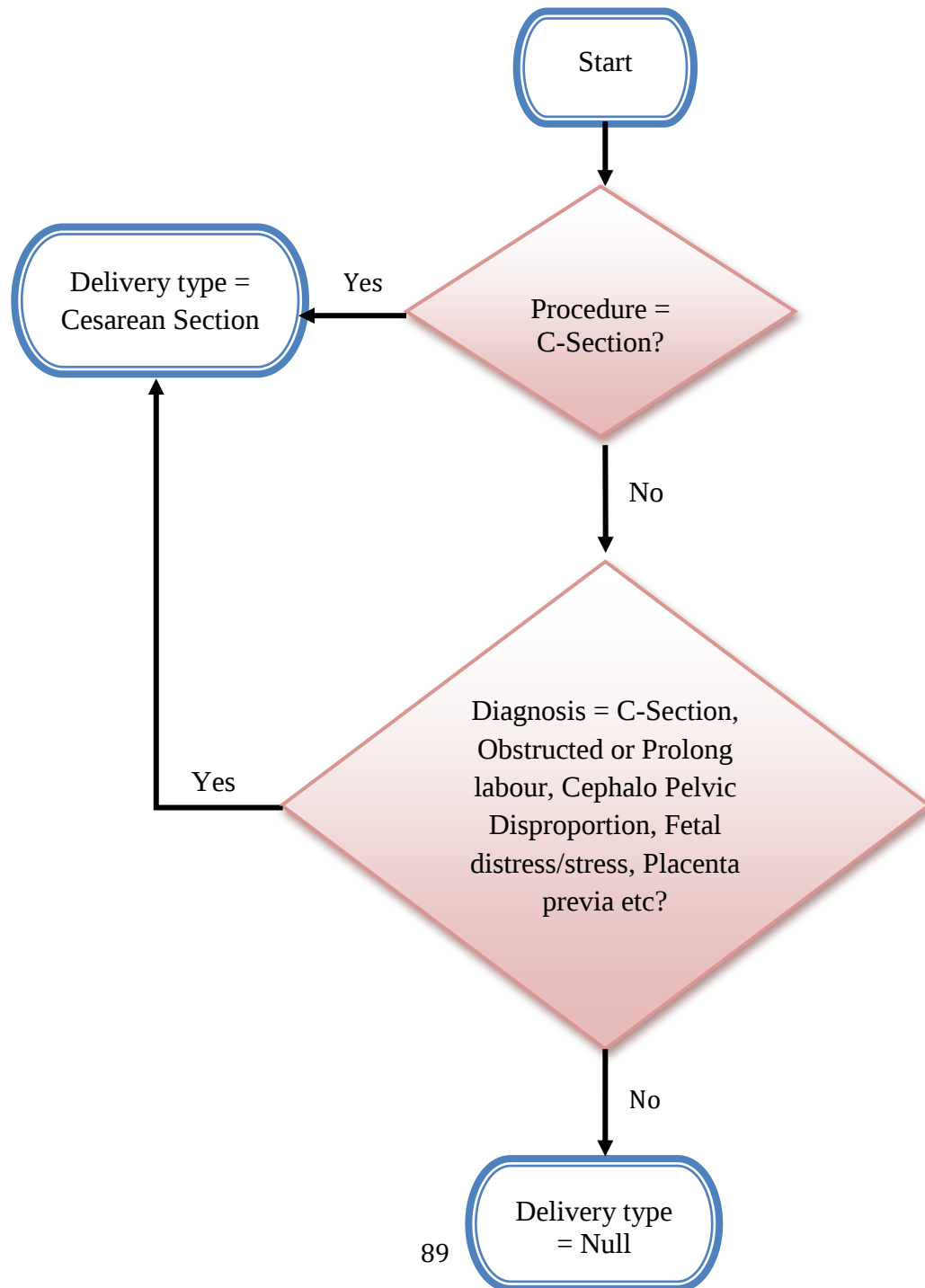
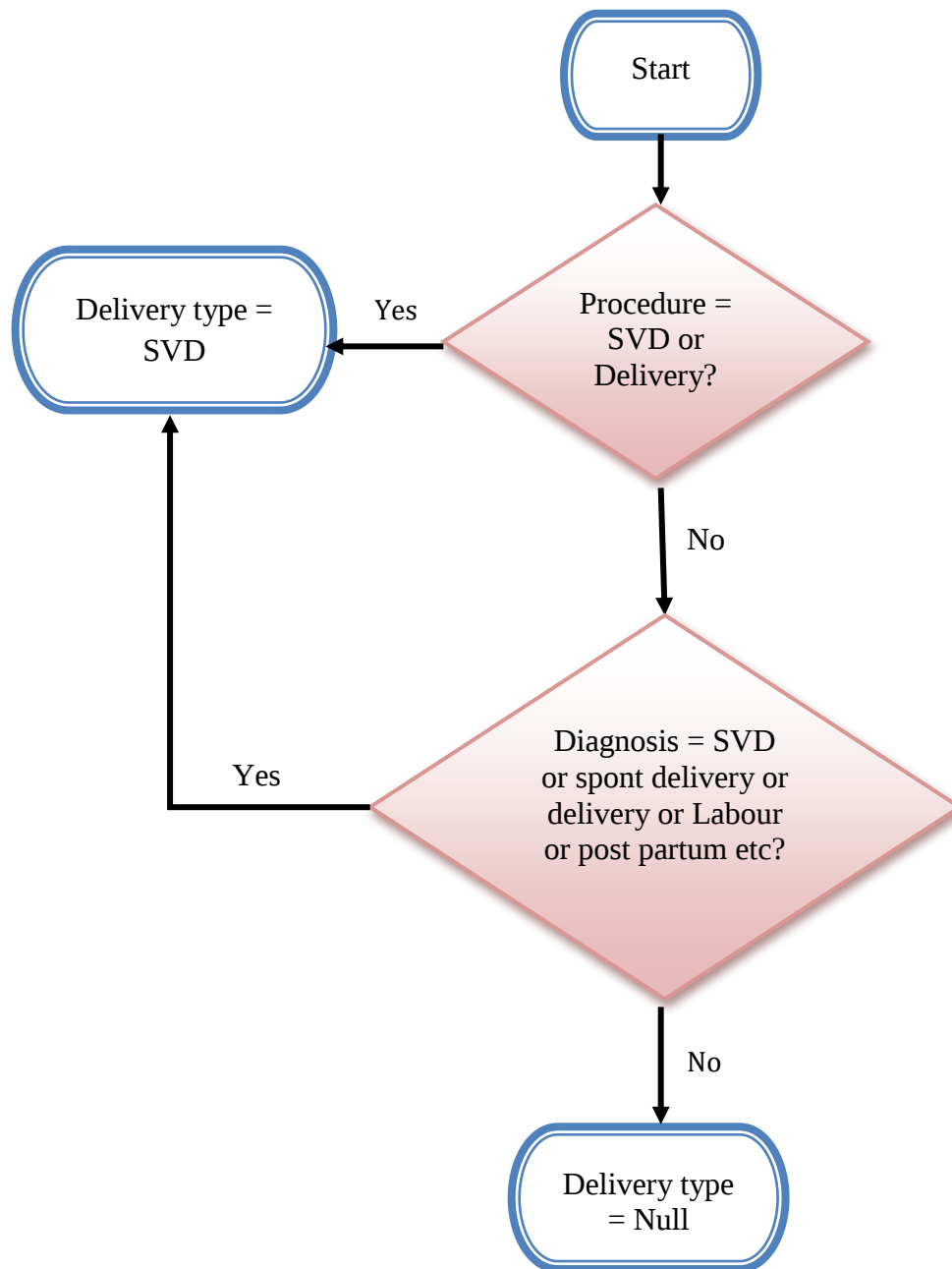


Figure 3.4: Flowchart for identifying spontaneous vaginal deliveries



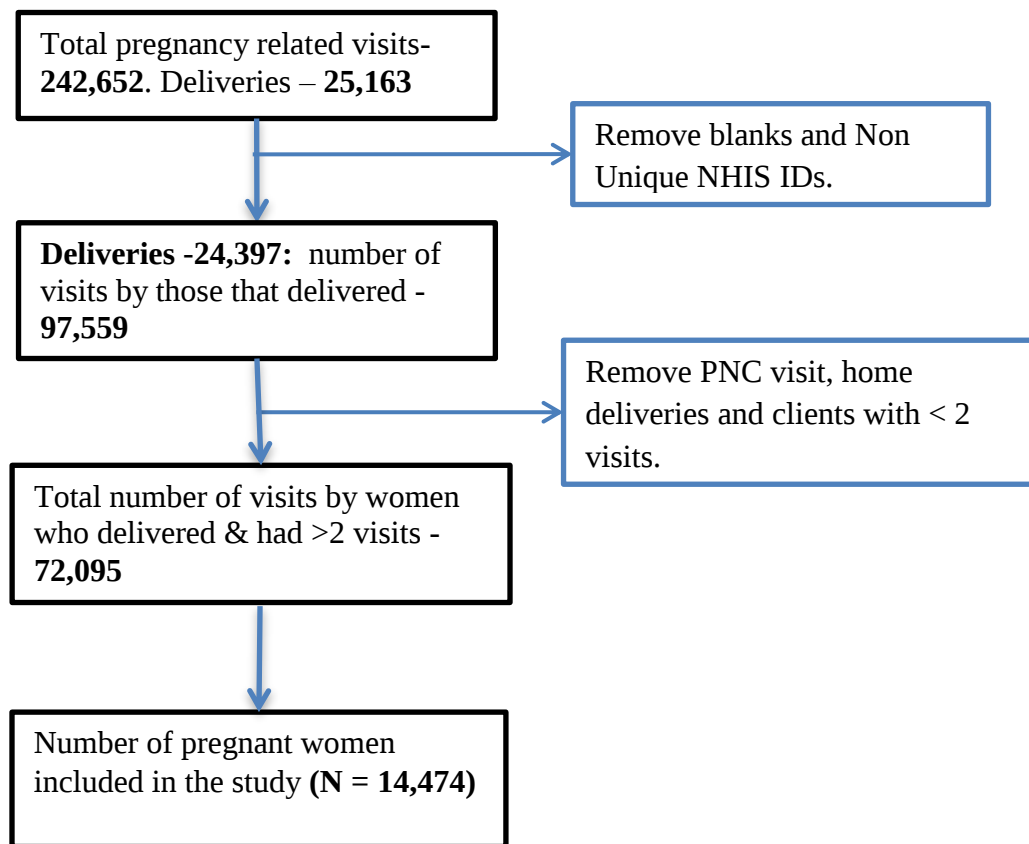
Queries were created in MS Access to implement the algorithms above in identifying visits that resulted in deliveries. After the implementations of the algorithms above were completed, another query was designed to identify duplicate deliveries (same person with two/more visits indicated as delivery visits). This situation usually arises for example where a pregnant woman initiates labour and delivery in one facility and completes the process in another facility. Duplicates were manually verified to determine the exact visit that resulted in the delivery. Two people verified all the duplicate deliveries and agreed on the visit that resulted in the delivery and the facility of delivery if different. All deliveries with no NHIS ID numbers were dropped. A sample (10%) of all the visits that resulted in deliveries were then extracted with the details on the procedure and diagnosis and an obstetric and gynecologist reviewed the deliveries to be sure that the delivery type as indicated for each visit was accurate based on the details described. All the deliveries that were reviewed by the obstetrician were accepted as accurate based on the procedure and diagnosis. All visits that were not pregnancy related, like diarrhoea, accident, postnatal visits etc, and deliveries that were not performed at a health facility (e.g home delivery, “born before arrival” etc.) were excluded. The details of all visits by women that delivered were extracted using queries and saved in a comma separated values (csv) file format.

3.7 Application of the Inclusion Criteria

The study inclusion criteria were; delivering at a health facility and having at least three visits to the health facilities. Figure 3.5 provides an overview of the inclusion of participants for the study. A total of 242,652 antenatal and postnatal related visits were made by pregnant women to 211 various health providers accredited by the NHIA to provide services to pregnant women in the Volta region in 2013. About 24,400 deliveries resulted from these visits and the total number

of visits made by these women that delivered was 97,559. Applying the inclusion criteria, 14,474 women were selected and included in the study and these women made a total of 72,095 antenatal and delivery related visits to 196 health providers.

Figure 3.5: Flowchart of participants' inclusion into the study



3.7.1 Data Transformation

The csv file was then imported into R using R Studio Version 0.99.491 (RStudio Team, 2015) (see appendix B6). The entire dataset was then ordered by date of visit and all visits that were made after delivery were dropped using a program written in R. In addition, pregnant women with less than 3 visits were also excluded as specified in the inclusion criteria. For each woman (NHIS ID), a program written in R iterated the dataset and extracted the sequence of providers the woman visited in the order in which they were visited, starting with first to be visited.

Dimension reduction and data transformation strategies were then used to reduce the health providers visited as follows: for each woman, the first provider visited and any subsequent visit to same provider was labeled A. The second provider visited and any subsequent visit to same provider was labeled B and third provider visited was labeled C and so on. This was to help reduce the number of providers to a manageable level and for easy comparison since the label becomes a placeholder for the provider. For each woman a function was written in R to transform and extract the sequence of visits as described above (see appendix B1 and B3).

3.8 Continuity of Care Measures

After reviewing the continuity of care indices frequently used in previous studies and the categorization by Jee & Cabana, (2006), four indices of continuity were selected to be measured for each patient. These included most frequent provider continuity to measure density, Bice and Boxerman continuity of care index and modified, modified continuity index to measure dispersion, and the sequential continuity to measure short-term sequence. In addition, a new continuity of care index called place of delivery continuity (PDC) was introduced to measure

continuity with respect to the provider where the woman delivered. These five continuity of care measures were computed for each patient/client, based on formulas described in the literature (Dreiherr et al., 2012; Reid et al., 2002; Saultz, 2003). In this study, the antenatal clinic (instead of individual physicians or midwives) was used as the provider considering that most healthcare providers in Ghana do group practice. In addition the NHIA claims data does not include the names or identification for the individual physicians or midwives that provided care to the client. Katz et al., (2014) have used this approach of measuring continuity of care at a clinic or facility level. The following sections describe how each of the five selected indices were estimated.

3.8.1 Most Frequent Provider Continuity (MFPC)

This index estimates the proportion of visits to the pregnant woman's regular clinic out of all visits. The values for this index ranges from 0 (no visit to the regular clinic) to 1 (all visits made to the regular clinic). Since the pregnant women had no primary care providers, as it was not a requirement as at the time of the study for a patient to have a primary care provider, the most frequently visited provider was considered to be the regular provider (Reid et al., 2002; Saultz, 2003). A function was written in R (see appendix B2 and B4) using the formula below to estimate this measure.

$$MFPC = \frac{Max(n_1, n_2, \dots, n_k) - 1}{N - 1}$$

Where $\max (n_1, n_2, \dots, n_k)$ is the number of visits to the provider with whom the woman had the greatest number of visits, and N is the total number of visits by the woman to all providers during the study period.

3.8.2 Modified, Modified Continuity Index (MMCI)

This index measures the dispersion between providers and is based on the number of clinics and number of visits only. The highest value for this index is 1 (all visits made to a single clinic). A function was written in R (see appendix B2 and B4) using the formula below to estimate this measure.

$$MMCI = \frac{1 - \frac{k}{N+0.1}}{1 - \frac{1}{N+0.1}}$$

Where k is the number of providers and N is the total number of visits to all providers during the study period (Cabana & Jee, 2004; Dreiherr et al., 2012; Magill & Senf, 1987; Reid et al., 2002).

3.8.3 Continuity of Care index (COC)

This index was estimated using the formula below and implemented in R (see appendix B2 and B4) using a function developed for the estimation.

$$COC = \frac{\sum_{i=1}^k n_i^2 - N}{N(N - 1)}$$

where k is the number of providers, n_i is the number of visits per provider i, and N is the total number of visits to all providers during the study period.

This index weights both the frequency of visits to each clinic and the dispersion of visits between clinics. Values for this index range from 0 (each visit made to a different clinic) to 1 (all visits made to a single clinic) (Bice & Boxerman, 1977; Dreiherr et al., 2012; Reid et al., 2002; Saultz, 2003).

3.8.4 Sequential Continuity Index (SECON)

This index measures the visits made to the clinic that the woman saw in her most recent visit. Index values range from 0 (every visit was made to a clinic either than the clinic seen in the previous visit) to 1 (all visits made to a single clinic) (Dreiherr et al., 2012; Reid et al., 2002; Saultz, 2003). A function was written in R (see appendix B2 and B4) using the formula below to estimate this measure.

$$SECON = \frac{\Phi_i + \dots + \Phi_{n-1}}{N - 1}$$

Where Φ_i takes a value of 1 if the current and subsequent visits are made to the same clinic, and has a value of 0 if these visits are made to different clinics. N is the total number of visits in the period. The final visit in the period was ignored and therefore N was reduced by 1 (N-1).

3.8.5 Place of Delivery Continuity Index (PDC)

This index is a special case of usual provider continuity introduced in this study to measure the proportion of ANC visits made to the health facility where the pregnant woman delivered (this is the last health facility visited in this study). This index is useful for assessing women who delivered at completely different health facilities from where ANC was sought. Index values range from 0 (delivered at an entirely new health facility other than the facilities visited during ANC) to 1 (delivered at a facility where all ANC visits were made). A function was written in R (see appendix B2 and B4) using the formula below to estimate this measure.

$$PDC = \frac{n_d - 1}{N - 1}$$

Where n_d is the number of visits to the facility of delivery by the pregnant woman, and N is the total number of visits.

3.8.6 Provider Continuity of Care Score

This indicator measured the continuity of care from the angle of the health facility (provider) to determine the extent of repeat visits to providers during ANC and delivery. This approach has been used by Katz et al., (2004) to measure continuity of care for healthcare providers. A program was written in R (see appendix B5) to estimate this indicator for all providers. First, the number of visits for a woman to each provider was counted by constructing a patient-provider matrix for each woman and provider (table 3.6). Second, the proportion of visits to a given provider out of the total number of visits made by a single woman was determined. The continuity of care score for each provider was calculated to represent an average of the proportion of visits that a provider got for all the women who visited the provider compared to other providers that those same women visited as shown in the table 3.7.

Possible scores for this index range from just greater than 0 (zero) to 1; a facility that was a woman's only provider was allocated a score of 1 for that woman. If a woman visited three providers in equal proportions, each provider was allocated a score of 0.33. Averages of all scores were calculated for each provider and then for all providers overall. The overall average score was used as the standard for comparison and providers that scored less than the standard were considered "below average" and those higher than the standard were deemed "above average" compared to other providers (Katz et al., 2004).

Table 3.6: Patient by facility matrix - frequency of facility visits by patient

Patient	Healthcare Facility					
	F ₁	F ₂	F ₃	F ₄	...	Total
P ₁	2	1	3	0		6
P ₂	0	2	0	1		3
P ₃	1	1	4	0		6
P ₄	0	0	0	3		3
...						
P _n	1	2	0	0		3

Table 3.7: patient by facility matrix - proportion of visits by patient

Patient	Healthcare Facility					
	F ₁	F ₂	F ₃	F ₄	...	Total
P ₁	0.33	0.16	0.50			1
P ₂	-	0.66	-	0.33		1
P ₃	0.16	0.16	0.66	-		1
P ₄	-	-	-	1		1
...						
P _n	0.33	0.66	-	-		1
Average	0.27	0.41	0.58	0.66		

3.9 Patients Sharing by Providers and Social Network Construction

Patient sharing was identified based on the visit patterns of the pregnant women. For each pregnant woman, the list of providers visited were identified in the order in which they were visited, starting with the first provider during the study period. Two providers shared a pregnant woman if she visited the two providers in the course of her pregnancy and delivery. However, for each network that was constructed, the specific link between providers was defined based on the

main purpose of the network diagram and the specific fragmentation to be visualized. For all network diagrams involving fragmentation during delivery, a pregnant woman had only one link/movement included. That is, the link from her most frequent ANC provider and the provider where she delivered. The assumption from the point of continuity of care is that, if a woman had her most ANC from a given facility, she should under normal circumstances be expected to deliver in that facility if there are no complications in the pregnancy. It therefore means anything short of that implies a fragmentation of the care during delivery.

A program was written in R (see appendix B7 for sample) to identify the directed edge list for each pregnant woman. For example, if a pregnant woman made three visits during her pregnancy, then the directed edge list would be from the provider of the first visit to the provider of the second visit, and from there to the provider of the third visit. For patient sharing during the entire ANC and delivery period (all the visits by all pregnant women), providers were connected if a woman moved from provider of previous visit to the other provider of subsequent visit. Patient sharing during delivery involves linking the most frequently visited provider during ANC and the provider of delivery. This approach enables the visualization of the fragmentation of care between the most frequently visited provider and the provider of delivery. A patient is said to have changed provider during delivery, if the provider of delivery is different from the provider where she sought most of her antenatal care. All connections from the source provider to the destination provider were all directed with curved edges used to indicate the direction of the edge with reading clockwise from a source node to a target node. A matrix made up of two columns was created with the first column representing the source node and the second the destination or target node. For each pregnant woman, the source and the destination nodes were identified and

appended to the matrix using row bind (rbind) command in R. The frequency of each pair of source and destination nodes was calculated. This count represents the weight of the connection between pair of nodes. Igraph package (Csardi & Nepusz, 2006) in R was used to help convert the data into a graph data. Except for the sequential pattern graph, all the other graphs were simplified by removing loops (where source and destination nodes are the same). The rgexf package (Yon, La-coa, & Kunst, 2015) was used to export the graph data in the graphml (Csardi & Nepusz, 2006) format to be used in Gephi (Bastian, Heymann, & Jacomy, 2009) for the visualization and data analysis. Networks were visualized using the Fruchterman-Reingold (Fruchterman & Reingold, 1991) and Force Atlas2 (Jacomy, Venturini, Heymann, & Bastian, 2014) algorithms as implemented in Gephi to optimally position providers in the visualizations based on their patient-sharing relations.

Five different types of provider network graphs were constructed to help visualize the fragmentation of care among providers during ANC and delivery. These were provider network for: (1) ANC and delivery to help visualize the fragmentation during ANC and delivery for all visits, (2) delivery to help visualize the fragmentation during delivery for those that delivered at a provider other than where they had their most ANC, (3) delivery at new places to help visualize the fragmentation during delivery for those that delivered at a facility that they never received ANC services from, (4) Cesarean Section delivery to help visualize the fragmentation during delivery for those that had CS at a facility other than where they had their most ANC and (5) Cesarean Section delivery for those that had CS at a facility that they never received ANC from. The colour of the nodes used in the diagrams indicate the community that the health facility belong or the facility type, while the size of the node indicates the weighted degree of the node

and edge weight indicate the number of clients shared. The community detection algorithm by Blondel, Guillaume, Lambiotte, & Lefebvre, (2008) implemented in Gephi was used to help detect communities in the network. The resolution was set to optimize the number of communities to be detected. A lower resolution results in higher number of communities while a higher resolution also results in smaller number of communities.

3.10 Patients Sharing by Districts and Social Network Construction

Fragmentation across districts was also identified based on the visit patterns of each pregnant woman. For each pregnant woman, the list of districts (the district where the facility visited is located) visited for care were identified in the order in which they were visited. Two districts shared a pregnant woman if she visited facilities located in both districts in the course of her pregnancy and delivery. However, for each network that was constructed, the specific link between districts was defined based on the main purpose of the network diagram and the specific fragmentation to be visualized. For district patient sharing during the entire ANC and delivery period (all the visits by all pregnant women), districts were connected if a woman moved from district of previous visit to the other district of subsequent visit. Patient sharing during delivery involves linking the most frequently visited district during ANC and the district of delivery. This approach enables the visualization of the fragmentation of care between the most frequently visited district and the district of delivery. A patient is said to have changed district during delivery, if the district of delivery is different from the district where she sought most of her antenatal care. Just as with providers, all connections from the source district to the destination districts were all directed with curved edges used to indicate the direction of the edge with reading clockwise from a source node to a target node. A matrix made up of two columns was

created with the first column representing the source district and the second the destination district. For each pregnant woman, the source and the destination nodes were identified and appended to the matrix. The weight of each pair of source and destination nodes was calculated. The data was subsequently converted into a graph data format and simplified by removing loops. The graph data was then exported to Gephi for the visualization and data analysis.

Four different types of district network graphs were constructed to help visualize the fragmentation of care among districts during ANC and delivery. These were district network for: (1) ANC and delivery to help visualize the fragmentation during ANC and delivery for all visits, (2) delivery to help visualize the fragmentation during delivery for those that delivered in a district other than where they had their most ANC, (3) Cesarean Section delivery to help visualize the fragmentation during delivery for those that had CS in a district other than where they had their most ANC and (4) delivery at new places to help visualize the fragmentation during delivery for those that delivered in a district that they never received ANC services from. Node colour shows the community that the district belongs, while the size of the node indicates the weighted degree of the node and edge weight indicate the number of clients shared.

3.11 Statistical Analysis

The statistical analysis was aided using R Studio Version 0.99.491 (RStudio Team, 2015) and Stata MP Version 14 (StataCorp, College Station, TX). Gephi was used for the social network analysis. For each provider, the total number of pregnant women who visited the provider at least once, the total number of visits, average number of visits per pregnant woman, total deliveries (by type of delivery) were determined. This was also done for the districts. Descriptive statistics

were employed to describe the various indices of continuity with other attributes of the patients/clients (age, number of providers visited, number of visits and type of delivery) and health facility (facility type, ownership and district) using the Gmisc (Max, 2016) and knitr (Yihui, 2016) packages in R. The level of continuity of care measures were compared by type of delivery. Test of associations to determine the factors that are related to delivery type and continuity of care and other variables of interest were conducted. Where a continuous variable was normally distributed, t-test was used to test the association between the variable and delivery type and when the variable was not normally distributed, Wilcoxon rank-sum test was used. Chi square test was used to test the association between categorical variables.

Continuity of care indices were analyzed both as continuous and also categorized as poor (0.00-0.24), low (0.25-0.49), medium (0.50-0.74), high (0.75-0.99) and perfect (1.0). The associations between the five continuity of care indices, age and the type of delivery were also analysed using simple logistics regression and analysis of variance. Multiple logistics regression was used to test the adjusted effect of each of the continuity of care indices, number of visits, number of providers visited and age of the pregnant woman on the type of delivery.

For social network data, Gephi was used to generate the network and centrality measures for the various facilities (table 3.8). Network data was also exported to Microsoft Excel to create tables for the providers and the various centrality measures.

An analysis of the extent of patient sharing among providers and districts was undertaken. For the purpose of this analysis, the number of pregnant women that had their most ANC from any

given provider were referred to as “potential deliveries” for the index provider. An analysis of the “potential deliveries” that actually “moved out” to deliver at other facilities was undertaken to determine the facilities whose antenatal clients were more likely to move to other facilities for delivery services. The proportion of the “potential deliveries” that moved for CS was also determined for each facility. In addition the proportion of clients who delivered at a facility that they never received ANC services from was also determined for each facility. This approach was also replicated at the district level to determine the potential deliveries moving out from one district to deliver in other districts and the proportion of clients who delivered at districts that they never received ANC services from.

3.11.1 Social Network Measures

The following general network and health facility centrality measures were estimated.

Table 3.8: Network Measures

Measure Type	Measure	Estimation Approach
Network	Average degree	Total number of connections divided by the number of facilities
	Average weighted degree	Sum of all edge weight divided by the number of facilities
	Density	Number of connections divided by the total number of all possible connections in the network.
	Diameter	The largest distance between any pair of facilities.
Facility Centrality	In-degree	The total number of facilities with patients moving from those facilities to the given facility.
	Out-degree	The total number of facilities that patients moved to from the given facility.
	Weighted In-degree	The total number of pregnant women (or visits in some cases) that moved from other facilities to the given facility
	Weighted Out-degree	The total number of pregnant women (or visits in some cases) that moved from the given facility to other facilities.
	Betweenness	Number of times a given facility is part of the shortest path between 2 others (i.e., serves as a necessary intermediary).
	Closeness	How quickly a facility can reach other facilities in the network

3.12 Quality Control

The two research assistants were given adequate training for two days to merge all the monthly claims data in Microsoft Excel and ensure that all the dates were in the same format. The researcher reviewed all the data that were merged by the research assistants and ensured the early detection and correction of any errors made. The researcher undertook daily data validation of all the data merged. The merged data for each district was imported into the Microsoft Access database that was developed to aid the data processing. The research assistants kept daily log of all the facilities and months for the data that were merged. To assure that all the computer programs were working well, a pilot testing of all the computer programs was done using a small sample data. Continuity of care indices and other outputs were calculated manually and compared with the results generated from the computer program.

3.13 Ethical Issues

The Institutional Review Board of the Noguchi Memorial Institute for Medical Research, College of Health Sciences, University of Ghana, Legon gave ethical approval for the study (study ID: 052/15-16).

Privacy and confidentiality

Complete confidentiality of the study participants was assured. Client names and other personal identifiers were removed from the dataset. In addition data use and confidentiality agreement was signed with the National Health Insurance Authority.

Data storage and security

All data files stored on the computer were protected using two level password authentication systems.

Declaration of conflict of interest

There is no conflict of interest on the part of the investigator for the study.

Data ownership and usage

The National Health Insurance Authority remains the owner of the data. The data will be used purposely to help answer the research questions identified above.

Potential risks/benefits

There are no risks associated with participation in this study

Funding for the study

This study was solely funded by the researcher

Chapter 4: Results

4.0 Background of Facilities and Participants

Table 4.1 describes the distribution of the facilities that were included in the study by the type of facilities and districts. It also shows the percent of monthly claims data submitted to the NHIA that were available for inclusion into the study. There were 113 (57.7%) health centres, 41 (20.9%) CHPS compounds, 26 (13.3%) hospitals and 16 (8.2%) for the others (clinics, maternity homes and polyclinics). Nkwanta South District had the highest number of facilities (18) followed by Keta Municipality (16) and Ho Municipality (15). Akatsi North District had the lowest number of facilities with just only a health centre and was followed by Krachi West and Adaklu Districts. Most of the facilities were government (84.7%) and CHAG (8.2%) owned with only (7.1%) privately owned. Ketu South Municipal and Ho Municipal had 3 hospitals each while 8 districts did not have any hospital included.

In all, the claims data used for this study represent about 77% of the expected reports from the health facilities. With the exception of Battor Catholic Hospital and Ketu South Municipal Hospital, all the providers in the southern part of the region had very low proportions of submitted reports. Most of these districts (Keta Municipal, Ketu North, Ketu South Municipal, Akatsi North, Akatsi South, South Tongu, Central Tongu and North Tongu) had submitted less than 7 months of reports. For example there were no reports for Akatsi North and South, North and Central Tongu, Ketu North and South from January to June. In addition, no reports were available for Keta Municipal and South Tongu from January to May. Eleven districts however, had above 90% of their expected monthly claims reports available with 2 districts having all their reports available for inclusion into the study.

Table 4.1: Facility and proportion of available reports by district and facility type, 2013. n(%).

District	Hospital	Health Centre	CHPS	Clinic	Maternity Home	Polyclinic	Total
Adaklu	-	3(88.9)	-	-	-	-	3(88.9)
Afadjato South	-	7(94.1)	2(91.7)	1(100.0)	-	-	10(94.2)
Agortime Ziope	-	3(94.4)	1(100.0)	-	-	-	4(95.8)
Akatsi North	-	1(41.7)	-	-	-	-	1(41.7)
Akatsi South	2(41.7)	4(33.3)	-	1(33.3)	-	-	7(35.7)
Biakoye	1(83.3)	3(88.9)	-	-	-	-	4(87.5)
Central Tongu	1(33.3)	1(33.3)	1(41.7)	-	1(33.3)	-	4(35.4)
Ho	3(94.4)	7(88.1)	2(91.7)	2(100.0)	-	1(100.0)	15(92.2)
Ho West	-	5(56.7)	2(66.7)	-	-	1(66.7)	8(60.4)
Hohoe	1(100.0)	7(81.0)	1(83.3)	-	-	-	9(83.3)
Jasikan	1(100.0)	5(68.3)	-	-	-	-	6(73.6)
Kadjebi	1(100.0)	6(100.0)	-	-	-	-	7(100.0)
Keta	2(54.2)	12(42.4)	-	-	2(33.3)	-	16(42.7)
Ketu North	1(33.3)	7(33.3)	-	-	-	-	8(33.3)
Ketu South	3(58.3)	5(40.0)	1(41.7)	2(41.7)	-	-	11(45.5)
Kpando	2(100.0)	4(95.8)	3(94.4)	-	1(100.0)	-	10(96.7)
Krachi East	-	6(98.6)	1(100.0)	-	-	-	7(98.8)
Krachi Nchumuru	-	5(100.0)	-	-	-	-	5(100.0)
Krachi West	1(100.0)	1(91.7)	-	-	-	-	2(95.8)
Nkwanta North	-	3(97.2)	6(94.4)	1(100.0)	1(100.0)	-	11(96.2)
Nkwanta South	2(95.8)	2(100.0)	14(100.0)	-	-	-	18(99.5)
North Dayi	1(100.0)	5(90.0)	5(85.0)	-	-	-	11(88.6)
North Tongu	1(75.0)	3(33.3)	-	-	-	-	4(43.8)
South Dayi	1(100.0)	5(96.7)	2(100.0)	1(83.3)	1(75.0)	-	10(94.2)
South Tongu	2(33.3)	3(77.8)	-	-	-	-	5(60.0)
Grand Total	26(74.4)	113(74.0)	41(91.3)	8(75.0)	6(62.5)	2(83.3)	196(77.4)

A total of 14,474 pregnant women with a total of 92,095 visits were included in the study. Ho Municipality had the highest number of pregnant women who attended a health facility in the municipality at least once (3,123) followed by Kpando Municipal (1,704), while Akatsi North had the lowest with 42 women. Overall, the region had an average of about 5 visits per pregnant women to a skilled provider during pregnancy and delivery as shown in table 4.2. The districts with the highest average number of visits per pregnant woman were: Ho municipality (5.2), Hohoe (4.7), Ketu South (4.3), Kadjebi (4.3) while Akatsi North and Ho West had the lowest of

2.3 and 2.5 respectively. The average number of visits per district was lower than the average number of visit for the region. This was because some clients visited more than one facility in the region and so contributed to the denominator of two or more facilities or districts. Districts with lower average visits per pregnant woman imply higher sharing of clients compared to those with higher average visits. The average number of visits per district for the region was 3.60 (the average of the average visits per district). This implies that on the average, the pregnant women make about 4 visits to health facilities in a district. Eleven (11) districts had averages above regional average per district while the rest of the fourteen (14) districts were below the average.

Two thousand, one hundred and eighty five (2,185) representing 15.1% of the study participants delivered by cesarean section (CS) and the rest (12,289) representing 84.9% had vaginal delivery (VD). Out of the women that had vaginal delivery, 1,094 (9%) had documented episiotomy and the rest (11,195) (91%) did not have. Five districts had higher than the regional rate of CS delivery. These were: Kpando Municipal (25.6%), Krachi West (20.9%), Ho Municipal (20.8%), Biakoye (17.4%) and Ketu North (16.8%). Eight districts namely Nkwanta North, Krachi Nchumuru, Krachi East, Adaklu, Agortime Ziope, Ho West, Afadjato South and Akatsi North had no CS deliveries. This could be due to the fact that CS are normally performed in hospitals and these districts did not have any hospitals as shown in table 4.1. The result of the CS from the study was comparable to what was reported by the GHS for 2013 for the Volta Region (figure 4.1).

Hospitals contributed more on all the indicators compared to the other provider types as shown in figure 4.2. The hospitals accounted for about 73% of all the visits by pregnant women, 83% of all deliveries, 100% of the CS deliveries and 79% of vaginal deliveries in the study. It was also

noted that about 15 out of the 26 hospitals were the highest contributors to the client visits and delivery details. These hospitals were; Volta Regional Hospital, Ho Municipal Hospital, Margaret Marquart Catholic Hospital, Hohoe Municipal Hospital, Ketu South Municipal Hospital, Krachi West District Hospital, Ho Royal Hospital, Catholic Hospital Anfoega, Nkwanta District Hospital, Peki Government Hospital, Jasikan District Hospital, Catholic Hospital Battor, Keta Municipal Hospital, Sacred Heart Hospital and Mary Theresa Hospital. Together, these hospitals account for 66% of all visits, 72% of all deliveries, 89% of all CS deliveries and 69% of all vaginal deliveries. In addition, five districts (Ho, Hohoe, Keta, Ketu South and Kpando) account for 53.2% of all the deliveries, 54.6% of visits, 66.7% of CS deliveries and 50.8% vaginal deliveries in the study.

About 96% of the pregnant women who visited a health facility at least once in the North Tongu district delivered in a health facility located in the district. The rest of the top six districts with the highest proportion of deliveries include: Keta (95.6%), South Tongu (94.0%), Ho (93.2%), Ketu South (91.8%) and Kadjebi (90.4%). The districts with the lowest proportion of deliveries were: Akatsi North (16.7%), Afadjato South (29.6%) and Ho West (41.0%). The average proportion of deliveries per district for the region was 73.0% with 9 districts recording levels below the regional average per district. Districts with lower proportion of deliveries means that more pregnant women that visited facilities in those districts during ANC had their deliveries in facilities located in other districts. This is an indication that the pregnant women prefer to have their deliveries in other health facilities located outside the given district. In addition, the average proportion of deliveries per hospital was 82.8% compared to 36% for health centres and 37% for clinics (table 4.2)

Figure 4.1: Comparison of C-Section reported by GHS and study for 2013

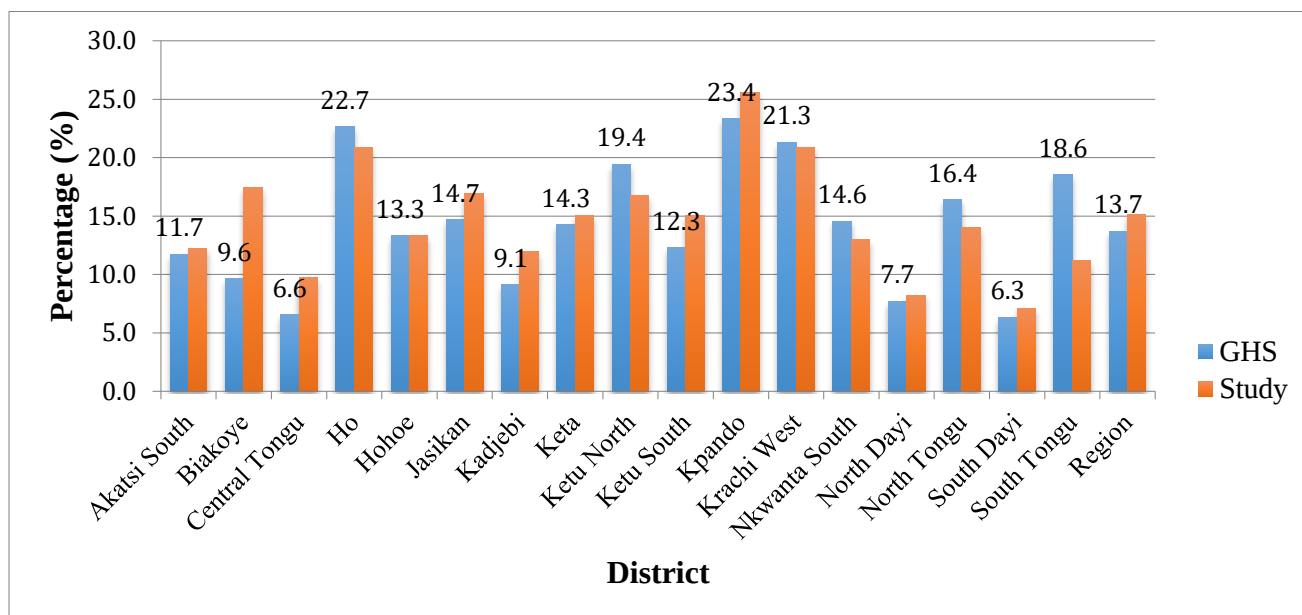


Figure 4.2: Proportion of visits and delivery by facility type, 2013

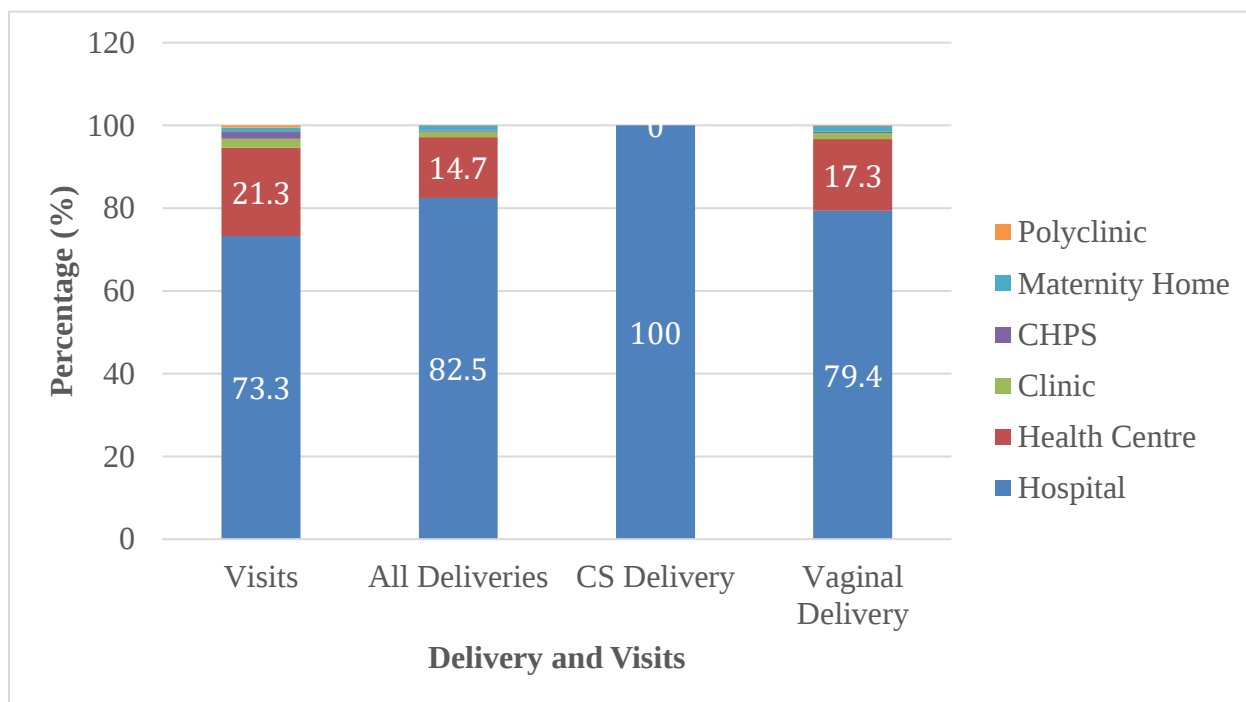


Table 4.2: Distribution of participants, visits and deliveries by district and providers, 2013

District/Provider Type	No. of Clients*	No. of Visits	Visit per client	Delivery			
				CS	VD	Total	Proportion Delivered (%)
District							
Adaklu	69	217	3.14	.	35	35	50.7
Afadjato South	402	1,147	2.85	.	119	119	29.6
Agortime Ziope	461	1,765	3.83	.	215	215	46.6
Akatsi North	42	98	2.33	.	7	7	16.7
Akatsi South	224	754	3.37	22	158	180	80.4
Biakoye	656	1,832	2.79	74	351	425	64.8
Central Tongu	131	486	3.71	11	102	113	86.3
Ho	3,123	16,375	5.24	606	2,304	2,910	93.2
Ho West	144	355	2.47	.	59	59	41.0
Hohoe	1,246	5,906	4.74	144	938	1,082	86.8
Jasikan	672	2,379	3.54	93	456	549	81.7
Kadjebi	779	3,316	4.26	84	620	704	90.4
Keta	1,132	4,488	3.96	163	919	1,082	95.6
Ketu North	340	1,220	3.59	51	253	304	89.4
Ketu South	1,334	5,697	4.27	184	1,039	1,223	91.7
Kpando	1,704	6,890	4.04	360	1,047	1,407	82.6
Krachi East	602	1,939	3.22	.	307	307	51.0
Krachi Nchumuru	459	1,354	2.95	.	324	324	70.6
Krachi West	944	3,390	3.59	134	507	641	67.9
Nkwanta North	471	1,748	3.71	.	352	352	74.7
Nkwanta South	980	3,335	3.40	100	669	769	78.5
North Dayi	626	2,218	3.54	41	461	502	80.2
North Tongu	456	1,889	4.14	61	375	436	95.6
South Dayi	713	2,843	3.99	43	561	604	84.7
South Tongu	133	454	3.41	14	111	125	94.0
Provider Type							
Hospital	14,421	52,853	3.66	2,185	9,758	11,943	82.82
Health Centre	5,854	15,325	2.62	.	2,130	2,130	36.39
CHPS	549	1,146	2.09	.	37	37	6.74
Clinic	504	1,603	3.18	.	187	187	37.10
Maternity Home	338	820	2.43	.	167	167	49.41
Polyclinic	139	348	2.50	.	10	10	7.19
Region	-	72,095	4.98	2,185	12,289	14,474	-

* Number of women who attended a health facility in the district at least once. CS = Cesarean Section, VD = Vaginal Delivery

Table 4.3 shows the demographic and visits characteristics of the study participants. The median age (maternal age) of the pregnant women who were included in the study was 27 and those that had CS were slightly older with a median age of 29 compared to 26 for those that had vaginal delivery. Most of the participants (79.3%) were within the ages 18 to 34 and about 5% were less than 18 years. About 20% of those who had CS were above 34 years compared to 14% of those who had vaginal delivery. There was a significant association between the ages of the women and the type of delivery, with higher ages associated with CS delivery ($P < 0.0001$). Cesarean section delivery was also found to be significantly associated with higher number of provider visits compared to vaginal delivery ($P < 0.0001$). The median number of visits made was 5 (interquartile range: 3-6) and those who had CS delivery was 5 (interquartile range: 4-7) compared with 4 (interquartile range: 3-6) for those who had vaginal delivery. The proportions of participants that made at least 4 ANC visits were 56.5% (CS delivery), 48.9% (vaginal delivery) and 50% overall. Cesarean section delivery was also found to be significantly associated with visiting more providers compared with vaginal delivery ($P = 0.0006$). About 59% (7,224) of those who had vaginal delivery visited only one provider during the ANC and delivery compared to 56% (1,225) of those who had CS. Forty three percent (935) of those who had CS, visited between 2 to 3 providers compared to 40% (4,976) of those with vaginal delivery. Averagely, those who delivered by CS visited about 1.6 health facilities (providers), while women who had vaginal delivery had about 1.5 providers.

Table 4.3: Demographic and visit characteristics of respondents.

Variables	Total	CS	VD	P-value*
Age				
Median (IR)	27 (22-32)	29 (24-33)	26 (22-31)	< 0.0001
< 18	764 (5.28%)	79 (3.62%)	685 (5.58%)	
18-24	4,634 (32.05%)	514 (23.53%)	4,120 (33.57%)	
25-34	6,851 (47.39%)	1,149 (52.61%)	5,702 (46.46%)	
35+	2,209 (15.28%)	442 (20.24%)	1,767 (14.40%)	
ANC Visits				
Median (IR)	5 (3-6)	5 (4-7)	4 (3-6)	< 0.0001
2-3	7,235 (49.99%)	951 (43.52%)	6,284 (51.14%)	
4-5	4,436 (30.65%)	666 (30.48%)	3,770 (30.68%)	
6+	2,803 (19.37%)	568 (26.00%)	2,235 (18.19%)	
Provider				
Median (IR)	1 (1-2)	1 (1-2)	1 (1-2)	0.0006
1	8,449 (58.37%)	1,225 (56.06%)	7,224 (58.78%)	
2	4,840 (33.44%)	715 (32.72%)	4,125 (33.57%)	
3	1,071 (7.40%)	220 (10.07%)	851 (6.92%)	
4+	114 (0.79%)	25 (1.14%)	89 (0.72%)	

All categories are reported in n (%). * Based on two-sample Wilcoxon rank-sum (Mann-Whitney) test

4.1 Sequential Patterns of Seeking Care

A total of 57,621 movements (link between subsequent and previous visits) were made from one visit to the other. The first facility visited by a participant and any subsequent visit to same facility was labeled ‘A’. The second facility visited and any subsequent visit to same facility was also labeled ‘B’ and third facility visited was labeled ‘C’ and so on as described in section 3.7.1. As shown in table 4.4, the movement of the client is from the facility label in the row to the facility label in the column. A total of 47,946 subsequent visits were made from the facility of first visit (‘A’) to same facility or other facilities. About 85% (40,832) of all the subsequent visits from ‘A’ were back to ‘A’ while 6,794 (14%) visits were ‘A’ to ‘B’ of which 2,179 moved back from ‘B’ to ‘A’. About 83% (47,946) of all subsequent visits were from ‘A’. In addition, about 75% (43,202) of all subsequent visits were to ‘A’, 22% (12,445) to ‘B’ and 3%

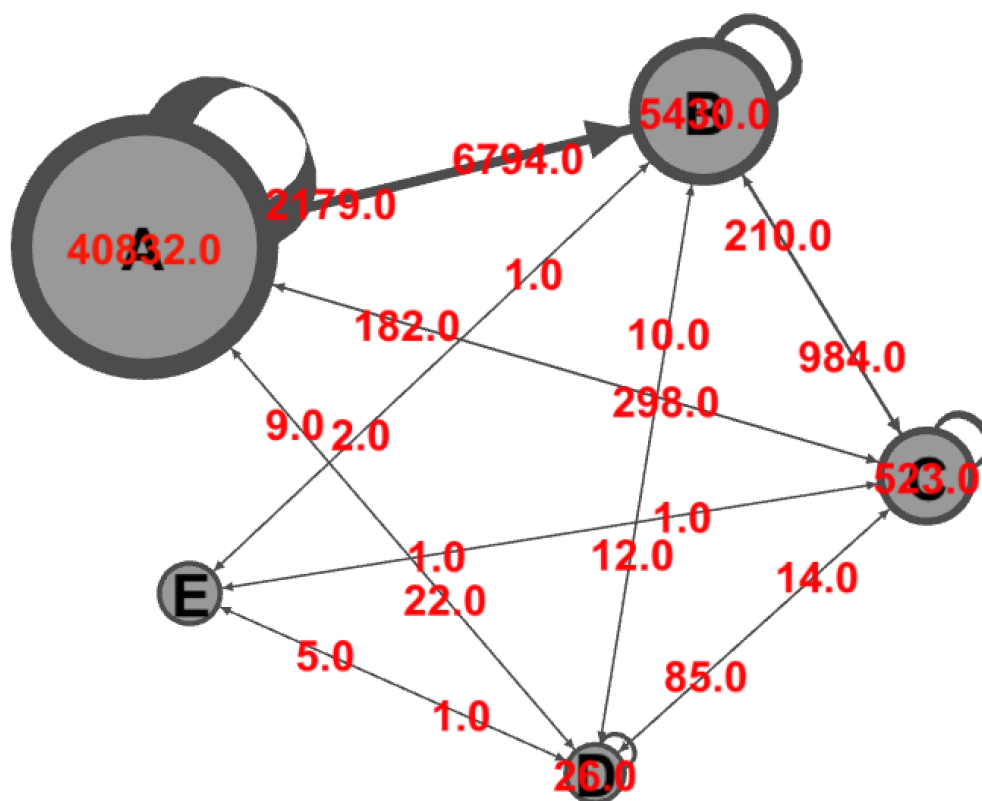
to 'C'. Overall, about 8.2% (4,744) of all subsequent visits from 'A' never visited 'A' subsequently. A total of 8 subsequent visits (by 7 women) were from other facilities to 'E'. Figure 4.3 shows the diagrammatic movement of the clients with the arrows indicating the direction of the subsequent visits.

Table 4.4: Sequential client movements among facilities in the Volta Region of Ghana, 2013.

	A	B	C	D	E	Total
A	40,832 (85.2)	6,794 (14.2)	298(0.6)	22 (0.1)	-	47,946 (83.2)
B	2,179 (25.3)	5,430 (63.1)	984 (11.4)	12 (0.1)	2 (0.0)	8,607 (14.9)
C	182 (18.2)	210 (21.0)	523 (52.3)	85 (8.5)	1 (0.1)	1,001 (1.7)
D	9 (14.1)	10 (15.6)	14 (21.9)	26 (40.6)	5 (7.8)	64 (0.1)
E	-	1 (33.3)	1 (33.3)	1 (33.3)	-	3 (0.0)
Total	43,202 (75.0)	12,445 (21.6)	1,820 (3.2)	146 (0.3)	8 (0.0)	57,621

Movement is from row to column. Values reported in number and percentages, n (%). Rows are reported in row percentages while column total is reported in column percentage.

Figure 4.3: Sequence of visits during pregnancy and delivery



4.2 Extent of Continuity of Care

A total of 8,449 (58.4%) of all the pregnant women had perfect continuity of care (a computed value of 1.0 on all measures) as shown in table 4.5. This means that they maintained only one provider throughout their ANC and delivery journey. In addition, 56.1% (1,225) of those delivered by CS had perfect continuity of care compared to 58.8% (7,224) of those who had vaginal delivery. This implies that 41.6% (6,025) of the participants had multiple providers during ANC and delivery. The average ($\pm$ SD) continuity of care indices for all the participants were: MFPC: 0.82 ± 0.25 ; MMCI: 0.86 ± 0.20 ; COC: 0.76 ± 0.30 ; SECON: 0.80 ± 0.28 ; PDC: $0.68 (\pm 0.41)$. For those that had CS delivery, the average continuity indices were: MFPC: $0.81 (\pm 0.25)$; MMCI: $0.85 (\pm 0.21)$; COC: $0.75 (\pm 0.30)$; SECON: 0.80 ± 0.28 ; PDC: $0.68 (\pm 0.41)$. For these indices, the mean score for CS delivery tends to be lower compared to VD.

In all, about 32% of the participants (78% of those with multiple providers) had less than high (<0.75) continuity of care score for the most frequently visited provider. An indication that, among those that had multiple providers, most of them made less than three quarters of their visits to their most frequently visited facility. The results also revealed that, there exist an association between the category of MFPC index and the type of delivery. Those with higher MFPC score were more likely to have vaginal delivery than those with lower MFPC score and this relationship between MFPC and delivery type was statistically significant (Pearson $\chi^2 (4) = 17.86$, $p = 0.001$). Also, with respect to the MMCI, about 24% (3,534) of the study participants scored less than 0.75 with 24.5% (3,008) for vaginal delivery against 24.1% (526) for CS. Again, those with higher MMCI score were more likely to have vaginal delivery than CS (Pearson $\chi^2 (4)$

= 24.27, $p < 0.001$). There exist strong associations between the various continuity of care indices and the type of delivery. The Pearson χ^2 statistics for the other continuity of care indices and the type of delivery are as follows: CoC ($\chi^2 (4) = 13.96$, $p = 0.007$), SECON ($\chi^2 (4) = 27.54$, $p < 0.001$), PDC ($\chi^2 (4) = 69.88$, $p < 0.001$).

In total, 2,147 (14.8%) of the pregnant women had zero place of delivery continuity of care score. This means that they had their delivery at a facility that they never visited during their ANC period. About 20% (428) of those that had CS delivery, delivered at a facility that they never visited during the ANC period compared with 14% (1,719) of those that had vaginal delivery. In all, 23% (3,354) of all pregnant women scored less than 0.5 on the PDC index with 29% (636) for CS and 22% (2,718) for VD. This shows that they made less than half of their ANC visits to the facility where they delivered. In addition, about 36% (5,218) of all pregnant women delivered at a facility that they had less than three quarters of their ANC visits.

There was also a strong relationship between the various continuity of care indices and age of the participants as shown in table 4.6. Women aged above 24 years, tend to have less number of providers ($F=6.63$, $p<0.001$), make more visits ($F=51.87$, $p<0.001$), have higher MFPC ($F=9.37$, $p<0.001$), have higher MMCI ($F=14.41$, $p<0.001$), have higher CoC ($F=10.56$, $p<0.001$), have higher SECON ($F=10.09$, $p<0.001$) and have higher PDC ($F=10.00$, $p<0.001$) compared to those below 25 years. Adjusting for age, number of visits, number of providers, MMCI, CoC, SECON and PDC, a 0.01 (1%) unit increase in MFPC results in 5.24 (CI: 1.82 – 15.07) times increase in the odds of vaginal delivery as compared to CS delivery. In addition, the odds of vaginal delivery decreases by 17% for every additional provider visited (CI: 0.68 - 0.99, $p=0.05$), decreases by

3% for every 1 year increase in maternal age, decreases by 10% for every additional visit made, reduces by 13.4 times and 2.1 for every 1% unit increase in CoC and SECON respectively, increase by 2.9 and 2.5 times for every 1% unit increase in MMCI and PDC respectively as compared to CS delivery, adjusting for all other factors (table 4.7).

Table 4.5: Number and proportion of women by continuity of care measures, Volta Region 2013.

Variables	Total	C-Section	Vaginal Delivery	P-value
MFPC				
Mean (SD)	0.82 (±0.25)	0.81 (±0.25)	0.82 (±0.25)	0.001
Poor (0.00-0.24)	212 (1.46%)	39 (1.78%)	173 (1.41%)	
Low (0.25-0.49)	982 (6.78%)	173 (7.92%)	809 (6.58%)	
Medium (0.50-0.74)	3,488 (24.10%)	508 (23.25%)	2,980 (24.25%)	
High (0.75-0.99)	1,343 (9.28%)	240 (10.98%)	1,103 (8.98%)	
Perfect (1.0)	8,449 (58.37%)	1,225 (56.06%)	7,224 (58.78%)	
MMCI				
Mean (SD)	0.86 (±0.20)	0.85 (±0.21)	0.86 (±0.20)	< 0.0001
Poor (0.00-0.24)	181 (1.25%)	33 (1.51%)	148 (1.20%)	
Low (0.25-0.49)	269 (1.86%)	57 (2.61%)	212 (1.73%)	
Medium (0.50-0.74)	3,084 (21.31%)	436 (19.95%)	2,648 (21.55%)	
High (0.75-0.99)	2,491 (17.21%)	434 (19.86%)	2,057 (16.74%)	
Perfect (1.0)	8,449 (58.37%)	1,225 (56.06%)	7,224 (58.78%)	
COC				
Mean (SD)	0.76 (±0.30)	0.75 (±0.30)	0.77 (±0.30)	0.009
Poor (0.00-0.24)	588 (4.06%)	107 (4.90%)	481 (3.91%)	
Low (0.25-0.49)	2,988 (20.64%)	460 (21.05%)	2,528 (20.57%)	
Medium (0.50-0.74)	2,234 (15.43%)	347 (15.88%)	1,887 (15.36%)	
High (0.75-0.99)	215 (1.49%)	46 (2.11%)	169 (1.38%)	
Perfect (1.0)	8,449 (58.37%)	1,225 (56.06%)	7,224 (58.78%)	
SECON				
Mean (SD)	0.80 (±0.28)	0.80 (±0.28)	0.80 (±0.29)	< 0.0001
Poor (0.00-0.24)	737 (5.09%)	102 (4.67%)	635 (5.17%)	
Low (0.25-0.49)	980 (6.77%)	144 (6.59%)	836 (6.80%)	
Medium (0.50-0.74)	2,886 (19.94%)	433 (19.82%)	2,453 (19.96%)	
High (0.75-0.99)	1,422 (9.82%)	281 (12.86%)	1,141 (9.28%)	
Perfect (1.0)	8,449 (58.37%)	1,225 (56.06%)	7,224 (58.78%)	
PDC				
Mean (SD)	0.73 (±0.38)	0.68 (±0.41)	0.73 (±0.37)	< 0.0001
Poor (0.00)	2,147 (14.83%)	428 (19.59%)	1,719 (13.99%)	
Very low (0.01-0.24)	272 (1.88%)	59 (2.70%)	213 (1.73%)	
Low (0.01-0.49)	935 (6.46%)	149 (6.82%)	786 (6.40%)	
Medium (0.50-0.74)	1,864 (12.88%)	222 (10.16%)	1,642 (13.36%)	
High (0.75-0.99)	807 (5.58%)	102 (4.67%)	705 (5.74%)	
Perfect (1.0)	8,449 (58.37%)	1,225 (56.06%)	7,224 (58.78%)	

Continuous values are reported with $\bar{x}$ ($\pm$ SD), while categories are reported in n (%).

Table 4.6: Mean continuity of care measure by age groups, Volta Region, 2013.

Variables	Total	< 18	18-24	25-34	35+	P-value
Provider						
Mean (SD)	1.51 (±0.67)	1.52 (±0.66)	1.54 (±0.68)	1.48 (±0.66)	1.52 (±0.67)	< 0.0001
Visits						
Mean (SD)	4.98 (±1.98)	4.41 (±1.53)	4.75 (±1.82)	5.14 (±2.07)	5.18 (±2.05)	< 0.0001
MFPC						
Mean (SD)	0.82 (±0.25)	0.80 (±0.26)	0.80 (±0.25)	0.83 (±0.24)	0.82 (±0.24)	< 0.0001
MMCI						
Mean (SD)	0.86 (±0.20)	0.83 (±0.22)	0.84 (±0.21)	0.87 (±0.20)	0.86 (±0.20)	< 0.0001
COC						
Mean (SD)	0.76 (±0.30)	0.74 (±0.31)	0.75 (±0.31)	0.78 (±0.29)	0.76 (±0.30)	< 0.0001
SECON						
Mean (SD)	0.80 (±0.28)	0.77 (±0.30)	0.78 (±0.29)	0.81 (±0.28)	0.80 (±0.28)	< 0.0001
PDC						
Mean (SD)	0.73 (±0.38)	0.71 (±0.39)	0.70 (±0.39)	0.74 (±0.37)	0.73 (±0.37)	< 0.0001

Table 4.7: Factors associated with vaginal delivery

Variable	Adjusted				
	Crude OR	P-value	OR	95% CI	P-value
Age	0.97	< 0.001	0.97	0.96 - 0.97	< 0.001
Number of visits	0.90	< 0.001	0.90	0.88 - 0.93	< 0.001
Number of providers	0.87	< 0.001	0.83	0.68 - 0.99	0.050
MFPC	1.20	0.054	5.24	1.82 - 15.07	0.002
MMCI	1.18	0.142	2.92	1.39 - 6.15	0.005
CoC	1.17	0.045	0.08	0.02 - 0.25	< 0.001
SECON	0.98	0.804	0.47	0.30 - 0.75	0.001
PDC	1.41	< 0.001	2.49	1.93 - 3.21	< 0.001

4.3 Extent of Repeat Visits to Providers (Provider Continuity)

The average provider continuity of care score for all providers in the region was 66.5% with a standard deviation of 32.1%. Hospitals had the highest score (72.0%) compared to maternity homes (61.1%), health centres (56.5%), clinics (51.2%), CHPS (44.3%) and polyclinics (44.2%) as shown in table 4.9. The provider continuity of care score represents the average proportion of the clients' visits that were made to the given healthcare provider or the district (in the case of district continuity of care score) compared to other providers/districts that those same clients also visited. The idea is to find the providers or districts with higher repeat visits by pregnant women during ANC and delivery.

The top twenty five (25) providers with the highest CoC score (table 4.8) include: Catholic Hospital Battor (95.9%), Ketu South Municipal Hospital (92.6%), Adutor Health Centre (87.7%), Aflao Central Hospital (83.3%), Akatsi District Hospital (82.7%) (see table 4.8 for details). What this shows is that, about 96% of all the visits made by the participants that attended the Catholic Hospital Battor, were made to same hospital, and only 4% of those visits were made to other providers. These top 25 providers with the highest CoC score consist of 11 hospitals, 13 health centres and 1 clinic all from 11 districts. The average provider continuity score for all providers per district varies across the various districts with North Tongu district having the highest average CoC score per facility (94.9%), followed by Ketu South (87.3%) and Akatsi South (78.8%) while Nkwanta South (49.9%), Afadjato South (51.3%), Akatsi North (51.7%) and Krachi Nchumuru (52.5%) had the lowest scores.

Ten districts had average provider continuity score above the regional average and five hospitals had provider continuity score lower than the regional average. Facilities with low continuity score implies that they shared their clients more with other facilities compared with those with higher score that were able to retain their clients throughout the pregnancy and delivery period. An analysis of the variance showed that, there was significant difference in the mean facility continuity score among the districts ($F=2.91$, $p<0.001$)

The average district continuity of care score was 81.1% (± 28.7) with 14 districts having scores below the regional average. The district continuity of care score ranges from as low as 51.7 (± 24.3) to a maximum of 94.9% (± 16.9) as shown in table 4.9. Districts with higher continuity of care score means they were able to retain pregnant women within the district compared to districts with low score. The districts with the highest continuity of care score include: North Tongu, Ketu South, Kadjebi, Keta and Central Tongu. Most of these districts are located in the southern part of the region which had low availability of data as shown in table 4.1.

Table 4.8: Top 25 Providers with the highest continuity of care score Volta Region, 2013

Provider Name	Clients*	Visits	Visit per client	Delivery	Prop Delivered	Continuity (%)**
Cath Hosp Battor	428	1794	4.2	413	96.5	95.9 (±15.8)
Ketu South Dist Hosp	1101	4687	4.3	1019	92.6	92.6 (±20.5)
Adutor HC	46	186	4.0	42	91.3	87.7 (±25.9)
Aflao Central Hosp	122	489	4.0	100	82.0	83.3 (±24.2)
Akatsi Dist Hosp	178	612	3.4	146	82.0	82.7 (±26.9)
Dabala HC	26	86	3.3	16	61.5	80.0 (±20.3)
St Anthonys Hosp	293	1088	3.7	281	95.9	79.7 (±30.7)
Juapong HC	27	91	3.4	21	77.8	78.5 (±25.9)
Likpe Bala HC	32	93	2.9	20	62.5	77.1 (±27.3)
Ho Mun Hosp	1420	5935	4.2	1172	82.5	76.5 (±31.8)
Anyanui HC	52	186	3.6	16	30.8	75.1 (±21.6)
Peki Govt Hosp	540	1843	3.4	459	85.0	75.0 (±29.6)
Hohoe Mun Hosp	1139	4967	4.4	973	85.4	74.7 (±32.6)
Volta Reg Hosp	1334	6244	4.7	1215	91.1	74.6 (±33.0)
Keta Mun Hosp	564	1748	3.1	523	92.7	74.5 (±29.6)
Likpe Bakwa HC	80	273	3.4	39	48.8	74.2 (±27.3)
New Ayoma HC	108	345	3.2	70	64.8	73.7 (±27.9)
Sacred Heart Hosp	494	1689	3.4	463	93.7	73.2 (±32.7)
Fodome Ahor HC	39	140	3.6	24	61.5	73.1 (±27.2)
Shia HC	22	74	3.4	11	50.0	72.8 (±29.0)
Santrokofi HC	24	92	3.8	2	8.3	72.8 (±17.1)
Lolobi HC	47	155	3.3	19	40.4	71.8 (±25.5)
Klikor HC	41	101	2.5	23	56.1	71.8 (±28.1)
Mater Ecclesiae Clinic	222	920	4.1	89	40.1	71.3 (±27.7)
Kadjebi HC	278	1050	3.8	135	48.6	70.7 (±29.1)

* Number of women who visited the provider at least once ** mean (SD)

Table 4.9: District and provider continuity of care, Volta Region, 2013. $\bar{x}$ ($\pm$ SD)

District	District continuity of care score	Average Provider Continuity Score (%)			
		Hospital	Health Centre	CHPS	All Facilities
Adaklu	59.0 ($\pm$ 26.7)	-	52.9 ($\pm$ 25.2)	-	52.9 ($\pm$ 25.2)
Afadjato South	59.3 ($\pm$ 27.6)	-	49.7 ($\pm$ 26.1)	23.9 ($\pm$ 09.9)	51.3 ($\pm$ 27.0)
Agortime Ziope	75.0 ($\pm$ 28.4)	-	59.0 ($\pm$ 31.3)	42.2 ($\pm$ 21.4)	58.7 ($\pm$ 31.2)
Akatsi North	51.7 ($\pm$ 24.3)	-	51.7 ($\pm$ 24.3)	-	51.7 ($\pm$ 24.3)
Akatsi South	83.2 ($\pm$ 26.7)	79.5 ($\pm$ 28.3)	45.0 ($\pm$ 24.0)	-	78.8 ($\pm$ 28.7)
Biakoye	63.6 ($\pm$ 32.6)	58.1 ($\pm$ 34.2)	53.5 ($\pm$ 24.3)	-	56.7 ($\pm$ 31.4)
Central Tongu	90.8 ($\pm$ 21.2)	62.0 ($\pm$ 33.4)	-	65.5 ($\pm$ 24.3)	63.5 ($\pm$ 29.7)
Ho	87.7 ($\pm$ 26.1)	74.3 ($\pm$ 33.0)	64.0 ($\pm$ 28.5)	36.2 ($\pm$ 22.0)	72.4 ($\pm$ 33.0)
Ho West	60.6 ($\pm$ 28.0)	-	60.4 ($\pm$ 27.5)	46.5 ($\pm$ 27.9)	59.3 ($\pm$ 28.1)
Hohoe	84.6 ($\pm$ 27.2)	74.7 ($\pm$ 32.6)	72.1 ($\pm$ 25.4)	51.5 ($\pm$ 32.2)	74.1 ($\pm$ 31.3)
Jasikan	75.6 ($\pm$ 32.1)	70.0 ($\pm$ 33.9)	63.6 ($\pm$ 30.1)	-	68.4 ($\pm$ 33.1)
Kadjebi	91.4 ($\pm$ 20.8)	62.9 ($\pm$ 30.2)	58.5 ($\pm$ 29.0)	-	60.8 ($\pm$ 29.7)
Keta	90.9 ($\pm$ 22.3)	73.9 ($\pm$ 31.1)	58.4 ($\pm$ 25.7)	-	69.2 ($\pm$ 30.5)
Ketu North	79.9 ($\pm$ 30.2)	79.7 ($\pm$ 30.7)	59.7 ($\pm$ 29.0)	-	76.2 ($\pm$ 31.3)
Ketu South	94.6 ($\pm$ 17.0)	90.1 ($\pm$ 22.8)	63.5 ($\pm$ 25.0)	-	87.3 ($\pm$ 24.7)
Kpando	76.6 ($\pm$ 32.4)	67.0 ($\pm$ 33.3)	46.4 ($\pm$ 29.7)	27.1 ($\pm$ 16.3)	61.5 ($\pm$ 33.7)
Krachi East	72.3 ($\pm$ 26.4)	-	57.4 ($\pm$ 28.8)	-	57.4 ($\pm$ 28.8)
Krachi Nchumuru	63.1 ($\pm$ 22.2)	-	52.5 ($\pm$ 24.6)	-	52.5 ($\pm$ 24.6)
Krachi West	70.8 ($\pm$ 32.2)	69.1 ($\pm$ 31.9)	35.5 ($\pm$ 16.9)	-	67.5 ($\pm$ 32.1)
Nkwanta North	83.3 ($\pm$ 21.9)	-	57.6 ($\pm$ 29.6)	54.3 ($\pm$ 22.9)	55.2 ($\pm$ 27.7)
Nkwanta South	73.3 ($\pm$ 33.6)	52.0 ($\pm$ 29.5)	33.7 ($\pm$ 16.0)	40.8 ($\pm$ 19.3)	49.9 ($\pm$ 28.3)
North Dayi	74.3 ($\pm$ 29.2)	68.9 ($\pm$ 29.2)	38.8 ($\pm$ 19.6)	35.6 ($\pm$ 19.8)	61.4 ($\pm$ 30.4)
North Tongu	94.9 ($\pm$ 16.9)	95.9 ($\pm$ 15.8)	78.5 ($\pm$ 25.9)	-	94.9 ($\pm$ 17.0)
South Dayi	87.5 ($\pm$ 24.5)	75.0 ($\pm$ 29.6)	53.2 ($\pm$ 29.7)	49.0 ($\pm$ 21.5)	65.5 ($\pm$ 31.2)
South Tongu	85.1 ($\pm$ 28.9)	60.0 ($\pm$ 35.9)	84.1 ($\pm$ 23.7)	-	72.1 ($\pm$ 32.6)
Grand Total	81.1 ($\pm$28.7)	72.0 ($\pm$32.4)	56.5 ($\pm$28.6)	44.3 ($\pm$23.5)	66.5 ($\pm$32.1)

As shown in table 4.10, CHAG health facilities had an average continuity score of 67.7% ($\pm$ 32.0) followed by Government health facilities with a score of 66.3% ($\pm$ 32.1). The one way analysis of variance (ANOVA) revealed that, there is no significant difference in the mean continuity of care score by facility ownership ($F=2.13$, $p=0.122$). There is however, a significant difference in the continuity of care score by the type of health facility ($F=12.25$, $p<0.001$). Pair difference were

found between health centre and CHPS ($p=0.001$), hospital and CHPS ($p<0.001$), hospital and health centre ($p<0.001$) and hospital and Maternity Home ($p<0.001$)

Table 4.10: Provider continuity of care by provider type and ownership for pregnant women attending ANC in the Volta Region of Ghana, 2013. $\bar{x}$ ($\pm$ SD)

Facility Type	Ownership			
	CHAG	Government	Private	All
CHPS	-	44.3 (± 23.5)	-	44.3 (± 23.4)
Clinic	62.5 (± 29.3)	32.5 (± 18.7)	56.6 (± 20.9)	61.1 (± 29.2)
Health Centre	51.9 (± 28.0)	56.9 (28.7)	-	56.5 (± 28.6)
Hospital	69.7 (± 32.2)	73.5 (± 32.3)	68.6 (± 34.3)	72.0 (± 32.5)
Maternity Home	-	-	51.2 (25.9)	51.2 (± 25.9)
Polyclinic	-	44.2 (± 25.7)	-	44.2 (± 25.7)
All	67.7 (± 32.0)	66.3 (± 32.1)	63.4 (± 32.8)	66.5 (± 32.1)

4.3.1 Summary for the extent of repeat visits to providers

Average extent of repeat visit to providers (provider continuity) for all facilities in the region is 66.5% (range: 19.5% - 95.9%) and varies by districts with those in the southern part of the region having higher repeat visits. Extent of repeat visits to providers in a district as a whole (district continuity) was higher with the regional average of 81.1% (range: 51.7% -94.9%). The district continuity score estimates the extent to which a district as a whole is able to retain pregnant women within the district during the ANC and delivery period.

4.4 Extent of Care Fragmentation among Providers

About 42% (6,025) of all the pregnant women had multiple providers during ANC and delivery. Nineteen percent (18.8) of all subsequent visits during ANC and delivery, 26% (3,769) of all deliveries and 32% (696) of all CS deliveries were fragmented across providers. Among those with multiple providers, 62.5% (72.5% CS and 60.7% VD) were fragmented across providers. In addition, 15% (2,133) of all deliveries (35.6% among those with multiple providers) and 20% (425) of all CS deliveries (44.6% among those with multiple providers) were performed at facilities that the pregnant women never received ANC services from. Table 4.16 provides summary of the key messages from the various figures among providers.

4.4.1 Fragmentation during Entire ANC and Delivery Visits

Figure 4.4 shows the network diagram that visualizes the extent of client sharing among the 196 healthcare providers (nodes) that shared at least a pregnant woman during the ANC and delivery period in the Volta region. This network diagram is based on the 19% of the clients' movement (subsequent visits) that were "fragmented". There were 1,412 links or connections between all the providers with each provider sharing an average of 55 client visits (weighted degree) with 7 other providers (degree). The network diagram has diameter of 6 and all the providers are at least connected to one another with 18 strongly and 2 weakly connected components. The network has a density of 0.037 and this is an indication that the network is not densely connected. This low density is expected since it is difficult for all providers to be able to share clients with all the other providers in the region looking at how geographically widespread the region is. The diagram shows that hospitals were central to the client-sharing network and the hospitals had

more pregnant women attending their facilities than the rest of the other provider types. However, the health centres (HC) and CHPS compounds had the largest nodes (providers) in the network. The HC accounts for 58% (113), CHPS accounts for 21% (41) while the hospitals accounts for 13% (26) of all the providers in the network. The top five central providers by the number of pregnant women shared (weighted degree) were: Margaret Marquart Catholic Hospital, Nkwanta District Hospital, Krachi West District Hospital, Ho Municipal Hospital and Volta Regional Hospital as shown in table 4.11. On the average, hospital shared more clients than the rest of the provider types. The average incoming-visits from other providers (weighted in-degree) for the hospitals were 263 compared to Clinic (50), Maternity Homes (49), HC (26), Polyclinic (25) and CHPS (7). Apart from the hospitals and the maternity homes, all the other type of providers had more client-visits moving from their facility to other providers compared to incoming client-visits. The average number of visits that “moved out” for the provider types were: hospitals (165), Polyclinic (78), Clinic (65), Maternity Homes (50), HC (43) and CHPS (15). As shown in table 4.11, most providers, especially the hospitals have high degree centrality but low closeness centrality. This is an indication of clustering in the network, with most hospitals embedded in clusters that were far away from the rest of the network. In addition, the low betweenness centralities also suggest that there were redundant connections that may bypass hospitals and other facilities.

The key message from the diagram (figure 4.4) is that there are about five cluster of communities that share a lot of patients. These communities perfectly follow along the geographical patterns in the region. The communities are located in the lower, middle and the upper parts of the region. Communities were mostly centred on key hospital or hospitals and surrounded by health centres

and CHPS centres. The community in the coastal area was centred on Keta Municipal, Sacred Heart and Ketu South Municipal Hospitals. Two communities were found in the middle part of the region, one was centred on the Volta Regional and Ho Municipal Hospitals, while the other was centred on Margaret Marquart Catholic and Hohoe Municipal hospitals and surrounded by Kpando health centre, Anfoega Catholic, Worawora and Jasikan District Hospitals. Three communities were also found in the upper part of the region and these were centred on Mary Theresa Hospital, Krachi West District Hospital and, Nkwanta District and St. Joseph Hospitals.

Figure 4.4: Network diagram of client sharing during ANC and delivery

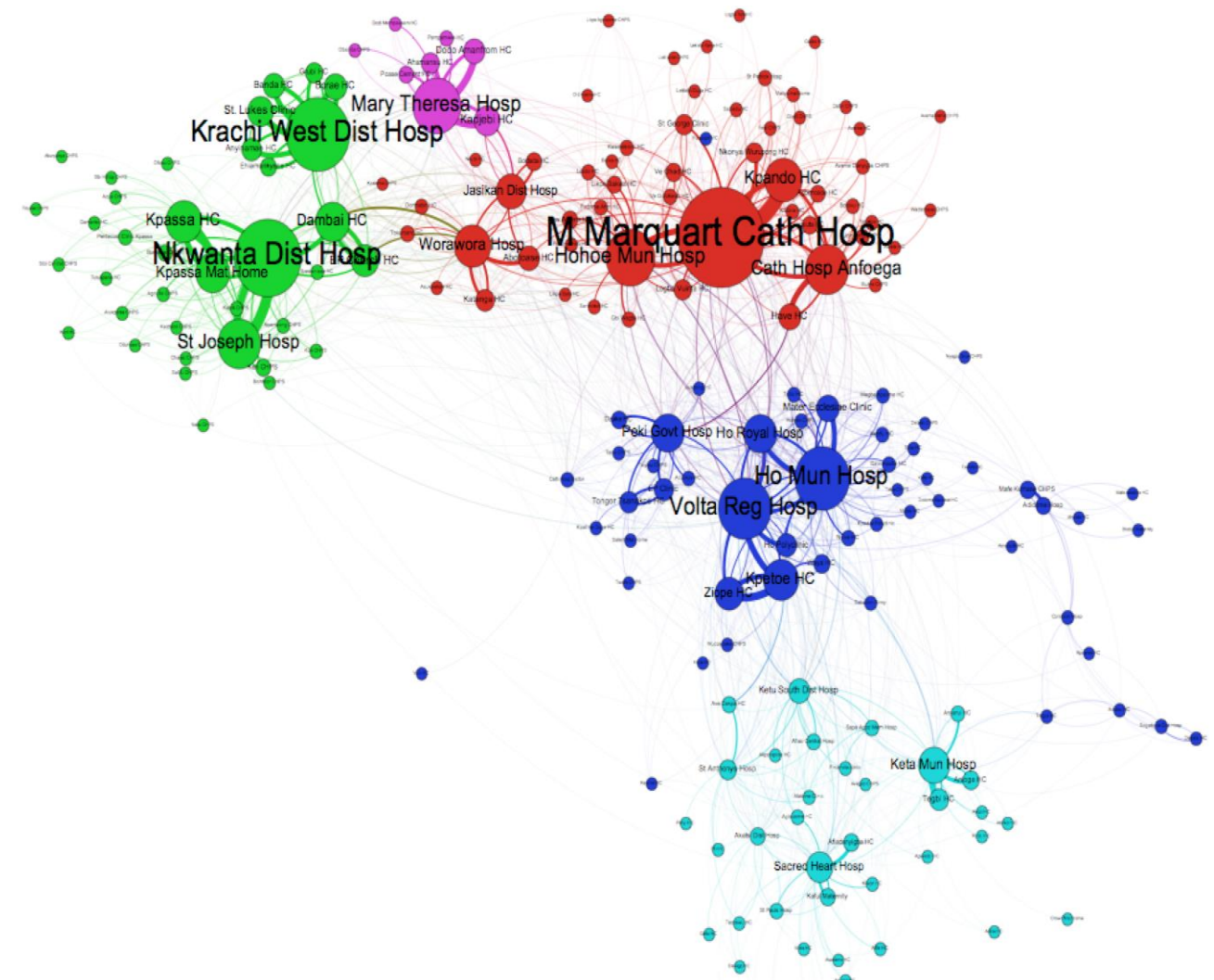


Table 4.11: Top twenty providers in the client network sharing during ANC and delivery in the Volta Region, 2013

Provider	In-Degree	Out-Degree	Weighted In-Degree*	Weighted Out-Degree**	Closeness Centrality	Betweenness Centrality	Eigenvector Centrality
M Marquart Cath Hosp	56	53	946	514	0.55	0.14	0.96
Nkwanta Dist Hosp	40	39	605	479	0.52	0.13	0.62
Krachi West Dist Hosp	18	19	450	568	0.45	0.04	0.34
Ho Mun Hosp	51	50	485	366	0.56	0.16	0.90
Volta Reg Hosp	49	41	569	243	0.53	0.10	1.00
Hohoe Mun Hosp	43	45	452	287	0.54	0.11	0.86
Mary Theresa Hosp	26	22	478	241	0.46	0.04	0.52
Cath Hosp Anfoega	38	32	405	219	0.48	0.08	0.78
St Joseph Hosp	36	30	380	238	0.44	0.07	0.44
Kpando HC	20	24	138	379	0.44	0.02	0.42
Worawora Hosp	26	20	315	181	0.44	0.03	0.60
Kpassa HC	17	15	208	281	0.39	0.02	0.18
Kpetoe HC	16	18	147	326	0.43	0.02	0.37
Kpassa Mat Home	13	10	241	210	0.38	0.01	0.21
Dambai HC	16	20	170	280	0.46	0.02	0.36
Ho Royal Hosp	29	30	231	198	0.50	0.04	0.66
Peki Govt Hosp	33	29	272	152	0.49	0.06	0.72
Keta Mun Hosp	31	16	299	94	0.39	0.05	0.61
Jasikan Dist Hosp	29	25	226	147	0.48	0.03	0.65
Ziope HC	10	11	164	176	0.40	0.00	0.22
EP Church HC	12	20	138	184	0.48	0.01	0.29
Sacred Heart Hosp	32	21	228	74	0.46	0.09	0.61
St. Lukes Clinic	8	7	171	120	0.35	0.00	0.09
Kadjebi HC	14	18	94	196	0.48	0.02	0.40
Mater Ecclesiae Clinic	16	22	72	161	0.47	0.01	0.46

* Number of in-coming client visits ** number of out-going client visits

4.4.2 Fragmentation during Delivery

Figure 4.5 shows the extent of care fragmentation during delivery in the Volta Region of Ghana. This network diagram is based on the 26% (3,769) of the pregnant women that changed their most frequent ANC facility during delivery to help visualize the extent of the fragmentation during delivery. The source node represents the most frequent ANC facility for the woman and the target (destination) node represents the facility where she had her delivery. Once again, all the facilities were connected to one another in the network with 97 strongly and 2 weakly connected components. There were 742 links between 190 facilities with each facility sharing an average of 20 pregnant women with 4 facilities. The network had a density of 0.021 and a diameter of 6. The top five central facilities that shared the most pregnant women during delivery were; Margaret Marquart Catholic Hospital (438), Ho Municipal Hospital (391), Volta Regional Hospital (381), Hohoe Municipal Hospital (342) and Nkwanta District Hospital (300) as shown in table 4.13. On the average, 123 pregnant women who had their most ANC from other facilities, moved to deliver in a hospital, compared to Maternity Homes (15.4), Clinic (13.8), HC (3.5), Polyclinic (0.5) and CHPS (0.2). On the average, 37 pregnant women who had their most ANC at hospitals “moved” out to other facilities to deliver compared to Polyclinic (31), Clinic (28.4), HC (19.8), Maternity Homes (14.4) and CHPS (7.1). This shows that for each hospital, an average of 123 pregnant women would move from their most frequent ANC provider to deliver in the hospital compared to 37 pregnant women who had the hospital as their most frequent ANC provider going to deliver at other facilities. In addition, for each health centre, about 4 pregnant women would move from their most ANC provider to deliver at a health centre while 20 women who attended the health centre for most part of their ANC would also go and deliver at other

facilities. This result indicates that if a pregnant woman were to move from her most frequent ANC provider to deliver elsewhere, she would most likely go to a hospital as compared to other facilities. Apart from the hospitals and the maternity homes, all the other types of providers have more pregnant women moving from their facilities to other providers compared to in-coming pregnant women.

An analysis of the proportion of pregnant women that had their most ANC from a given facility (“potential deliveries”) and actually delivered at the facility to help determine the providers whose antenatal women were more likely to “move out” to deliver at other facilities was undertaken. The results show that, the proportion of “potential deliveries” that move out from the index facility to deliver at other facilities varies by facilities. Seventy eight (78) health facilities including (Ho Polyclinic, Bonakye CHPS, Gbi Wegbe HC, Agbozome HC, Ve Golokwati HC and Adzokoe HC) had the highest proportion with all (100%) of the “potential deliveries” moving out to deliver at other facilities. These facilities included 42 health centres, 29 CHPS, 4 clinics, 2 maternity homes and a polyclinic. Together, these facilities account for 483 of the “potential deliveries” that moved out. This was followed by Santrokofi HC (95.5%) and Dodo Amanfrom Health Centre (94.4%) of the proportion of “potential deliveries” moving out to deliver at other facilities. This shows that for every woman that had her most ANC and delivered at the Dodo Amanfrom Health Centre for example, about 17 women that also had their most ANC at the facility would go and deliver at other facilities. The facilities with the highest proportion of “potential deliveries” going to deliver elsewhere included: Botoku HC (83.3), Ave Dakpa HC (81.8), Kwamekrom HC (81.3), Abotoase HC (80.0) and Afiadenyigba HC (79.7). Those with the lowest proportion include: St Patrick Hospital (0.0), St Anthonys Hospital (1.9), Battor Catholic Hospital (2.0), Sape Agbo Memorial Hospital (2.0), Comboni Hospital (3.2) and

Ketu South Municipal Hospital (4.4). This shows that every woman that had her most ANC from the St Patrick hospital, delivered at the hospital. So if a woman had her most ANC at the St Patrick Hospital, St Anthonys Hospital or Battor Catholic Hospital for example, she would most likely deliver there as compared to other facilities. In addition, if a woman had her most ANC at Dodo Amanfrom Health Centre, there is a 94.4% chance that she would most likely not deliver there. However, Dormabin HC had the highest proportion of women that moved to other facilities for CS. The facilities with the highest proportion of CS movement include: Dormabin HC (57.1), Agbenoxoe HC (45.0), Aflao Central Hospital (42.1) and New Ayoma HC (40.9).

In accordance with the CHPS policy, 91% of the women that attended CHPS compounds as their regular ANC facilities, moved from their index CHPS compounds to other facilities for delivery, while 55% moved from their index health centres to other facilities and 10%, moved from hospitals to other facilities for delivery services. The health centres and the hospitals are the biggest contributors of the fragmentation in the region, accounting for 57% (2,154) and 26% (965) respectively of all the women that moved to other facilities for delivery services. Most of the potential deliveries that went to other facilities to deliver had vaginal delivery. The proportion of the “potential deliveries” that moved for CS delivery was about 18.5% (696) overall (table 4.12). A greater proportion (84.6%) of the women that moved from their regular ANC provider to deliver, went to hospitals, as compared to health centres (10.2%), maternity homes (2.0%), clinics (2.9%) and CHPS (0.2%). The details of the movement during delivery for each facility that had more than 5 deliveries are presented in appendix A1

Table 4.12: Movement of pregnant women among facilities during delivery, Volta Region, 2013

Moved from	Moved to							% of fragmentation	PD* moved out (%)	Moved out for CS n(%)	Moved to deliver at new place n(%)**
	CHPS n(%)	Clinic n(%)	Health Centre n(%)	Hospital n(%)	Maternity Home n(%)	Poly clinic n(%)	Total				
CHPS	1 (0.4)	1 (0.4)	18 (6.3)	259 (90.9)	6 (2.1)		285 (100)	7.6	90.5	42(14.7)	149 (52.3)
Clinic			27 (11.6)	201 (86.6)	4 (1.7)		232 (100)	6.2	75.1	42(18.1)	133 (57.3)
Health Centre		59 (2.7)	125 (5.8)	1913 (88.8)	57 (2.6)		2154 (100)	57.2	55.2	396(18.4)	1273 (59.1)
Hospital	6 (0.6)	50 (5.2)	192 (19.9)	706 (73.2)	10 (1)	1 (0.1)	965 (100)	25.6	9.9	203(21.0)	528 (54.7)
Maternity Home			21 (29.2)	51 (70.8)			72 (100)	1.9	44.4	8(11.1)	38 (52.8)
Polyclinic			1 (1.6)	60 (98.4)			61 (100)	1.6	87.1	5(8.2)	26 (42.6)
Total	7 (0.2)	110 (2.9)	384 (10.2)	3190 (84.6)	77 (2)	1 (0)	3769 (100)	100	26.0	696(18.5)	2147 (57)

* PD – Potential deliveries

** Delivered at facility where they never received ANC services from

Figure 4.5: Provider Client sharing network during delivery

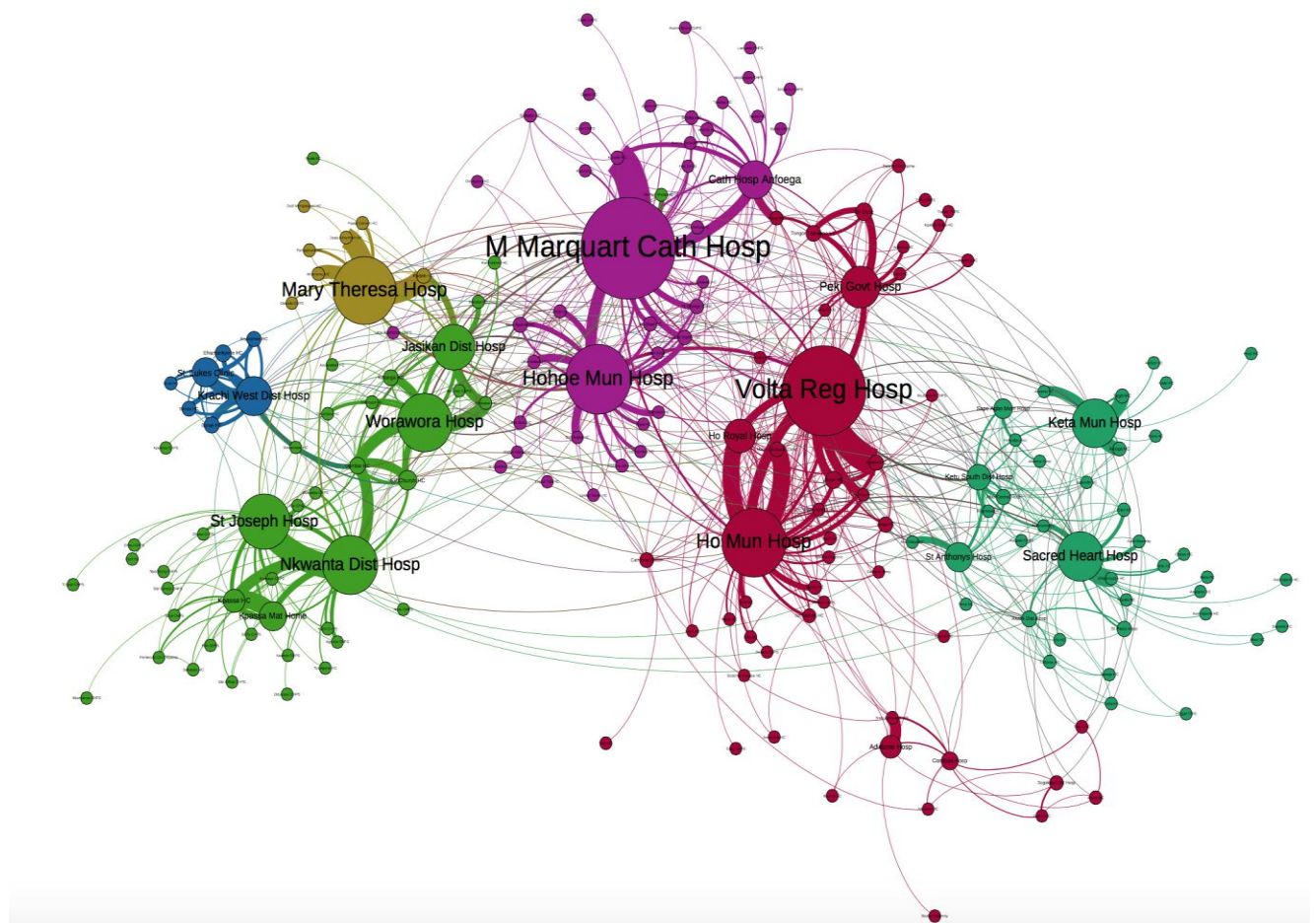


Table 4.13: Network characteristics of providers with the highest weighted degree during delivery in the Volta Region, 2013

Provider	In-Degree	Out-Degree	Weighted In-Degree*	Weighted Out-Degree**	Closeness Centrality	Betweenness Centrality	Eigenvector Centrality	Prop (%) of potential del – moving ***	Prop moving out for CS (%)
M Marquart Cath Hosp	48	27	382	56	0.52	0.10	1.00	5.8	14.3
Ho Mun Hosp	38	27	241	150	0.54	0.11	0.87	13.9	24.0
Volta Reg Hosp	41	23	332	49	0.51	0.08	0.98	5.3	16.3
Hohoe Mun Hosp	39	25	245	97	0.52	0.09	0.91	11.7	33.0
Nkwanta Dist Hosp	27	13	199	101	0.46	0.06	0.33	27.9	10.9
Mary Theresa Hosp	17	11	236	24	0.42	0.03	0.46	7.9	29.2
Worawora Hosp	20	5	197	29	0.40	0.01	0.65	13.2	27.6
Krachi West Dist Hosp	14	16	114	102	0.44	0.05	0.17	16.9	2.9
St Joseph Hosp	34	4	183	21	0.39	0.04	0.42	15.0	19.1
Jasikan Dist Hosp	28	16	141	48	0.46	0.04	0.76	13.0	16.7
Keta Mun Hosp	23	7	155	17	0.37	0.03	0.61	4.4	17.7
Sacred Heart Hosp	33	10	158	14	0.35	0.06	0.76	4.4	0.0
Peki Govt Hosp	26	13	125	40	0.44	0.05	0.62	10.7	32.5
Dambai HC	6	12	17	145	0.43	0.01	0.16	66.2	17.9
Cath Hosp Anfoega	23	11	109	52	0.44	0.03	0.52	12.4	25.0
Kpassa HC	11	4	45	107	0.36	0.01	0.06	43.5	9.4
Ho Royal Hosp	20	13	90	48	0.48	0.02	0.66	14.1	27.1
Kpetoe HC	8	6	12	123	0.38	0.00	0.37	46.4	20.3
Kpando HC	3	9	4	128	0.39	0.01	0.19	58.7	18.0
Kpassa Mat Home	6	5	71	51	0.36	0.00	0.05	38.6	11.8
Kadjebi HC	4	10	10	101	0.45	0.01	0.25	44.7	29.7
Mater Ecclesiae Clinic	6	10	9	96	0.42	0.00	0.36	54.6	13.6
Ketu South Dist Hosp	19	10	55	44	0.44	0.03	0.56	4.4	40.9
Abotoase HC	1	12	2	96	0.46	0.00	0.06	80.0	26.0
St. Lukes Clinic	6	4	71	23	0.33	0.00	0.04	37.1	34.8
EP Church HC	2	12	30	62	0.45	0.00	0.09	48.1	19.4
St Anthonys Hosp	26	4	71	4	0.35	0.02	0.68	1.9	25.0

* Number of in-coming clients ** number of out-going clients *** proportion of the potential deliveries that went to other providers to deliver

4.4.2.1 Fragmentation during Delivery at New Places

Figures 4.6 and 4.7 show the extent of fragmentation for those women that delivered at facilities that they never attended during the ANC period. There were 179 facilities and 537 links in the network with 105 strongly and 1 weakly connected components. Averagely, each facility shared about 12 pregnant women (average weighted degree) with 3 facilities (average degree). The colour of the node indicates the community (figure 4.6) that the facility belongs to (modularity) or the type of facility (figure 4.7), while the size of the node indicates the number of client shared (weighted degree) and the weight of the edge indicates the number of pregnant women shared. The network graph had a density of 0.017, and a diameter of 9. The top five central facilities by the number of client shared (weighted degree) included: Ho Municipal Hospital, Volta Regional Hospital, Hohoe Municipal Hospital, Margaret Marquart Catholic Hospital, and Worawora Hospital as shown in table 4.14. The results shows that 19.0% (231) of all the pregnant women that delivered at the Volta Regional Hospital never received ANC from the Hospital but only visited the hospital for delivery. This proportion varies according to facilities with Worawora hospital having the highest proportion of first time visit deliveries of 34.0% (132). This is followed by St. Joseph hospital (25.2%), Sacred Heart hospital (23.8%), Jasikan District hospital (22.8%) and Nkwanta District hospital (20.9) as shown in table 4.14 with the average proportion of new delivery per hospital estimated at 18.7%. Ho Municipal hospital had 105 pregnant women who had their most ANC services from the hospital but delivered at other health facilities that they never visited during ANC. This is the highest number of women moving from their regular ANC provider to deliver at a facility they never visited during ANC. Most of these women from Ho Municipal hospital went to Ho Royal Hospital and the Regional Hospital for delivery.

Averagely, hospitals had the highest number of people coming there to deliver on their first visit (72) compared to health centre (2), clinic (4), maternity home (6) and polyclinic (1).

Figure 4.6: Communities in the provider network for delivery at a new provider.

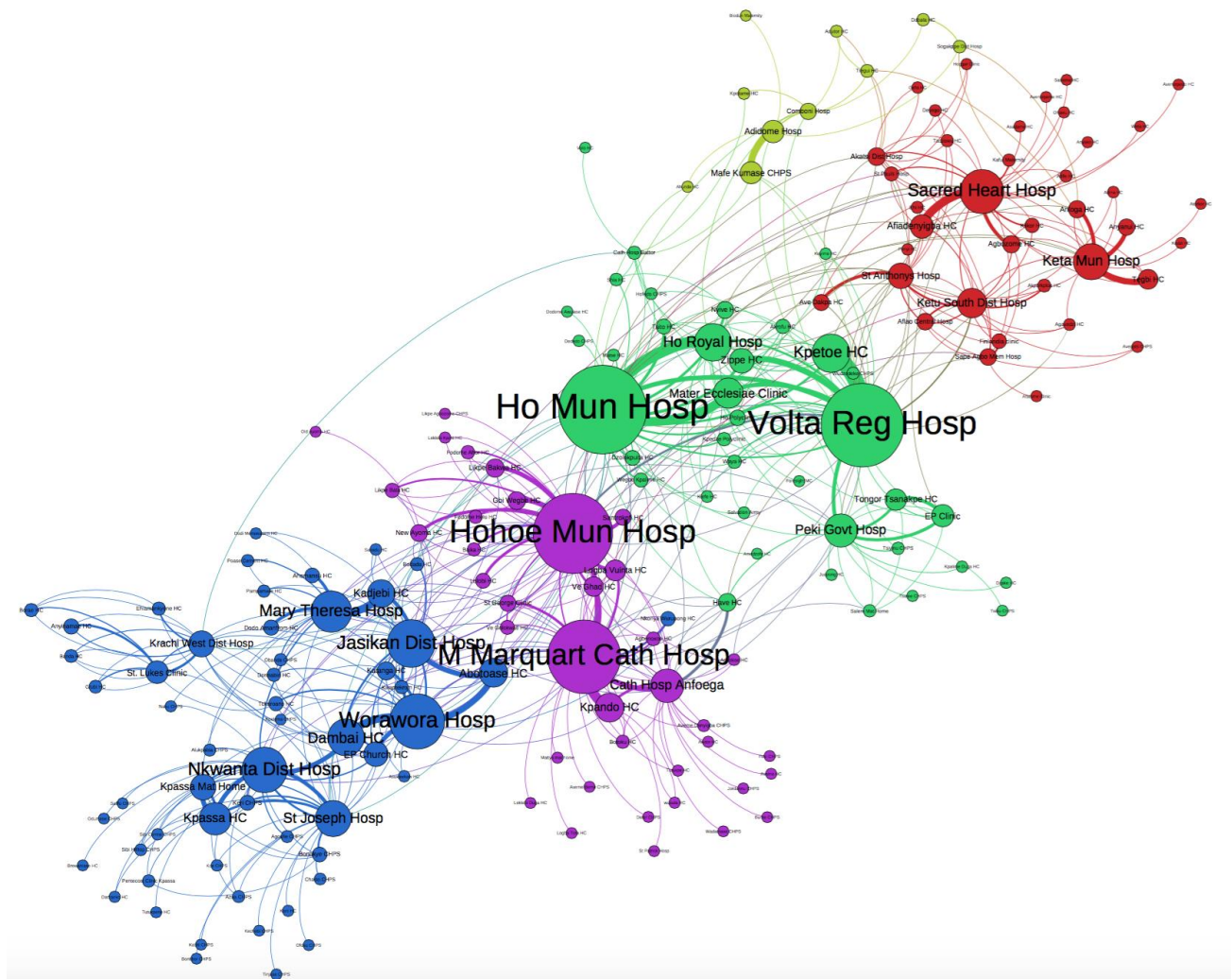


Table 4.14: Network characteristics of the providers with the highest number of pregnant women delivering at facility they did not visit during ANC, 2013

Provider	In-Degree	Out-Degree	Weighted In-Degree*	Weighted Out-Degree**	Closeness Centrality	Betweenness Centrality	Eigenvector Centrality	Deliveries	Prop of new deliveries (%)
Ho Mun Hosp	31	22	169	105	0.53	0.15	0.82	1172	14.4
Volta Reg Hosp	33	15	231	25	0.46	0.08	0.89	1215	19.0
Hohoe Mun Hosp	30	21	182	62	0.50	0.12	0.95	973	18.7
M Marquart Cath Hosp	32	14	194	27	0.43	0.08	1.00	1293	15.0
Worawora Hosp	16	5	132	24	0.38	0.02	0.59	388	34.0
Jasikan Dist Hosp	23	11	105	25	0.42	0.04	0.74	461	22.8
Nkwanta Dist Hosp	21	5	96	26	0.36	0.04	0.37	460	20.9
Sacred Heart Hosp	26	6	110	7	0.29	0.05	0.59	463	23.8
Mary Theresa Hosp	14	5	95	12	0.37	0.02	0.39	517	18.4
Kpetoe HC	6	5	8	89	0.37	0.00	0.30	154	5.2
Ho Royal Hosp	16	10	72	22	0.42	0.03	0.62	383	18.8
Dambai HC	3	10	8	84	0.39	0.02	0.14	91	8.8
Keta Mun Hosp	15	4	80	9	0.27	0.03	0.39	523	15.3
St Joseph Hosp	25	4	76	13	0.37	0.04	0.39	302	25.2
Cath Hosp Anfoega	18	7	50	30	0.41	0.03	0.61	476	10.5
Peki Govt Hosp	14	9	52	27	0.41	0.03	0.26	459	11.3
Kpassa HC	8	3	23	53	0.30	0.01	0.07	184	12.5
Mater Ecclesiae Clinic	5	5	5	63	0.37	0.00	0.38	89	5.6
Ketu South Dist Hosp	14	6	36	30	0.34	0.02	0.45	1019	3.5
Kpando HC	1	7	2	62	0.34	0.01	0.12	94	2.1
Abotoase HC	1	7	2	61	0.41	0.00	0.07	26	7.7
Kadjebi HC	3	7	3	57	0.39	0.00	0.26	135	2.2
Krachi West Dist Hosp	10	12	20	34	0.36	0.04	0.18	616	3.3
Kpassa Mat Home	4	5	26	27	0.34	0.00	0.02	152	17.1
St Anthonys Hosp	18	3	49	3	0.34	0.03	0.51	281	17.4

* Number of in-coming clients ** number of out-going clients

4.4.2.2 During Cesarean Section Delivery

Figures 4.8 and 4.9 show the connectivity of various providers during C-section delivery. This network represents the 31.9% (696) of the clients that had CS and delivered at facilities other than their regular ANC provider. There were 132 facilities and 267 links between facilities with each facility sharing an average of 5 clients (average weighted degree) with 2 other facilities (degree). The colour of the nodes in figure 4.8 indicates the community that the facility belongs to (modularity) and figure 4.9 indicates the type of facility, while the size of the node indicates the number of clients shared (weighted degree) and the edge weight indicates the number of pregnant women shared. The top five central facilities by number of clients shared were: Margaret Marquart Catholic Hospital, Volta Regional Hospital, Ho Municipal Hospital, Hohoe Municipal Hospital and Worawora Hospital as shown in table 4.15. Margaret Marquart Catholic Hospital had the highest number of pregnant women (123) who had their most ANC services from other facilities but came there to deliver by CS. This was followed by the Volta Regional Hospital (98), Worawora Hospital (52) and Mary Theresa Hospital (48). The facilities where women had their most ANC from but moved (weighted out-degree) to have CS from other facilities include; Ho Municipal Hospital (36), Hohoe Municipal Hospital (32), Kadjebi HC (30), Dambai HC (26), Kpetoe HC (25), Abotoase HC (25) etc. The results from table 4.15 show that a large proportion of the women that had CS, did not get it from their regular ANC provider. For example, about 70% of all the women that had CS at the Worawora Hospital actually had their most ANC from other facilities while 41% actually never had ANC from the hospital. In addition, 34% of all CS delivery at the Regional Hospital had their most ANC from other facilities while 25% never attended ANC at the Regional Hospital. The proportion of women that had CS at a facility they never attended during ANC was very high for most hospitals. These

were; Jasikan District hospital (38%), St Anthony, Nkwanta District and St Joseph hospitals (33%) each, and Peki Government hospital (30%). Facilities with the low proportion of CS delivery on first visit (delivery at a facility they did not visit during ANC) were Krachi West District Hospital, Aflao Central Hospital and Ketu South Municipal Hospital. The proportion of women who had CS in facilities other than their regular ANC provider was 31.9% while those that had CS from facilities they never attended during ANC was 19.5%. Figure 4.10 shows the network diagram for client sharing for CS delivery at new facilities.

Figure 4.8: Provider network during C-section delivery by network communities

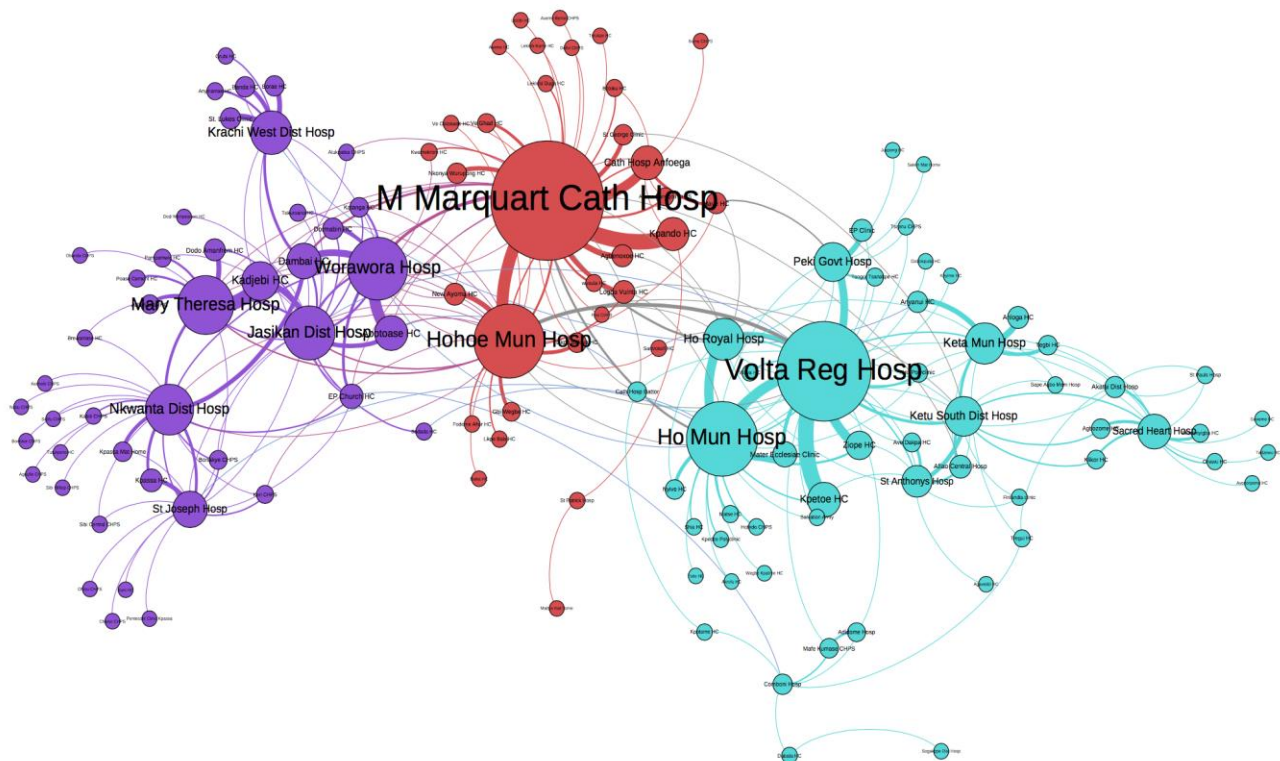


Figure 4.9: Provider network during C-section delivery by provider type

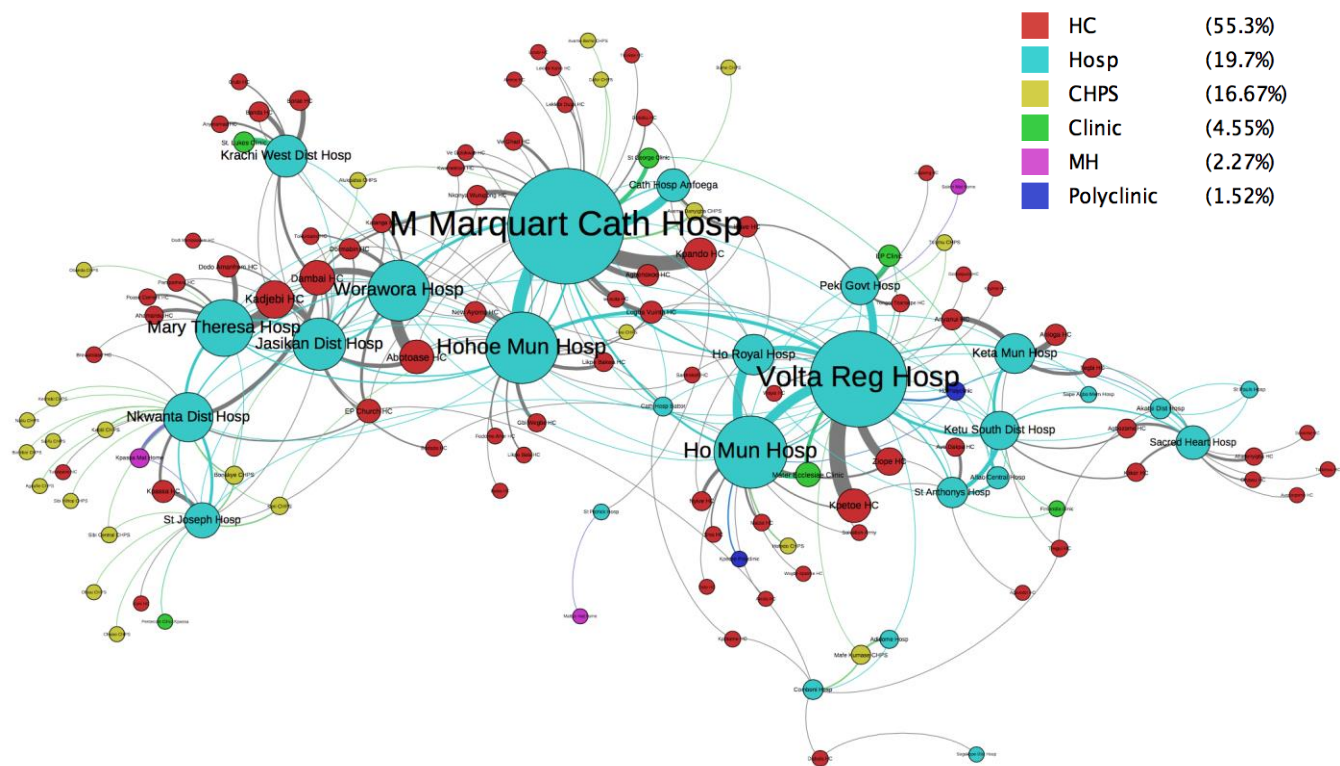


Figure 4.10: Provider network during C-section at new facility

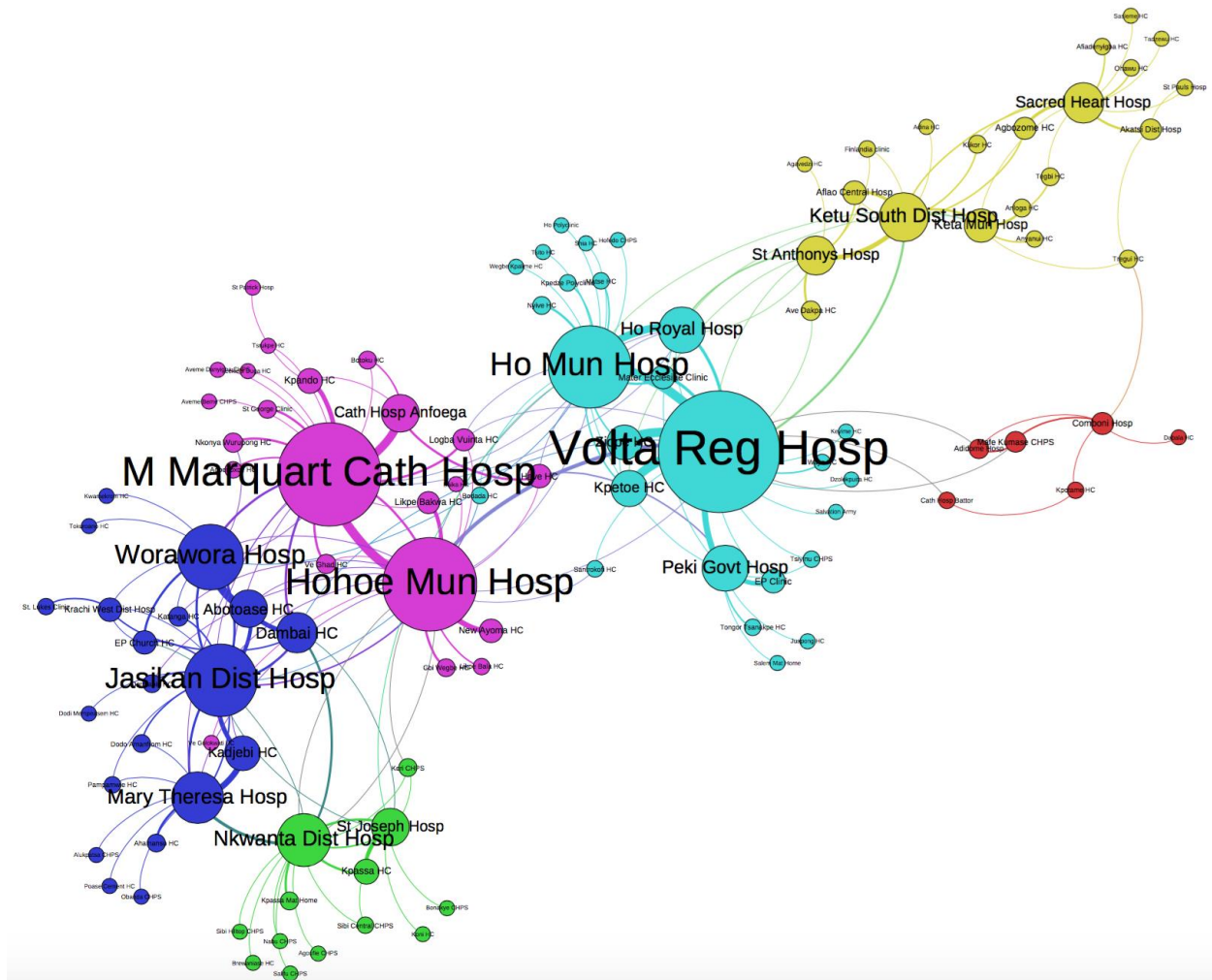


Table 4.15: Network characteristics of facilities involved in CS Delivery in the Volta Region, 2013

Provider	In-Degree	Out-Degree	Weighted In-Degree*	Weighted Out-Degree**	Closeness Centrality	Betweenness Centrality	Eigenvector Centrality	Total CS deliveries	Proportion of CS from others	CS for first time visit	Proportion of first time CS***
M Marquart Cath Hospital	34	6	123	8	0.45	0.03	1.00	353	34.8	60	17.0
Volta Reg Hospital	22	7	98	8	0.56	0.04	0.75	286	34.3	72	25.2
Ho Mun Hospital	19	8	39	36	0.59	0.03	0.27	202	19.3	23	11.4
Hohoe Mun Hospital	23	9	42	32	0.61	0.05	0.92	144	29.2	36	25.0
Worawora Hospital	16	3	52	8	0.42	0.01	0.79	74	70.3	30	40.5
Mary Theresa Hospital	11	5	48	7	0.47	0.01	0.40	84	57.1	22	26.2
Jasikan Dist Hospital	17	5	41	8	0.51	0.01	0.54	93	44.1	35	37.6
Nkwanta Dist Hospital	18	4	34	11	0.44	0.01	0.28	61	55.7	20	32.8
Krachi West Dist Hospital	9	3	33	3	0.37	0.01	0.02	134	24.6	5	3.7
Ho Royal Hospital	9	4	21	13	0.46	0.01	0.76	118	17.8	15	12.7
Keta Mun Hospital	8	3	30	3	0.40	0.00	0.37	89	33.7	13	14.6
Ketu South Dist Hospital	8	6	13	18	0.46	0.01	0.41	157	8.3	10	6.4
Kadjebi HC	0	5	0	30	0.45	0.00	0.00	-	-	-	-
Peki Govt Hospital	7	3	17	13	0.44	0.00	0.08	43	39.5	13	30.2
St Joseph Hospital	13	3	23	4	0.44	0.01	0.18	39	59.0	13	33.3
Dambai HC	0	6	0	26	0.46	0.00	0.00	-	-	-	-
Abotoase HC	0	5	0	25	0.44	0.00	0.00	-	-	-	-
Kpetoe HC	0	3	0	25	0.44	0.00	0.00	-	-	-	-
Sacred Heart Hospital	13	0	25	0	0.00	0.00	0.35	74	33.8	19	25.7
Cath Hospital Anfoega	7	1	11	13	0.32	0.00	0.42	41	26.8	6	14.6
Kpando HC	0	3	0	23	0.34	0.00	0.00	-	-	-	-
St Anthonys Hospital	9	1	20	1	0.32	0.00	0.46	51	39.2	17	33.3
Ziope HC	0	3	0	17	0.44	0.00	0.00	-	-	-	-
Mater Ecclesiae Clinic	0	2	0	13	0.43	0.00	0.00	-	-	-	-
EP Church HC	0	7	0	12	0.49	0.00	0.00	-	-	-	-
Aflao Central Hospital	2	3	2	8	0.34	0.00	0.30	17	11.8	1	5.9
Kpassa HC	0	2	0	10	0.34	0.00	0.00	-	-	-	-

* Number of in-coming clients ** number of out-going clients *** Proportion that delivered at new place by CS

Table 4.16: Summary table for the extent of fragmentation among providers

Number	Network Diagram	Summary of Key Message
1	Figure 4.4	This visualizes the fragmentation during the entire ANC and Delivery period. It shows there are about five communities that share patients with each other and communities are centred on key hospitals. These communities follow the geographical pattern in the region.
2	Figure 4.5	This visualizes the fragmentation during delivery. It shows that hospitals are the central facilities during deliveries with patients moving from their regular ANC providers to hospital for delivery.
3	Figure 4.6 and Figure 4.7	These show the fragmentation during delivery for those that delivered at facilities that they did not visit during their ANC period. Like figure 4.5, hospitals are the central facilities for those that delivered at facilities they never visited during ANC.
4	Figure 4.8 and Figure 4.9	These show the fragmentation during delivery for those that delivered by CS. For those that fragmented their care during CS delivery, most of them came from the health centres. There were others that also moved from hospitals to other hospitals for CS.
5	Figure 4.10	This shows the combination of those that delivered by CS at facilities that they never visited during ANC. Hospitals in Ho, Kpando, Hohoe and Jasikan are more central to CS delivery in this network.

4.5 Extent of Care Fragmentation among Districts

Nine percent (8.9) of all subsequent visits during ANC and delivery, 12.7% (1,838) of all deliveries and 20% (436) of all CS deliveries were fragmented across districts. Among those with multiple providers, 30.5% (45.6% CS and 27.7% VD) were fragmented across districts. In addition, 51.6% (1,108) of all deliveries performed at facilities that the pregnant women never received ANC services from were fragmented across districts. About thirteen (12.8) percent of CS and 8% of all deliveries were performed at districts that the women never received ANC services from. Table 4.18 provides summary of the key messages from the various figures among districts.

4.5.1 Fragmentation during Entire ANC and Delivery Visits

Figure 4.11 shows the extent of care fragmentation among districts during ANC and delivery visits by pregnant women in the Volta Region. This network diagram is based on the 9% of the clients' movement (subsequent visits) across districts that were "fragmented". The network graph had a density of 0.45 with each district sharing an average of 206 client visits (average weighted degree) with an average of 11 (average degree) other districts. Kpando Municipal shared more client visits than the rest of the districts. It had 621 in-coming visits (weighted in-degree) from other districts and 487 out-going visits (weighted out-degree) to other districts as shown in table 4.17. Kpando Municipal mostly received visits from Biakoye, Hohoe, Afadjato South and North Dayi as shown in figure 4.11. Ho Municipal also mostly shared client visits with Agortime, South Dayi, Ho West and Adaklu. Krachi West and Krachi Nchumuru mostly shared clients with each other while Nkwanta South mostly shared clients with Krachi East and

Nkwanta North. Apart from Kpando Municipal, the next districts that share more clients were; Ho Municipal, Krachi West, Krachi Nchumuru and Nkwanta South Districts. Ho Municipal shared clients with 22 others district as compared to 15 by Kpando (degree). There is high sharing of clients between Krachi Nchumuru and Krachi West with little sharing between these two districts and the rest of the districts in the region. A comparison between figure 3.2 and figure 4.11 shows that districts that are closer to each other share more pregnant women compared to distant districts. For example, the following districts share boundaries and share more clients: Krachi Nchumuru and Krachi West; Nkwanta North, Nkwanta South and Krachi East; Kpando, Hohoe, Biakoye, Jasikan, Afadjato and North Dayi; Ho, Ho West, Adaklu and South Dayi.

Figure 4.11: Client sharing among districts during ANC and delivery in the Volta Region, 2013

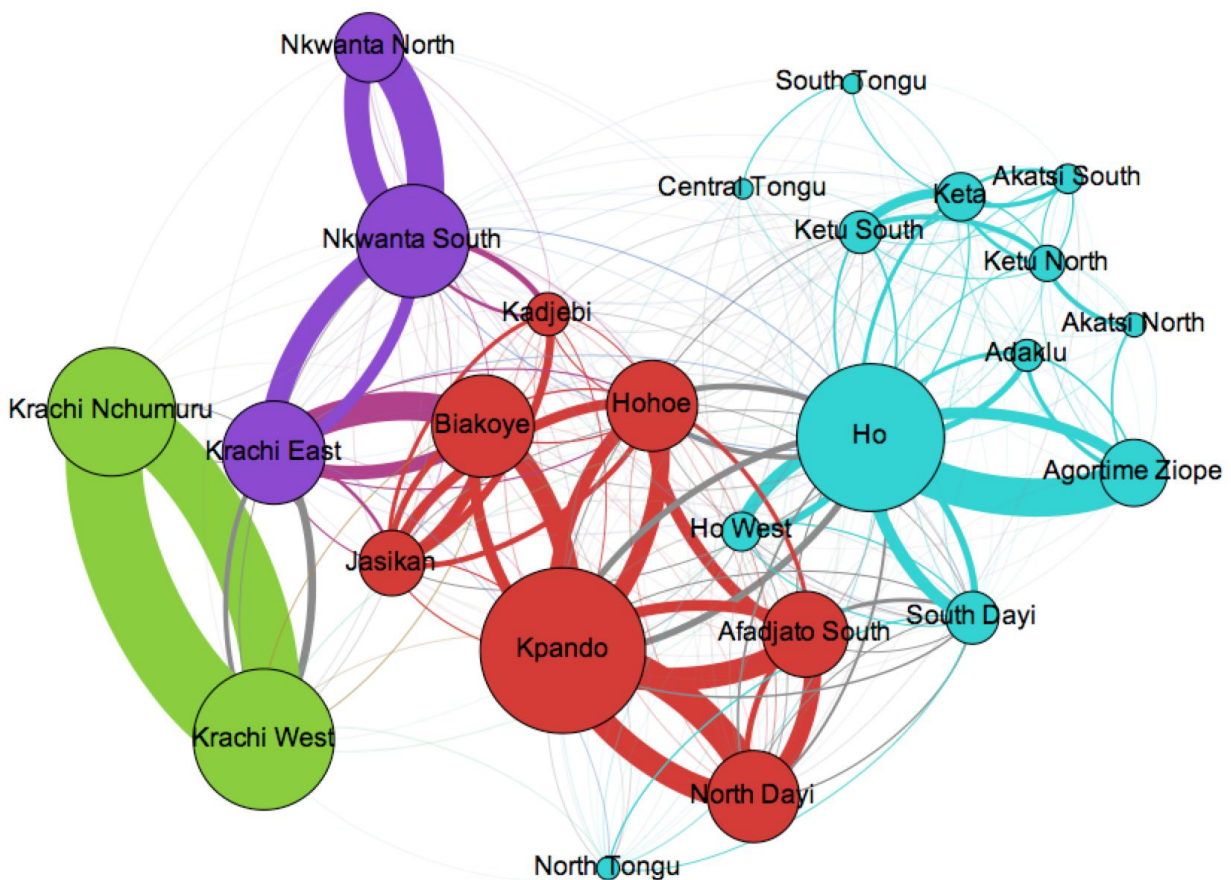


Table 4.17: Characteristics of District-Client Sharing During ANC and Delivery in the Volta Region, 2013

District	Visits						Delivery		C-Section		First visit delivery		CS delivery on first visit		% delivery on first visit	% of potential del – moving out	Prop moving out for CS (%)	Prop of CS from others (%)	Prop of first visit CS (%)
	In-Degree	Out-Degree	Weighted in-degree	Weighted out-degree	Closeness Centrality	Betweenness Centrality	Weighted in-degree	Weighted out-degree	Weighted in-degree	Weighted out-degree	Weighted in-degree	Weighted out-degree	Weighted in-degree	Weighted out-degree					
Adaklu	6	5	61	60	0.53	0.01	5	23	0	5	1	15	0	3	2.9	43.4	21.7	-	-
Afadjato South	10	15	151	369	0.73	0.02	12	207	0	39	8	108	0	22	6.7	65.9	18.8	-	-
Agortime Ziope	8	10	91	290	0.6	0.02	8	171	0	49	7	136	0	31	3.3	45.2	28.7	-	-
Akatsi North	4	7	21	40	0.59	0.01	1	25	0	4	1	17	0	4	14.3	80.6	16.0	-	-
Akatsi South	9	7	49	54	0.57	0.01	16	34	2	9	12	20	1	5	6.7	17.2	26.5	9.1	4.5
Biakoye	12	13	324	318	0.69	0.02	129	148	26	32	100	80	16	18	23.5	33.3	21.6	35.1	21.6
Central Tongu	7	7	13	21	0.57	0.01	6	14	2	4	4	12	1	4	3.5	11.6	28.6	18.2	9.1
Ho	22	21	599	377	0.89	0.14	322	116	91	21	257	51	69	11	8.8	4.3	18.1	15.0	11.4
Ho West	8	6	68	106	0.56	0.00	18	50	0	5	7	39	0	4	11.9	54.9	10.0	-	-
Hohoe	12	16	300	258	0.75	0.02	123	99	30	34	83	64	25	22	7.7	9.4	34.3	20.8	17.4
Jasikan	11	10	206	164	0.62	0.01	132	71	39	17	101	47	34	15	18.4	14.5	23.9	41.9	36.6
Kadjebi	14	12	96	108	0.67	0.03	42	50	11	22	23	34	8	16	3.3	7.0	44.0	13.1	9.5
Keta	16	12	165	78	0.67	0.05	95	34	25	5	68	20	19	2	6.3	3.3	14.7	15.3	11.7
Ketu North	11	6	105	47	0.55	0.02	66	19	20	4	45	17	17	4	14.8	7.4	21.1	39.2	33.3
Ketu South	14	13	71	128	0.69	0.03	29	69	6	26	13	59	0	23	1.1	5.5	37.7	3.3	0.0
Kpando	15	15	621	487	0.73	0.03	255	88	94	10	144	42	51	5	10.2	7.1	11.4	26.1	14.2
Krachi East	11	14	225	423	0.71	0.03	29	213	0	48	11	141	0	32	3.6	43.4	22.5	-	-
Krachi Nchumuru	4	7	476	357	0.59	0.00	51	89		28	18	15	0	2	5.6	24.6	31.5	-	-
Krachi West	8	8	410	517	0.60	0.01	117	59	36	2	22	24	5	2	3.4	10.1	5.1	26.9	3.7
Nkwanta North	6	8	161	237	0.60	0.00	12	101	0	22	7	60	0	16	2.0	22.9	21.8	-	-
Nkwanta South	15	18	416	304	0.80	0.06	169	42	33	15	97	25	21	10	12.6	6.5	35.7	33.0	21.0
North Dayi	14	10	340	225	0.63	0.02	120	49	8	19	43	32	4	14	8.6	11.4	38.8	19.5	9.8
North Tongu	12	9	31	24	0.62	0.03	15	8	4	1	6	4	2	1	1.4	1.9	12.5	6.6	3.3
South Dayi	16	15	126	149	0.73	0.05	44	56	4	14	12	43	3	13	2.0	9.1	25.0	9.3	7.0
South Tongu	5	6	24	9	0.55	0.00	22	3	5	1	18	3	4	1	14.4	2.8	33.3	35.7	28.6
Total	270	270	5,150	5,150	-	-	1,838	1,838	436	436	1,108	1,108	280	280	7.7	12.7	23.8	20.0	12.8

4.5.2 Fragmentation during Delivery

Figure 4.12 shows the extent of care fragmentation during delivery. About 13% (1,838) of the women delivered in a district other than the district where they had their most antenatal care. Ho municipal and Kpando municipal had the highest number (322 and 255 respectively) of women coming from other districts to deliver in their districts. Generally, the structure of the network diagram during delivery is similar to the network structure during the entire ANC and delivery period. The proportion of “potential deliveries” that move out from a given district to deliver at other districts varies. Akatsi North district had the highest proportion (80.6%) of “potential deliveries” moving out to deliver in other districts. Other districts with high proportion moving out for delivery services include: Afadjato South (65.9%), Ho West (54.9%), Agortime Ziope (45.2%), Krachi East (43.4%) and Adaklu (43.4%) and as shown in figure 4.13. Most of the districts with high proportion of women moving out to deliver in other districts did not have hospitals. These include Akatsi North, Afadjato South, Ho West, Agortime Ziope, Adaklu and Krachi East.

Figure 4.14 visualizes the extent of care fragmentation during CS delivery while figure 4.15 visualizes the extent of care fragmentation for those that had CS at facilities that they never received ANC services from. About 437 representing 20% of all those who had CS, delivered in a district other than where they had their most antenatal care. Kpando Municipal and Ho Municipal had the highest number (94 and 91 respectively) of clients coming from other districts for CS delivery (table 4.17). Most of the clients that moved from other districts to deliver in the Kpando Municipal were from Biakoye, Hohoe, Afadjato South and North Dayi and those that

moved to the Ho municipal were mostly from Agortime Ziope, South Dayi and Ho West. The network graphs (figure 4.14 and 4.15) clearly show more women move from Agortime Ziope where they had their regular ANC to Ho Municipality for CS services and most of the times they only visit the municipality for delivery services. That is, they never visit a facility in the municipality for ANC services prior to the delivery. Again there is high movement from Krachi Nchumuru to Krachi West and Nkwanta North to Nkwanta South for CS delivery. There were also high movements from Krachi East to Biakoye for delivery on first visit (figure 4.15).

Figure 4.12: Client sharing among districts during delivery in the Volta Region, 2013

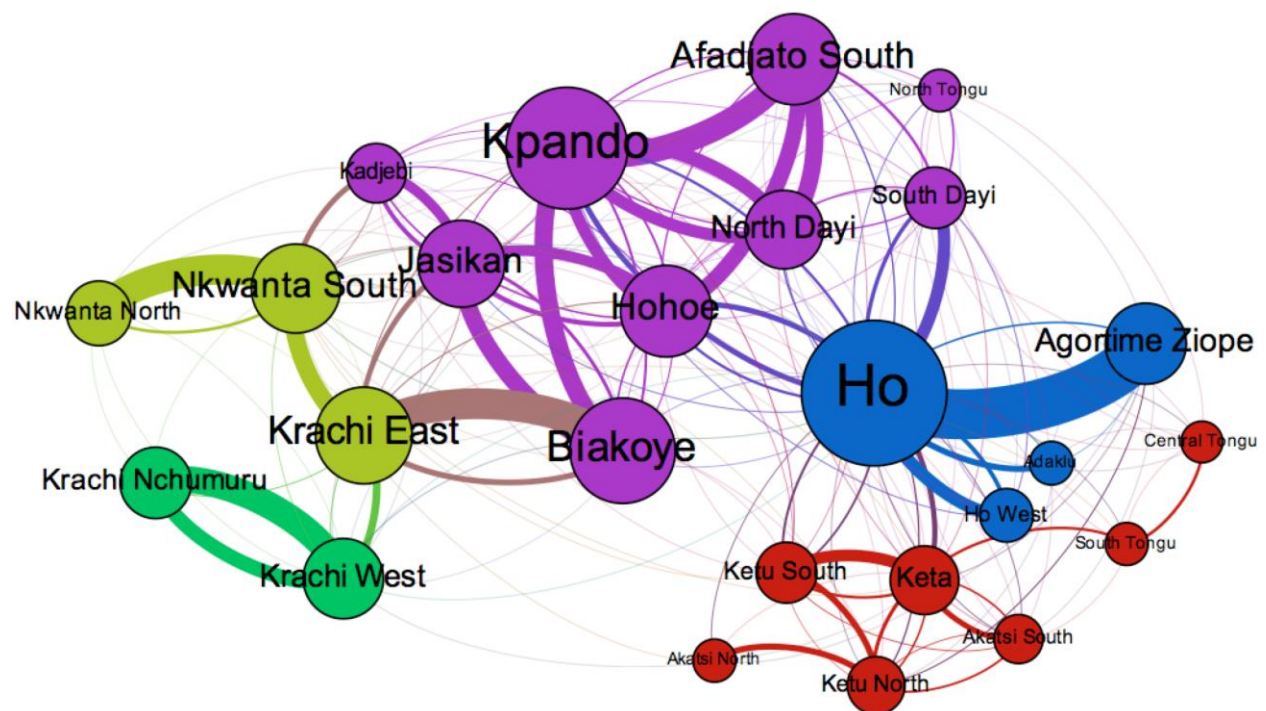


Figure 4.13: Proportion of “potential deliveries” going to deliver in other districts

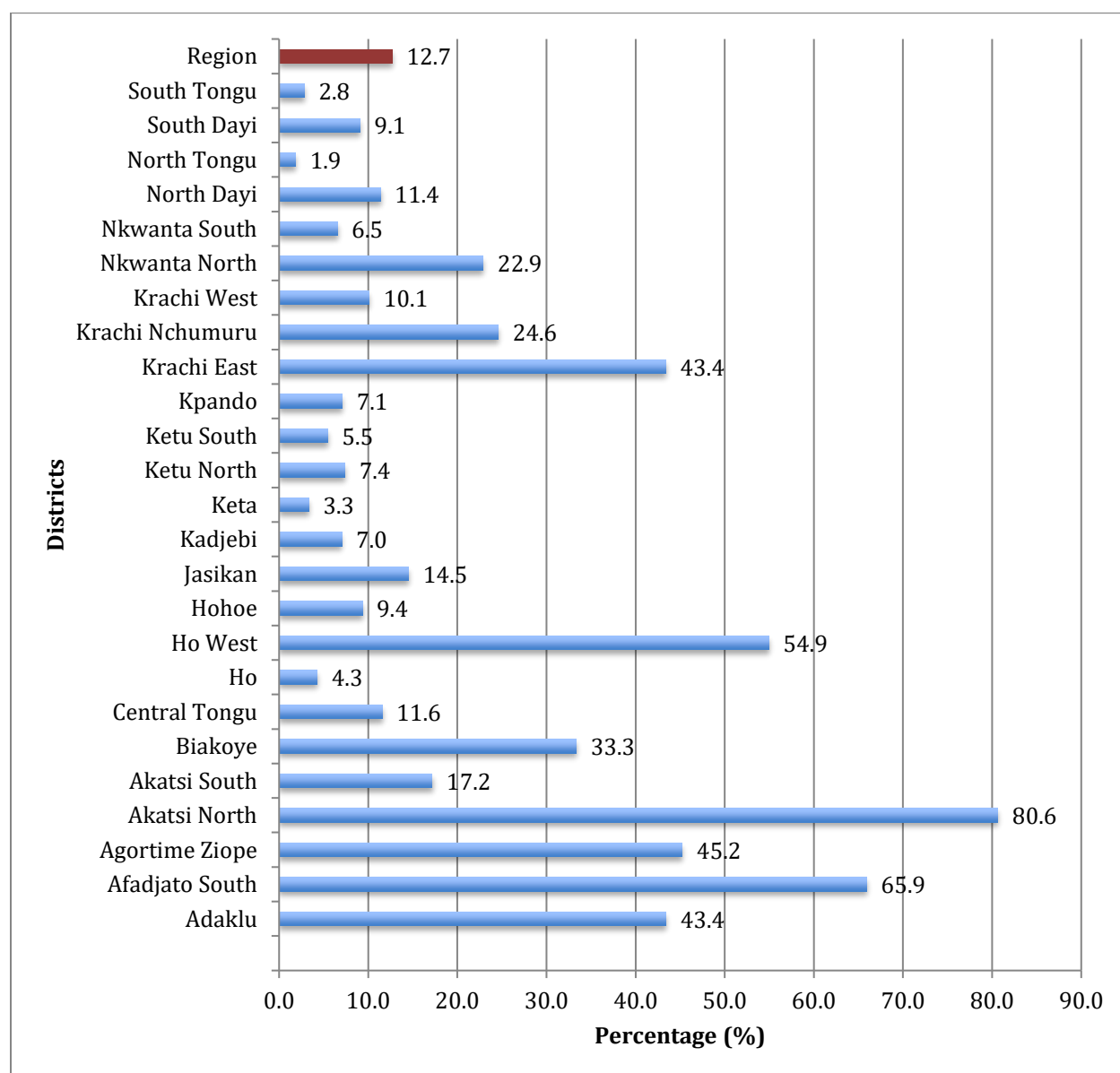


Figure 4.14: Client sharing among districts during CS Delivery

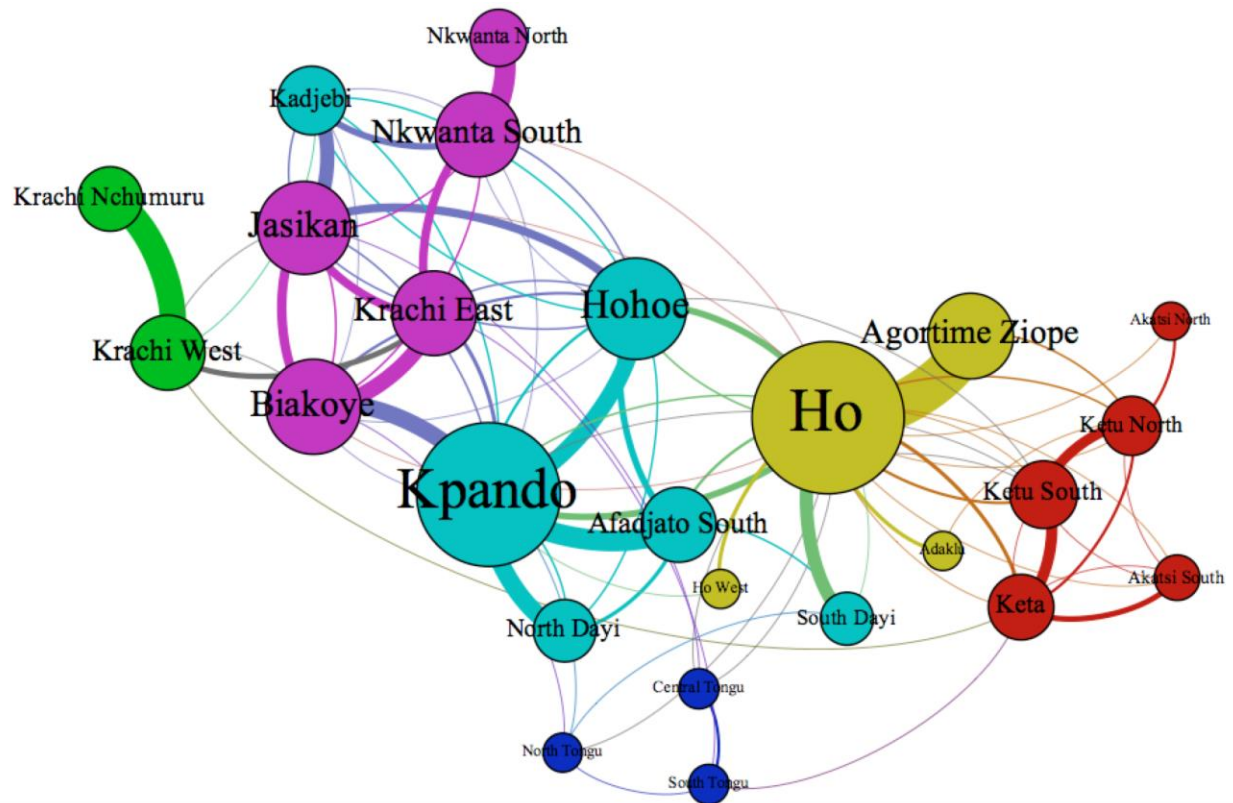


Figure 4.15: Client sharing among districts during Delivery at New Place (on first visit)

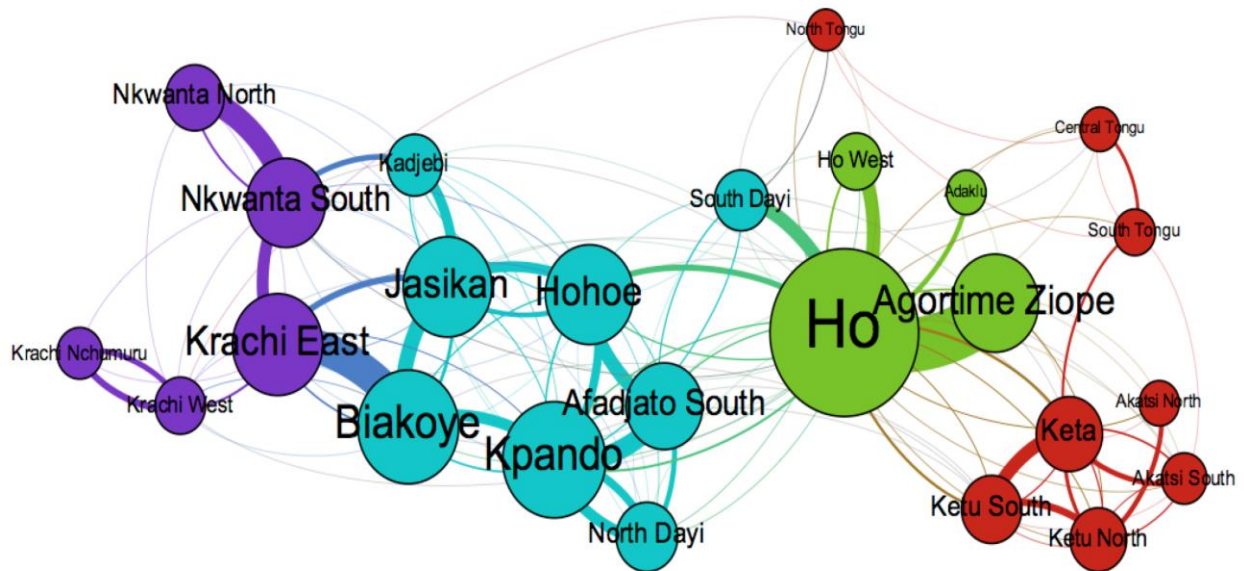


Table 4.18: Summary of the extent of fragmentation

Number	Network Diagram	Summary of Key Message
1	Figure 4.11	Geographically closer districts tend to share more clients compared to distant districts. Kpando, Ho Municipal, Nkwanta South, Krachi West are more central districts in the sharing of pregnant women during ANC and delivery. Krachi West and Krachi Nchumuru shares more patients compared to any pair of districts.
2	Figure 4.12	There are five communities in the sharing of pregnant women by districts. The biggest community is centred on Kpando District. However Ho Municipal and Kpando are the most central districts during delivery.
3	Figure 4.14	Ho Municipal and Kpando district are the most central districts during CS delivery. More women move from Agortime Ziope to Ho and from Krachi Nchumuru to Krachi West for CS delivery compared to all the other districts.
4	Figure 4.15	There are four community of districts that share pregnant women that deliver at facilities they did not receive ANC services from. A high number of women from Agortime Ziope go to Ho, Krachi East to Biakoye, Nkwanta North to Nkwanta South, and Afadjato South to Kpando to deliver on their first visit compared to the other districts.

Chapter 5: Discussion

5.0 Introduction

Maternal mortality has over the years remained a global health issue with most of the deaths occurring in sub-Saharan Africa (WHO et al., 2015). Many of these deaths according to the experts can be prevented with appropriate prenatal care with skilled providers and supervised deliveries (Say et al., 2014). Therefore skilled ANC attendance and skilled (facility) delivery have become key global indicators for measuring the coverage of maternal health programmes across the world. The World Health Organization, until recently had recommended a minimum of 4 antenatal visits for pregnant women with no medical condition and whose pregnancies were progressing smoothly (World Health Organization, 2002). This has since been updated to a minimum of 8 ANC contacts for a positive pregnancy experience (World Health Organization, 2016b). These contacts are expected to help prevent and address issues that may arise as a result of the pregnancy.

Ghana has over the years been improving on the skilled ANC attendance and delivery indicators with the 2014 GDHS showing that 87% of the pregnant women received the minimum of 4 ANC visits, an increase from the 69% in 2003 while skilled delivery increased from 46% in 2003 to 74% in 2014 (Ghana Statistical Service et al., 2015). However, what remained unanswered was whether these ANC visits were made to several providers or to a single provider. In addition, it was unclear whether some pregnant women change their regular ANC providers during delivery, considering that labour and delivery constitute a critical point in the fight against maternal mortality since complications during delivery account for most of the maternal deaths in Ghana.

Addressing these issues, this study used national health insurance claims data and measured the extent of longitudinal CoC with reference to the pregnant women (extent of repeat visits made) and the care providers (extent of repeat visits received). Additionally, it also measured the extent of care fragmentation (the extent to which an individual spread her care) among care facilities and across districts in the Volta Region. Such analysis that makes use of the available routine health insurance claims data can greatly add value to the current monitoring of skilled antenatal and delivery in the country and help estimate utilization and proportion of women making the minimum of 8 ANC visits as recommended by the WHO. Knowing the extent of repeat follow up visits to the same or different care providers will contribute to our understanding of the dynamics of health seeking behaviour during pregnancy and childbirth. This novel approach of using social network analysis to measure the extent of care fragmentation can also contribute to identifying the key central facilities to the provision of ANC and delivery services in the region and strengthening them. Additionally such studies can also help to monitor adherence to policy on ANC and delivery by CHPS compound and Health Centres. Below are the key findings from the study.

Using 5 CoC indices, the study revealed that 58% of all the pregnant women had perfect CoC: maintaining only one provider throughout ANC and delivery. There were medium to high levels of CoC during pregnancy among the various CoC indices. In addition, 32% of all the women and 78% of those that had multiple providers, had less than three quarters of the visits to their most frequently visited provider. Cesarean Section delivery rate was 15% and varies across districts (range 7.1 to 25.6%).

The average proportion of repeat visits to providers (provider continuity) in the region was 67% and varies across the districts and by type of provider. Average proportion of repeat visits to providers in a district (district continuity) was 81% for the region and varies by districts. Although hospitals constituted 13% of the providers in the study, they accounted for 73% of all visits and 83% of all deliveries.

About 19% of all subsequent visits during ANC and delivery, 26% of all deliveries and 32% of all CS deliveries were fragmented across providers. Among those with multiple providers, 62.5% of all deliveries (72.5% CS and 60.7% VD) were fragmented across providers. In addition, 15% of all deliveries (35.4% among those with multiple providers) and 20% of all CS deliveries (44.3% among those with multiple providers) were performed at facilities that the pregnant women did not receive ANC services from.

Nearly 9% of all subsequent visits during ANC and delivery, 13% of all deliveries and 20% of all CS deliveries, 30.5% (45.6% CS and 27.7% VD) of all deliveries by women with multiple providers were fragmented across districts. In addition, 51.6% (1,108) of all deliveries performed at facilities that the pregnant women never received ANC services from were fragmented across districts.

5.1 Continuity of Care

The study found relatively medium to high levels of CoC indices (MFPC: 0.82 ± 0.25 ; MMCI: 0.86 ± 0.20 ; COC: 0.76 ± 0.30 ; SECON: 0.80 ± 0.28 ; PDC: 0.68 ± 0.41) among pregnant women with 58% of the women having perfect continuity of care. Compared to the other indices, place

of delivery continuity of care (PDC) had the lowest score, an indication that, more pregnant women switched providers during delivery. The results of the study are comparable to other studies that measured CoC indices using claims data for other conditions that require regular follow up visits with providers. Chan et al, (2012) found high CoC indices (0.56 to 0.90) at the facility level and low to high (0.37 to 0.78) at the individual physician level among patients with chronic conditions. Pollack et al., (2015) also found perfect CoC among patients with chronic conditions at the practice group level to be between about 23% and 46% while Dreiherr et al., (2012) found high CoC indices (“UPC: 0.75; MMCI: 0.81; COC: 0.67; SECON: 0.70”) in primary care setting among adults in a health insurance programme with 36% having perfect continuity.

Continuity of care indices in this study were also found to be different from what have been reported elsewhere. Low levels of CoC have been reported among antenatal women with lower proportion having CoC score above 50%: 24% of antenatal women in Brussels (Beeckman et al., 2010); 26% in Brussels and 30% in the Netherlands (Vanden Broeck et al., 2016). Meur et al., (2015) also reported CoC score of 43% among pregnant women in France while Cheng, Chen, & Hou, (2010) also found CoC levels between 28% and 36% among health insurance beneficiaries in Taiwan. These studies, however, measured CoC using a single physician or midwife as the provider as opposed to using the health facility as the provider in this study. The differences in the CoC score could therefore be due in part to the approach used, since it is difficult seeing the same physician or midwife during visits, compared to same facility. There is however, limited literature in the healthcare space measuring CoC during pregnancy at the level of the health facility or group practice.

This study also found strong association between the type of delivery and the various continuity of care indices, number of visits, number of providers visited and maternal age. Most frequent provider continuity (MFPC), MMCI and PDC were positively associated with vaginal delivery with the odds of vaginal delivery increasing for every unit increase in these indices. On the other hand; maternal age, number of visits, number of providers, CoC and SECON were negatively associated with vaginal delivery with the odds of vaginal delivery decreasing for every unit increase in these factors. These findings are consistent with other studies that found high continuity was associated with high spontaneous vaginal delivery and less CS delivery (Mclachlan et al., 2012; Sandall et al., 2013, 2016; Sandall, 2013; Waldenstrom & Turnbull, 1998; Wong et al., 2015). The results also agree with other findings that show advanced maternal age (Bayou, Mashalla, & Thupayagale-Tshweneagae, 2016; Gordon, Milberg, Daling, & Hickok, 1991; Yoshioka-Maeda, Ota, Ganchimeg, Kuroda, & Mori, 2016) and higher number of prenatal visits (Carter et al., 2016) were associated with CS delivery.

It was also found that, while hospitals account for 13% of all the facilities included in the study, they account for 73% of all visits and 83% of all deliveries in the study. This could be an indication that most of the pregnant women prefer to go to hospitals for ANC and delivery services. This is further supported by the fact that for those pregnant women that changed their usual ANC providers during delivery, most (85%) left their usual providers to hospitals to deliver. This preference is supported by findings from Dako-Gyeke et al., (2013) where participants from a focus group discussion said for safety, especially when complication arises, it was good to deliver in the hospital. These women rightly view the hospitals as the safest place to go for delivery as compared to the other type of providers. Kruk et al., (2009) also found

preference for hospital and Mission Facility delivery compared to primary care facilities located closer to the respondents in Tanzania. They found that “more than 40% of women who chose to deliver in health facilities in a poor, rural district of Tanzania bypassed their nearest health facility, choosing to deliver at the government hospital or mission facilities”. Ngo & Hill, (2011) also found high preference for hospital delivery in Vietnam with 57% of the women delivering at district and provincial hospitals. Again Kruk et al., (2017) found that “Quality of basic maternal care functions was substantially lower in primary than secondary care facilities” in five African countries (Kenya, Namibia, Rwanda, Tanzania, and Uganda) with poor quality being associated with low delivery volume. Poor quality of the ANC and delivery care at these primary care facilities is the key reason why women prefer hospitals.

It is to be expected by the structure of the healthcare system in Ghana, that hospitals would be safer since they are relatively more equipped and better staffed as compared to the others. The fact that most pregnant women prefer to go to hospitals for antenatal and delivery services is an indication that it takes more than geographical access to get pregnant women to use the CHPS compounds and the health centres for antenatal services. It is known that most of these lower level health facilities are not adequately equipped and staffed with the appropriate midwives and nurses to provide skilled ANC and delivery (in the case of health centres) services. The absence of key staff at these lower level facilities means they do not have the capacity to provide the needed ANC and delivery services and therefore more women would go to the hospitals that are relatively capacitated to provide these services.

The results also reveal that only 50% of the women had made the recommended minimum number of 4 ANC visits. This is far below the national average of 87% reported by the 2014 GDHS. However, this could be due in part to differences in the approach. The GDHS is a survey of representative sample of Ghanaians, and uses self-reported measures, so the participants are able to indicate all the various places that they sought ANC and delivery care within the limits of response bias. This study on the other hand uses the ANC visits records of the pregnant women who were duly registered with NHIS to determine the number of visits made and the providers visited. This approach has the tendency to omit visits that were made to non-accredited NHIA providers and even where a visit was made to an accredited NHIS provider, a non-indication of a valid NHIS ID would exclude the visit from the study.

The study also found an average of 15% CS delivery rate in the region and this varies from as low as 7.2% to as high as 25.6% across the districts. This is comparable to the DHIMS II data for 2013 for the Volta Region that shows the CS delivery rate was 13.7%. The CS rate reported is consistent with the World Health Organization's recommendation of between 10% and 15% (World Health Organization, 2015). Betrán et al., (2016) in accessing the global trend of CS rates in 150 countries using the latest data, estimated that 18.6% of all births occur by CS. Zhang et al., (2016) also found the average CS rate in the Netherlands to be 15.6%. In Ethiopia, Bayou, Mashalla, & Thupayagale-Tshweneagae, (2016), found CS rate of 19.2% in Addis Ababa. In addition, the district rates of the CS delivery in this study were also consistent with the data from DHIMS II (figure 4.1). The slight differences could be due to the methodological issues. This study used pregnant women that had valid national health insurance, delivered with and made not less than three visits to an accredited NHIS provider. So women who delivered in a non-

accredited facility, had no NHIS ID, made less than 3 visits to skilled providers were excluded while these women were included in the GHS DHIMS II data.

5.2 Provider Continuity of care

The average proportion of visits of pregnant women that can be attributed to a provider out of all the visits made by those same women was not very high (67%) for all providers in the region. As in the study by Katz et al., (2004) that found 43% of the providers had a continuity score greater than 60%, this study also found that 36% of the providers had a continuity score greater than 60%. Katz et al., (2014) found the average CoC index for health facilities (physician integrated network clinics) to be between 67% and 77% in Canada. Frohlich et al., (2006) also measured provider continuity for each physician in two regions in Canada and found provider CoC to be 70%: (Winnipeg: 76% and Rural South: 71%) with rural physicians having lower scores compared to urban physicians. These works were undertaken in the health systems that encourage patients to have regular providers and as such are more likely to repeatedly visit the providers compared to Ghana where the patient can choose to change provider regularly.

The results show hospitals were more likely to get higher repeat visits by clients compared to the other provider types. It was also found that providers in the southern part of the region had higher continuity score than the rest of the region. This high score could be partly due to the fact that providers in that part of the region had low proportion of submitted reports (table 4.1). For example in the North Tongu District, only Battor Catholic Hospital consistently submitted reports for the various months while the rest of the other providers had very low proportion of

submitted reports. So all the additional visits to other providers by the women who visited Battor Catholic Hospital would not be included in the study since the other providers did not submit the reports. This then would seem as if the women that visited Battor Catholic Hospital did not visit any other provider, thus giving the hospital a high proportion of repeat visit. This same situation applies to other hospitals like Ketu South Municipal and Akatsi South District Hospitals. As expected, districts continuity of care scores were found to be consistently higher than the average provider continuity score for the providers in the districts. This is an indication that the districts as a whole are able to retain more pregnant women than the providers. To the best of my knowledge, this is one of the first study to measure district continuity of care which gives an indication of the extent to which a district collectively facilitates repeat visits to providers in the district.

5.3 Fragmentation of care

This study also set out to determine the extent of care fragmentation among providers and across districts. To the best of my knowledge, this is one of the first study to apply social network analysis to determine the extent of care fragmentation among providers and districts during pregnancy and delivery. Using NHIS claims data, this study constructed provider networks based on patient sharing during the entire ANC and during delivery period. Network metrics (weighted in-degree and weighted out-degree) were used not only to determine extent of care fragmentation, but the providers contributing to the fragmentation. This approach is able to identify the providers most influenced or contributing to the fragmentation as compared to methods that only measure the fragmentation (Frandsen et al., 2015; Liu & Yeung, 2013). The study found high level of care fragmentation among providers and across districts with a high

proportion (42%) of pregnant women having multiple providers during ANC and delivery. Fragmentation during delivery was especially higher among those that had CS compared to vaginal delivery (72.5% and 60.7% among those with multiple providers). Additionally, a high proportion of pregnant women delivered at facilities that they never visited or received any ANC services from. A key component of the continuity of maternity care is relational continuity which requires that a pregnant woman is delivered by a team of midwives or care professionals who are more familiar with her pregnancy and with whom she may have developed some mutual relationship with. Delivery at a facility that the woman never visited and by a team that is not familiar with the woman and her pregnancy could have serious implication for quality of care during delivery in the country. Evidence from Dako-Gyeke et al., (2013) shows that some pregnant women believe that receiving care from multiple providers “would be complementary to each other”. The result of high fragmented care from the study is consistent with what have been reported. Bourgeois, Olson, & Mandl, (2010) found 31% of patients were treated at 2 or more hospitals in Massachusetts while Raven et al., (2016) found that 61.1% of ED visits were fragmented (out-of-network) among Medicaid beneficiaries. Akeju et al., (2016) also found that 25% pregnant women in Nigeria fragmented their care (utilized multiple health facilities) during their pregnancy. However, other studies also show contrary results. Stulberg et al., (2016) found that 22% of patients with ectopic pregnancies had fragmented care across facilities and that those that fragmented their care were more likely to be Medicaid recipients. Using Medicare claims data from 2000-2010, Agha, Frandsen, & Rebitzer, (2017) also found between 69 to 78% care fragmentation among Medicare beneficiaries with the average number of providers between 9 and 12. Galanter et al., (2013) found 2 % of the patients in Chicago fragmented their care between five urban teaching hospitals in Chicago. There are a number of possible reasons for

these differences. The study by Stulberg et al., (2016) was under-powered with only a small sample having the ectopic pregnancies and this could explain some of the differences. The study by Agha, Frandsen, & Rebitzer, (2017) recorded very high fragmentation partly because of the duration of the data used (11 years). The likelihood that somebody may visit a different provider other than the primary care provider increases with time. Again Galanter et al., (2013) recorded low fragmentation because of the use of urban teaching hospitals with visits outside of these teaching hospitals not considered.

Relational continuity is found to be associated with improved delivery outcomes for pregnant women as it allows for interaction and better communication between the pregnant woman and the care providers, leading to the development of relationships of mutual trust (Cheng et al., 2011; Sandall, 2013; Sandall et al., 2016; Williams et al., 2010; Wong et al., 2015). As noted by Senah, (2003) and Ghana Statistical Service et al., (2015), complications during delivery account for most of the maternal deaths in Ghana, and as such greater emphasis need to be placed on labour and delivery as this period plays critical role in safe delivery during childbirth. It is therefore important that a pregnant woman is delivered by a team of midwives or care professionals who are more familiar with the woman and her pregnancy and one that she may have developed some mutual relationship with. Delivering at a facility that the woman never visited and by a team that do not know the woman could have serious implications for quality of care. This is coupled with the fact that medical records systems in Ghana are predominantly manual and fragmented as a result of the absence of an integrated electronic health records system. One can only imagine the implication of this fragmented care for a pregnant woman with a pre-existing condition or who is allergic to certain medication, but goes to deliver in a facility

that is not privy to her already existing condition or allergy and in the course of delivery aggravates her condition. This is even more so in cases of emergency when the pregnant women may visit the facility without their ANC booklets. This high fragmentation of care during pregnancy has implication for care coordination. High ANC visits alone may therefore not be enough to ensure quality ANC and delivery for pregnant women since it is possible to have high ANC attendance fragmented across several providers or fragmented at critical points in the pregnancy pathway. There is therefore the need to emphasize continuity and coordination of care along the pregnancy pathway. As noticed by Agha et al., (2017) and Elhauge, (2010), care provision often involves many providers and there is need for proper coordination to reduce fragmentation. However, pregnant women in Ghana currently are not required to have primary care providers during pregnancy. The absence of the primary care provider means there is no care professional responsible for coordinating the care that an individual pregnant woman receives. This can also lead to provider shopping and health insurance fraud (Dsane-Selby, 2013; National Health Insurance Authority, 2013b). As suggested by Elhauge, (2010) and Frandsen et al., (2015), the absence of a responsible provider coordinating the care across the various providers may “lead to suboptimal care, including important health care issues being inadequately addressed, poor patient outcomes, and unnecessary or even harmful services that ultimately both raise costs and degrade quality”. There is therefore the need for policy requiring patients (especially pregnant women) to have primary care providers who will be responsible and accountable for coordinating the care that a pregnant woman receives during pregnancy and delivery. This will ensure that the primary care provider gets feedback whenever a patient is referred. It is worthy to note that the NHIA as part of the capitation implementation, requires patients to have preferred primary care providers. However, this is limited to the 4 regions that

are currently implementing or piloting capitation rollout and covers only subscribers of the NHIS. However, there is need for a more holistic approach to this, since not every Ghanaian is enrolled onto the NHIS. The MoH need to formulate policies that require every patient in Ghana (not only NHIS subscribers) to have primary care providers. The Volta Region is one of the pilot regions for the capitation rollout. As part of the process, subscribers are required to choose their preferred primary care provider who will provide primary care services to the subscriber. This is expected to improve the CoC and reduce care fragmentation in the region.

This study measured longitudinal continuity and fragmentation using the health facility (group practice) as the provider as opposed to individual physician or midwife used in other studies. Group practice may therefore make it difficult for a pregnant woman to see the same midwife or clinician on every visit. Therefore high longitudinal continuity may not necessarily lead to development of trusting relationship (relational continuity) between the women and the clinician since the woman could meet different clinicians on each visit. The implication is that, even among those with perfect or high continuity, there could still be fragmentation during labour and delivery as the woman could meet different midwives in the delivery room that she never met during the ANC period. The group practice therefore may mask some of the fragmentations.

The study also found that geographically closer providers and districts were more likely to share patients compared to distant providers and districts. This is consistent with work done by Lee et al., (2011) that also show that geographically proximate providers were more likely to share patients. Additionally, districts with no hospitals were more likely to have higher levels of fragmentation: having more pregnant women (“potential deliveries”) moving to nearby districts

with hospitals for delivery services. Hospitals were more at the receiving end of the care fragmentation with more women moving to hospitals for delivery services. This was consistent with what was found by Lee et al., (2011) that hospitals takes patients from many other health facilities (high in-degree) but sends patients to few health facilities (low out-degree). Additionally, Gabrysch et al., (2011) in Zambia also found that, distance and the level of obstetric care that a facility provides, affects skilled delivery. The shorter the distance to the delivery facility and the higher the level of obstetric care, the more likely women would go for facility birth.

This study found that hospitals in general and in particular Margaret Marquart Catholic Hospital and the Volta Regional Hospital were among the most central healthcare facilities in the region that received pregnant women from other facilities during ANC and delivery. Margaret Marquart Catholic Hospital receives pregnant women from other healthcare providers throughout the ANC and delivery while the Regional Hospital was more likely to receive women during delivery.

According to the structure of the healthcare delivery in Ghana, health services in the district are supposed to be integrated with the district health administration coordinating the care delivery while the district hospital acts as the first referral point for the health centres and CHPS compounds in the district (Government of Ghana, 1996; Ministry of Health, 2016). It would therefore be expected that movements of pregnant women would be “vertical” along the hierarchy of the healthcare delivery system in a district. It was however, found that even in districts that have hospitals, there were still high proportions of the pregnant women going from the districts where they had their most ANC to deliver in other districts and in some cases even

in districts that they never received ANC services from. It may be understandable to find high proportions of women moving from districts that do not have hospitals to deliver in other districts with hospitals given the high preference for hospital delivery as indicated in the study. According to Dako-Gyeke et al., (2013), providers' impatience, long waiting time, insufficient time with provider and unfriendly attitude of staff are among some possible reasons why some pregnant women may move from one provider to the other. However, further investigations are needed to understand why there are a lot of fragmentation among providers, across districts and even among districts that have hospitals.

5.4 WHO recommendation on Midwife-led Continuity of care model

The World Health Organization's recommendations on the midwife-led continuity of care model requires that "a known midwife or small group of known midwives supports a woman throughout the antenatal, intrapartum and postnatal continuum" (World Health Organization, 2016b). This context-specific recommendation is applicable in settings with well-functioning midwifery programmes where there are adequate ANC and delivery infrastructure and capacity across all levels of the healthcare system. For example, Ghana's health policy requires that CHPS compounds do not undertake delivery services except in emergency cases (Ministry of Health, 2016). Therefore, even though they are located within the various communities and are geographically accessible, pregnant women who visit them for ANC services will have to move to higher level facilities during delivery. Similarly, CS is performed in advanced level facilities and as such health centres and other similar level facilities although allowed to undertake deliveries cannot undertake CS. As such, all women that require CS will have to be referred or move to hospitals for the CS. The results of this study show that, in line with the health policy,

almost all the women that attended CHPS compounds as their regular ANC facilities, moved to higher level facilities especially hospitals for delivery services. This is an indication that the policy is being followed. Likewise all the women that attended other facility types except hospitals as their regular ANC facilities, and required CS moved from their index facility to hospitals for CS delivery. However, the health centres, which are required to provide vaginal delivery services, and the hospitals were the biggest contributors to care fragmentation during delivery. It is common knowledge that most of the health centres do not have the requisite number and category of staff and resources to undertake delivery services. It may therefore not be surprising to see the health centres as the highest contributor to fragmentation during delivery. It is however not clear why a woman would attend a particular hospital as her regular ANC facility but chooses to deliver in a different hospital.

In the large health facilities especially hospitals, they may have team of midwives responsible for ANC and a different team at the labour ward responsible for deliveries, and periodically rotate the midwives. This makes it difficult if not impossible for the woman to be delivered by a known midwife that she had contact with during the ANC period. This situation is not technically different from the woman who delivers in a facility that she never attended during her ANC period. Therefore having a group of midwives in charge of ANC and another in charge of labour and delivery as is done in the case of the large health facilities is contrary to the midwife-led model and contributes to care fragmentation during delivery.

The implementation of the WHO recommendation requires a well-functioning maternal health care system at all levels of care delivery. This may be difficult to achieve in Ghana's current

healthcare system where lower-level facilities are not adequately staffed and equipped. Women who therefore attend these lower level facilities may therefore have to move to relatively advanced facilities especially hospitals for delivery services.

5.5 Evaluation of the Conceptual framework

As discussed in the conceptual framework in section 1.9, the number of visits, the number of providers visited, the number of visits to each provider and the sequence of the visits are key variables required for measuring the various CoC indices and determining fragmentation. As shown in the results, these were sufficient for measuring the levels of CoC and FoC. In this study, only maternal age was used as the individual level variable since the NHIS claims data only included age and sex as the individual level variables. The results show maternal age was associated with continuity and fragmentation of care. Other system factors discussed in the conceptual framework that were found to be associated with CoC and FoC included the type of delivery (CS deliveries were more fragmented), number of visits, and the availability of key staff at the facility. Geographic location (district) and level of the health facility were found to contribute to continuity and fragmentation with hospital having more repeat visits than the other facility types and district without hospital having more fragmentation during delivery.

Although this conceptual framework was designed to be used with health insurance claims data or administrative/medical records, it can also be adopted for survey data where participants can provide the number of visits made to each provider during the ANC and delivery. Adopting this for survey data can also help measure the extent to which a personal relationship (relational continuity) has been built between the pregnant woman and the care provider.

5.6 Limitations

This study has some limitations because of the use of secondary data. First, the results of the study may not be generalizable to the pregnant women in the region in general but only to those that sought care through the NHIS. This is because the study used health insurance claims data and as such included only pregnant women who had valid health insurance and accessed accredited health providers. In addition, visits to accredited providers for which NHIS ID were not indicated were also not included while women who sought ANC and delivery care in other facilities that were not accredited by the NHIA had no chance of being included in the study.

The second limitation is the low proportions of submitted reports by some of the health providers. This is particularly the case for providers in the southern part of the region, making it difficult to compare the result of the providers and districts in the southern part of the region to the rest of the providers and districts. For example, Battor Catholic and Ketu South Municipal Hospitals and their respective districts had exceptionally good provider/district continuity (repeat visits). The low reporting by the other providers in these districts could make the providers and the districts have high continuity and by extension low fragmentation. However, it is also entirely possible that these providers and their respective districts could indeed have high continuity and low fragmentation of care and not necessarily as a result of low reporting by the neighboring providers or districts. Nonetheless, more representative data from these districts are needed to ascertain the true levels of provider continuity and fragmentations among providers and across districts in the southern part of the region.

The third limitation is the absence of referral data. It may be that some pregnant women may have need for specialist services and as a result, were referred to other providers for those services. It is therefore possible that some of the multiple visits to different providers may be the results of referral services and not necessarily FoC. As part of addressing this limitation, fragmentation during delivery was defined to have a more stable measure in such a way to take care of situations where there may be the need for referral visits. For example, a visit sequence of AAAABA where the last provider is the provider of delivery would not be considered fragmented during delivery by the definition used in the study but would be if one considers the last two visits. Again a visit sequence of AAAABB would be considered fragmented in this study but would not be if one considers the last two visits.

The fourth limitation is the fact that some of the providers (especially lower level providers like the health centres and the CHPS compounds) did not specify the NHIS ID and GDRG codes all the times. Since this study needed to uniquely identify all women and their visits, the absence of the NHIS ID for some visits meant that those visits could not be linked to a unique person and were therefore not included. In addition, some providers did not appropriately use the right GDRG codes for some of the visits. This made it initially difficult to determine the visits that resulted in deliveries. This challenge was however, addressed by developing a scheme that used a combination of the procedure performed and diagnosis to identify deliveries (see section 3.6.1). Nevertheless, the inappropriate use of the GDRG codes and the non-use of unique NHIS ID could affect future works that may utilize the NHIA claims data if not corrected by the NHIA.

The fifth limitation is the absence of the maternal health/delivery outcomes in the NHIS claims data. The study could not therefore explore the relationship between continuity of care or fragmentation of care and maternal health outcomes.

Chapter 6: Conclusion and Recommendations

6.1 Conclusion

Despite the high levels of CoC among the pregnant women, there is also high fragmentation during the critical period of labour and delivery among those with multiple providers. Most of the health facilities are not able to retain the pregnant women who visit their facilities during ANC, resulting in care fragmentation. This situation seems to be made worse by the fact that there is high preference for hospital delivery. This preference has resulted in high levels of fragmentation of care during delivery among the various care providers (facilities) and across districts in the region and is even more profound in districts that have no hospitals with higher proportions of the women moving from these districts to other districts with hospitals for delivery services. Geographically closer facilities and districts shared more pregnant women than distant providers and districts. Additionally, some pregnant women (15%) delivered at facilities that they never visited or received any ANC services from. This high level of fragmented care during the critical period of delivery have serious consequence for the fight against maternal mortality considering the fact that most of the maternal deaths in Ghana occur during labour and delivery. There is therefore the need for concerted effort to ensure continuity and coordination of care throughout the ANC and delivery period and where women had to deliver in other facilities other than their regular ANC provider, there must be smooth transition of the care for the woman. This among others, calls for patients to have primary care providers who will be responsible and accountable for coordinating the care that an individual patient receives.

This study also demonstrates that using innovative tools like social network analysis (SNA), the NHIS claims data can be useful in understanding the healthcare delivery landscape in the country.

6.2 Recommendations

In view of the findings from the study, the following are recommended to the MoH, NHIA and GHS.

1. The high level of fragmentation among providers and across districts call for policy on continuity and care coordination in Ghana. The MoH and NHIA should provide policies that require a patient to have primary care provider responsible for coordinating the care that a patient receives to ensure continuity and reduce care fragmentation.
2. The NHIA should intensify monitoring and claims auditing to help providers comply with the appropriate use of the GDRG codes and the NHIS ID for all claims.
3. The MoH, GHS and NHIA should educate patients on the importance and benefits of continuity of care and why patients need to have and maintain primary care providers.

6.3 Contribution to Knowledge

Research work and published literature on continuity and fragmentation of care in the Africa is generally limited and virtually nonexistent for antenatal and delivery care. Considering the paucity of literature in the healthcare space, this study contributes to filling that gap, particularly:

1. To the best of my knowledge, this is one of the first study that measured the level of continuity and fragmentation of care in general and particularly during ANC and delivery in Ghana and thus contributes to filling the literature gap on continuity and fragmentation of care in Ghana.
2. This study has shown that there is medium to high CoC during pregnancy and that among those with multiple facilities there is generally greater fragmentation during delivery, and this was particularly higher for those that had CS delivery.
3. To the best of my knowledge, this is one of the first study to extend the concept of provider continuity (Katz et al., 2004) to a higher level by measuring district continuity which gives an indication of the extent to which a district collectively facilitates repeat visits to facilities and integration of care at the district level.
4. This study also adds to the literature, another continuity of care index (place of delivery continuity). This index measures the proportion of antenatal care (measured by visits) provided by the health facility where the pregnant woman delivered.
5. This study also uses a novel approach of social network analysis (SNA) to measure the extent of care fragmentation among facilities and across districts as against the approach where SNA is used to describe network metrics.

6.4 Future Research

This study has shown that there is the need for further work in Ghana to fully understand the extent of continuity and fragmentation of care in the country. It is recommended based on the findings from this research that the following areas should be considered in future studies:

1. Future studies should explore why some pregnant women change providers during ANC and particularly why some would leave their regular ANC providers and go to different providers for delivery services.
2. Considering the low reporting in the southern part of the region, further studies should consider using more representative data from providers to ascertain the levels of provider continuity and fragmentations among providers and across districts.
3. There is the need to investigate the extent to which continuity or care fragmentation contribute to delivery outcomes in Ghana, since studies elsewhere have shown a link between continuity of care and delivery outcomes.
4. Future studies should consider measuring continuity and fragmentation at the individual clinician level since measuring continuity and fragmentation at the facility level may mask some of the fragmentations.

References:

- Adei, D., Amankwah, E., & Sarfo Mireku, I. (2015). An Assessment of the National Health Insurance Scheme in the Sekyere South District, Ghana. *Current Research Journal of Social Sciences*, 7(3), 67–80.
- Agha, L., Frandsen, B. R., & Rebitzer, J. B. (2017). *Causes and Consequences of Fragmented Care Delivery: Theory, Evidence, and Public Policy* (NBER Working Paper No. w23078. No. w23078). Retrieved from <https://ssrn.com/abstract=2903779>
- Agyei-Baffour, P., Oppong, R., & Boateng, D. (2013). Knowledge , perceptions and expectations of capitation payment system in a health insurance setting : a repeated survey of clients and health providers in Kumasi , Ghana, 1–9.
- Agyemang, K. K., Adu-Gyamfi, A. B., & Afrakoma, M. (2013). Prospects and Challenges of Implementing a Sustainable National Health Insurance Scheme : The Case of the Cape Coast. *Developing Country Studies*, 3(12), 140–149.
- Agyepong, I. A., & Nagai, R. A. (2011). “ We charge them ; otherwise we cannot run the hospital ” front line workers , clients and health financing policy implementation gaps in Ghana. *Health Policy*, 99(3), 226–233. <https://doi.org/10.1016/j.healthpol.2010.09.018>
- Agyepong, I. A., & Yankah, B. (2012). Understanding the NHIS Provider Payment System and Capitation. *The Chronicle*. Retrieved from <http://thechronicle.com.gh/understanding-the-nhis-provider-payment-system-and-capitation/>
- Aikins, M., Aryeetey, R., Adongo, B., & Mcgough, L. (2014). Socio-economic differences in cost of pregnancy-related health services in the peri-urban Accra , Ghana. *Journal of Public Health*, 37(3), 540–546. <https://doi.org/10.1093/pubmed/udu072>
- Akazili, J., Garshong, B., Aikins, M., Gyapong, J., & McIntyre, D. (2012). Progressivity of health care financing and incidence of service benefits in Ghana. *Health Policy and Planning*, 27(SUPPL.1). <https://doi.org/10.1093/heapol/czs004>
- Akazili, J., Gyapong, J., & McIntyre, D. (2011). Who pays for health care in Ghana ? *International Journal for Equity in Health*, 10(1), 26. <https://doi.org/10.1186/1475-9276-10-26>
- Akazili, J., Welaga, P., Bawah, A., Achana, F. S., Oduro, A., Awoonor-williams, J. K., ... Phillips, J. F. (2015). Is Ghana ’ s pro-poor health insurance scheme really for the poor ? Evidence from Northern Ghana. *BMC Health Services Research*, 1–9. <https://doi.org/10.1186/s12913-014-0637-7>
- Akeju, D. O., Oladapo, O. T., Vidler, M., Akinmade, A. A., Sawchuck, D., Qureshi, R., ... von Dadelszen, P. (2016). Determinants of health care seeking behaviour during pregnancy in Ogun State, Nigeria. *Reproductive Health*, 13(1), 32. <https://doi.org/10.1186/s12978-016-0139-7>
- Alazri, M., Heywood, P., Neal, R. D., & Leese, B. (2007). Continuity of Care: Literature review and implications. *Sultan Qaboos University Medical Journal*, 7(3), 197–206. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3074883/>
- Alhassan, R. K., Duku, S. O., Janssens, W., Nketiah-, E., Spieker, N., Ostenberg, P. Van, & Arhinful, D. K. (2015). Comparison of Perceived and Technical Healthcare Quality in Primary Health Facilities : Implications for a Sustainable National Health Insurance Scheme in Ghana, 1–19. <https://doi.org/10.1371/journal.pone.0140109>
- Alhassan, R. K., Nketiah-Amponsah, E., Akazili, J., Spieker, N., Arhinful, D. K., & Wit, T. F. R. De. (2015). Efficiency of private and public primary health facilities accredited by the National Health Insurance Authority in Ghana. *Cost Effectiveness and Resource Allocation*, 1–14. <https://doi.org/10.1186/s12962-015-0050-z>

- Alhassan, R. K., Nketiah-Amponsah, E., Spieker, N., Arhinful, D. K., & Rinke de Wit, T. F. (2016). Perspectives of frontline health workers on Ghana's National Health Insurance Scheme before and after community engagement interventions. *BMC Health Services Research*, 16(1), 192. <https://doi.org/10.1186/s12913-016-1438-y>
- Amo-adjei, J., Anku, P. J., Amo, H. F., & Effah, M. O. (2016). Perception of quality of health delivery and health insurance subscription in Ghana. *BMC Health Services Research*, 1–11. <https://doi.org/10.1186/s12913-016-1602-4>
- Amo, T. (2014). The National Health Insurance Scheme (NHIS) in the Dormaa Municipality , Ghana : Why Some Residents Remain Uninsured ? *Global Journal of Health Science*, 6(3), 82–89. <https://doi.org/10.5539/gjhs.v6n3p82>
- Amporfufu, E. (2011). Private hospital accreditation and inducement of care under the ghanaiian national insurance scheme. *Health Economics Review*, 1(1), 13. <https://doi.org/10.1186/2191-1991-1-13>
- Amu, H., & Dickson, K. S. (2016). Health insurance subscription among women in reproductive age in Ghana : do socio-demographics matter ? *Health Economics Review*. <https://doi.org/10.1186/s13561-016-0102-x>
- Anderson, J. G. (2002). Evaluation in health informatics: Social network analysis. *Computers in Biology and Medicine*, 32(3), 179–193. [https://doi.org/10.1016/S0010-4825\(02\)00014-8](https://doi.org/10.1016/S0010-4825(02)00014-8)
- Anko, T. Y. K., & Adetunde, I. A. (2011). Times Series Analysis Model for Registration and Claims Figures of Health Insurance Schemes : A Case Study of the Builsa Health Insurance Scheme. *African Journal of Basic & Applied Sciences*, 3(1), 19–26.
- Antwi, S., & Zhao, X. (2012). A logistic regression model for Ghana National Health Insurance claims. *International Journal of Business and Social Research (IJBSR)*, 2(7), 139–147.
- Arthur, E. (2012). Wealth and antenatal care use : implications for maternal health care utilisation in Ghana. *Health Economics Review*, 2(1), 1. <https://doi.org/10.1186/2191-1991-2-14>
- Aryeetey, G. C., Jehu-Appiah, C., Spaan, E., Agyepong, I., & Baltussen, R. (2012). Costs, equity, efficiency and feasibility of identifying the poor in Ghana's National Health Insurance Scheme: Empirical analysis of various strategies. *Tropical Medicine and International Health*, 17(1), 43–51. <https://doi.org/10.1111/j.1365-3156.2011.02886.x>
- Aryeetey, G. C., Nonvignon, J., Amissah, C., Buckle, G., & Aikins, M. (2016). The effect of the National Health Insurance Scheme (NHIS) on health service delivery in mission facilities in Ghana : a retrospective study. *Globalization and Health*, 1–9. <https://doi.org/10.1186/s12992-016-0171-y>
- Aryeetey, G. C., Westeneng, J., Spaan, E., Jehu-Appiah, C., Agyepong, I. A., & Baltussen, R. (2016). Can health insurance protect against out-of-pocket and catastrophic expenditures and also support poverty reduction? Evidence from Ghana's National Health Insurance Scheme. *International Journal for Equity in Health*, 15(1), 116. <https://doi.org/10.1186/s12939-016-0401-1>
- Aryeetey, R., Aikins, M., Dako-Gyeke, P., & Adongo, P. (2015). Pathways utilized for antenatal health seeking among women in the Ga East District, Ghana. *Ghana Medical Journal*, 49(1), 2–7.
- Bae, S.-H., Nikolaev, A., Seo, J. Y., & Castner, J. (2015). Health care provider social network analysis: A systematic review. *Nursing Outlook*, 63(5), 566–584. <https://doi.org/10.1016/j.outlook.2015.05.006>
- Banfield, M., Gardner, K., Mcrae, I., Gillespie, J., Wells, R., & Yen, L. (2013). Unlocking information for coordination of care in Australia : a qualitative study of information continuity in four primary health care models. *BMC Family Practice*, 14(1), 1. <https://doi.org/10.1186/1471-2296-14-34>
- Barach, P. R., & Lipshultz, S. E. (2016). Readmitting Children with Heart Failure: the Importance of Communication, Coordination, and Continuity of Care. *The Journal of Pediatrics*.

<https://doi.org/10.1016/j.jpeds.2016.07.027>

- Barnet, M., & Shaw, T. (2013). What do consumers see as important in the continuity of their care? *Supportive Care in Cancer*, 21(9), 2637–2642. <https://doi.org/10.1007/s00520-013-1889-1>
- Barnett, M. L., Christakis, N. A., O'Malley, J., Onnela, J.-P., Keating, N. L., & Landon, B. E. (2012). Physician Patient-Sharing Networks and the Cost and Intensity of Care in US Hospitals. *Med Care*, 50(2), 152–160. <https://doi.org/10.1097/MLR.0b013e31822dcef7>
- Bass, R. D., & Windle, C. (1972). Continuity of Care: An Approach to Measurement. *American Journal of Psychiatry*, 129(2), 196–201. <https://doi.org/10.1176/ajp.129.2.196>
- Bastian, M., Heymann, S., & Jacomy, M. (2009). Gephi: an open source software for exploring and manipulating networks. In *International AAAI Conference on Weblogs and Social Media*.
- Bavelas, A. (1950). Communication Patterns in Task-Oriented Groups. *The Journal of the Acoustical Society of America*, 22(6), 725–730.
- Bayou, Y. T., Mashalla, Y. J. S., & Thupayagale-Tshweneagae, G. (2016). Patterns of caesarean-section delivery in Addis Ababa, Ethiopia. *Afr J Prm Health Care Fam Med*, 8(2), 1–6. <https://doi.org/http://dx.doi.org/10.4102/phcfm.v8i2.953>
- Beadles, C. A., Voils, C. I., Crowley, M. J., Farley, J. F., & Maciejewski, M. L. (2014). Continuity of medication management and continuity of care: Conceptual and operational considerations. *SAGE Open Medicine*, 2, 2050312114559261. <https://doi.org/10.1177/2050312114559261>
- Beeckman, K., Louckx, F., & Putman, K. (2010). Determinants of the number of antenatal visits in a metropolitan region. *BMC Public Health*, 10(1), 527. <https://doi.org/10.1186/1471-2458-10-527>
- Belling, R., Whittock, M., McLaren, S., Burns, T., Catty, J., Jones, I. R., & Rose, D. (2011). Achieving Continuity of Care : Facilitators and Barriers in Community Mental Health Teams. *Implementation Science*, 6(1), 23. <https://doi.org/10.1186/1748-5908-6-23>
- Bentler, S. E., Morgan, R. O., Virnig, B. A., & Wolinsky, F. D. (2014a). Do Claims-Based Continuity of Care Measures Reflect the Patient Perspective ? <https://doi.org/10.1177/1077558713505909>
- Bentler, S. E., Morgan, R. O., Virnig, B. A., & Wolinsky, F. D. (2014b). The Association of Longitudinal and Interpersonal Continuity of Care with Emergency Department Use , Hospitalization , and Mortality among Medicare Beneficiaries The Association of Longitudinal and Interpersonal Continuity of Care with Emergency Departmen, 12. <https://doi.org/10.1371/journal.pone.0115088>
- Betrán, A. P., Ye, J., Moller, A., Zhang, J., & Gülmezoglu, A. M. (2016). The Increasing Trend in Caesarean Section Rates : Global , Regional and National Estimates : 1990-2014. *PLoS ONE*, 11(2), 1–12. <https://doi.org/10.1371/journal.pone.0148343>
- Bice, T. W., & Boxerman, S. B. (1977). A quantitative measure of continuity of care. *Medical Care*, 15(4), 347–349.
- Blondel, V. D., Guillaume, J.-L., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. *Journal of Statistical Mechanics:Theory and Experiment*, 10, 1000.
- Boachie, M. K. (2016). Preferred Primary Healthcare Provider Choice Among Insured Persons in Ashanti Region , Ghana. *Int J Health Policy Manag.*, 5(3), 155–163. <https://doi.org/10.15171/ijhpm.2015.191>
- Boateng, D., & Awunyor-vitor, D. (2013). Health insurance in Ghana : evaluation of policy holders ' perceptions and factors influencing policy renewal in the Volta region. *International Journal for Equity in Health*, 12(1), 1. <https://doi.org/10.1186/1475-9276-12-50>
- Bodenheimer, T. (2008). Coordinating Care — A Perilous Journey through the Health Care System. *The New England Journal of Medicine*.

- Boehme, M. W. J., Buechele, G., Frankenhauser-Mannuss, J., Mueller, J., Lump, D., Boehm, B. O., & Rothenbacher, D. (2015). Prevalence, incidence and concomitant co-morbidities of type 2 diabetes mellitus in South Western Germany--a retrospective cohort and case control study in claims data of a large statutory health insurance. *BMC Public Health*, 15, 855. <https://doi.org/10.1186/s12889-015-2188-1>
- Bosomprah, S., Ragno, P. L., Gros, C., & Banskota, H. (2015). Health insurance and maternal, newborn services utilisation and under-five mortality. *Archives of Public Health = Archives Belges de Santé Publique*, 73, 51. <https://doi.org/10.1186/s13690-015-0101-0>
- Bourgeois, F. C., Olson, K. L., & Mandl, K. D. (2010). Patients treated at multiple acute health care facilities: quantifying information fragmentation. *Arch Intern Med*, 170(22), 1989–1995. <https://doi.org/10.1001/archinternmed.2010.439>
- Browne, J. L., Kayode, G. A., Arhinful, D., Fidler, S. A. J., Grobbee, D. E., & Klipstein-grobusch, K. (2016). Health insurance determines antenatal , delivery and postnatal care utilisation : evidence from the Ghana Demographic and Health Surveillance data. *BMJ*, 13–18. <https://doi.org/10.1136/bmjopen-2015-008175>
- Cabana, M. D., & Jee, S. H. (2004). Does continuity of care improve patient outcomes? *J Fam Pract*, 53(12), 974–980.
- Carapinha, J. L., Ross-degnan, D., Desta, A. T., & Wagner, A. K. (2010). Health insurance systems in five Sub-Saharan African countries: Medicine benefits and data for decision making. *Health Policy*. <https://doi.org/10.1016/j.healthpol.2010.11.009>
- Carter, E. B., Tuuli, M. G., Caughey, A. B., Odibo, A. O., Macones, G. A., & Cahill, A. G. (2016, March). Number of prenatal visits and pregnancy outcomes in low-risk women. *J Perinatol*. Nature America, Inc. Retrieved from <http://dx.doi.org/10.1038/jp.2015.183>
- Cebul, R., Rebitzer, J., Taylor, L., & Votruba, M. (2008). Organizational Fragmentation and Care Quality in the U.S. HealthCare System. *The Journal of Economic Perspectives*, 22(4), 93–114. <https://doi.org/10.3386/w14212>
- Chambers, D., Wilson, P., Thompson, C., & Harden, M. (2012). Social network analysis in healthcare settings: A systematic scoping review. *PLoS ONE*, 7(8). <https://doi.org/10.1371/journal.pone.0041911>
- Chami, G. F., Ahnert, S. E., Voors, M. J., & Kontoleon, A. A. (2014). Social Network Analysis Predicts Health Behaviours and Self-Reported Health in African Villages. *PLoS ONE*, 9(7). <https://doi.org/10.1371/journal.pone.0103500>
- Chan, C.-L., You, H.-J., Huang, H.-T., & Ting, H.-W. (2012). Using an integrated COC index and multilevel measurements to verify the care outcome of patients with multiple chronic conditions. *BMC Health Services Research*, 12(1), 1–12. <https://doi.org/10.1186/1472-6963-12-405>
- Chandola, V., Sukumar, S. R., & Schryver, J. C. (2013). Knowledge discovery from massive healthcare claims data. *Proceedings of the 19th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining - KDD '13*, 1312. <https://doi.org/10.1145/2487575.2488205>
- Cheng, S. H., Chen, C. C., & Hou, Y. F. (2010). A Longitudinal Examination of Continuity of Care and Avoidable Hospitalization. *Arch Intern Med*, 170. <https://doi.org/10.1001/archinternmed.2010.340>
- Cheng, S. H., Hou, Y. F., & Chen, C. C. (2011). Does continuity of care matter in a health care system that lacks referral arrangements? *Health Policy Plan*, 26. <https://doi.org/10.1093/heapol/czq035>
- Cragin, L. a, Laney, a S., Lohff, C. J., Martin, B., Pandiani, J. a, & Blevins, L. Z. (2009). Use of insurance claims data to determine prevalence and confirm a cluster of sarcoidosis cases in Vermont. *Public Health Reports (Washington, D.C. : 1974)*, 124(3), 442–6. Retrieved from

<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2663881&tool=pmcentrez&rendertype=abstract>

- Creswick, N., & Westbrook, J. I. (2010). Social network analysis of medication advice-seeking interactions among staff in an Australian hospital. *International Journal of Medical Informatics*, 79(6), e116–e125. <https://doi.org/10.1016/j.ijmedinf.2008.08.005>
- Csardi, G., & Nepusz, T. (2006). The igraph software package for complex network research. *InterJournal, Complex Sy*, 1695.
- Dako-Gyeke, P., Aikins, M., Aryeetey, R., McCough, L., & Adongo, P. B. (2013). The influence of socio-cultural interpretations of pregnancy threats on health-seeking behavior among pregnant women in urban Accra, Ghana. *BMC Pregnancy Childbirth*, 13(1), 211. <https://doi.org/10.1186/1471-2393-13-211>
- Dalaba, M. A., Akweongo, P., Aborigo, R., Awine, T., Azongo, D. K., Asaana, P., ... Oduro, A. (2014). Does the national health insurance scheme in Ghana reduce household cost of treating malaria in the Kassena-Nankana districts?, 1, 1–7.
- Dalinjong, P. A., & Laar, A. S. (2012). The national health insurance scheme : perceptions and experiences of health care providers and clients in two districts of Ghana. *Health Economics Review*, 2(1), 1. <https://doi.org/10.1186/2191-1991-2-13>
- de-Graft Aikins, A. (2005). Healer shopping in Africa : new evidence from rural-urban qualitative study of diabetes experiences. *BMJ*. <https://doi.org/10.1136/bmj.331.7519.737>
- Debpuur, C., Dalaba, M. A., Chatio, S., Adjuik, M., & Akweongo, P. (2015). An exploration of moral hazard behaviors under the national health insurance scheme in Northern Ghana : a qualitative study. *BMC Health Services Research*, 1–9. <https://doi.org/10.1186/s12913-015-1133-4>
- Department of Health. (2011). *National Maternity Services Plan*. (C. Biotext, Ed.). Commonwealth of Australia. <https://doi.org/D0159>
- Department of State Rhode Island. (n.d.). Continuity of Care. Retrieved August 8, 2016, from <http://www.health.ri.gov/healthcare/about/continuity/index.php>
- Derbile, E. K., & Geest, S. Van Der. (2013). Repackaging exemptions under National Health Insurance in Ghana : how can access to care for the poor be improved ? *Health Policy Plan*, (October 2012), 586–595. <https://doi.org/10.1093/heapol/czs098>
- Desikan, P., Hsu, K., & Srivastava, J. (2011). Data mining for healthcare management. In *2011 SIAM International Conference on Data Mining*. Mesa, Arizona USA.
- Dietrich, A. J., & Marton, K. I. (1982). Does continuous care from a physician make a difference? *J Fam Pract*, 15(5), 929–37.
- Dixon, J., Luginaah, I., & Mkandawire, P. (2014a). Gendered Inequalities within Ghana's National Health Insurance Scheme: Are Poor Women Being Penalized with a Late Renewal Policy? *Journal of Health Care for the Poor and Underserved*, 25(3), 1005–2020.
- Dixon, J., Luginaah, I., & Mkandawire, P. (2014b). The National Health Insurance Scheme in Ghana's Upper West Region: A gendered perspective of insurance acquisition in a resource-poor setting. *Social Science and Medicine*, 122, 103–112. <https://doi.org/10.1016/j.socscimed.2014.10.028>
- Dixon, J., Tenkorang, E. Y., & Luginaah, I. (2013). Ghana's National Health Insurance Scheme: a national level investigation of members' perceptions of service provision. *BMC International Health and Human Rights*, 13(1), 35. <https://doi.org/10.1186/1472-698X-13-35>
- Donaldson, M. S. (2001). Continuity of Care: A Reconceptualization. *Medical Care Research and Review*, 58(3), 255–290. <https://doi.org/10.1177/107755870105800301>

- Douglas A. Luke, & Harris, J. K. (2007). Network Analysis in Public Health: History, Methods, and Applications. *Annu Rev Public Health*, (28), 69–93.
- Dreier, J., Comaneshter, D. S., Rosenbluth, Y., Battat, E., Bitterman, H., & Cohen, A. D. (2012). The association between continuity of care in the community and health outcomes: a population-based study. *Israel Journal of Health Policy Research*, 1(1), 21. <https://doi.org/10.1186/2045-4015-1-21>
- Drewe, J. a. (2010). Who infects whom? Social networks and tuberculosis transmission in wild meerkats. *Proceedings. Biological Sciences / The Royal Society*, 277(1681), 633–642. <https://doi.org/10.1098/rspb.2009.1775>
- Dsane-Selby, L. (2013). Health Insurance Fraud - Ghana's Perspective. In *NHIS@10 Conference*. Accra, Ghana: National Health Insurance Authority.
- Du, D. (n.d.). Social Network Analysis: Lecture 4-Centrality Measures. Canada: Faculty of Business Administration, University of New Brunswick, NB Canada Fredericton.
- Dunn, A. G., & Westbrook, J. I. (2011). Interpreting social network metrics in healthcare organisations: A review and guide to validating small networks. *Social Science and Medicine*, 72(7), 1064–1068. <https://doi.org/10.1016/j.socscimed.2011.01.029>
- Dwumoh, D., Essuman, E. E., & Afagbedzi, S. K. (2014). Determinant of factors associated with child health outcomes and service utilization in Ghana : multiple indicator cluster survey conducted in 2011, 1–10.
- Dzakpasu, S., Soremekun, S., Manu, A., Asbroek, G., Tawiah, C., Hurt, L., ... Kirkwood, B. R. (2012). Impact of Free Delivery Care on Health Facility Delivery and Insurance Coverage in Ghana ' s Brong Ahafo Region. *PLoS ONE*, 7(11). <https://doi.org/10.1371/journal.pone.0049430>
- Eghan, K., Mordi, D., & Malik, M. (2015). *Assessment of the Medicines Benefit Program of the Ghana National Health Insurance Scheme. Submitted to the US Agency for International Development by the Systems for Improved Access to Pharmaceuticals and Services (SIAPS) Program*. Arlington, VA.
- Elhauge, E. (2010). *The Fragmentation of U.S. Health Care: Causes and Solutions. The Fragmentation of U.S. Health Care: Causes and Solutions*. <https://doi.org/10.1093/acprof:oso/9780195390131.001.0001>
- Fattore, G., Frosini, F., Salvatore, D., & Tozzi, V. (2009). Social network analysis in primary care: The impact of interactions on prescribing behaviour. *Health Policy*, 92(2–3), 141–148. <https://doi.org/10.1016/j.healthpol.2009.03.005>
- Fenenga, C. J., Nketiah-amponsah, E., Ogink, A., Arhinful, D. K., Poortinga, W., & Hutter, I. (2015). Social capital and active membership in the Ghana National Health Insurance Scheme - a mixed method study. *International Journal for Equity in Health*, 1–12. <https://doi.org/10.1186/s12939-015-0239-y>
- Fenny, A. P., Asante, F. A., Arhinful, D. K., Kusi, A., Parmar, D., & Williams, G. (2016). Who uses outpatient healthcare services under Ghana's health protection scheme and why? *BMC Health Services Research*, 16(1), 174. <https://doi.org/10.1186/s12913-016-1429-z>
- Fenny, A. P., Asante, F. A., Enemark, U., & Hansen, K. S. (2015). Malaria care seeking behavior of individuals in Ghana under the NHIS : Are we back to the use of informal care ? *BMC Public Health*, 1–8. <https://doi.org/10.1186/s12889-015-1696-3>
- Fenny, A. P., Asante, F. A., Enemark, U., & Hansen, K. S. (2015). Treatment-Seeking Behaviour and Social Health Insurance in Africa : The Case of Ghana Under the National Health Insurance Scheme. *Global Journal of Health Science*, 7(1), 296–314. <https://doi.org/10.5539/gjhs.v7n1p296>
- Fenny, A. P., Enemark, U., Asante, F. A., & Hansen, K. S. (2014). Patient Satisfaction with Primary

Health Care – A Comparison between the Insured and Non-Insured under the National Health Insurance Policy in Ghana. *Global Journal of Health Science*, 6(4), 9–21.
<https://doi.org/10.5539/gjhs.v6n4p9>

- Fenny, A. P., Hansen, K. S., Enemark, U., & Asante, F. A. (2014). Quality of uncomplicated malaria case management in Ghana among insured and uninsured patients. *International Journal for Equity in Health*, 1–12.
- Forster, D. A., McLachlan, H. L., Davey, M., Biro, M. A., Farrell, T., Gold, L., ... Waldenström, U. (2016). Continuity of care by a primary midwife (caseload midwifery) increases women's satisfaction with antenatal, intrapartum and postpartum care : results from the COSMOS randomised controlled trial. *BMC Pregnancy and Childbirth*, 1–13. <https://doi.org/10.1186/s12884-016-0798-y>
- Frandsen, B. R., Joynt, K. E., Rebitzer, J. B., & Jha, A. K. (2015). Care fragmentation quality costs among chronically ill patients. *Am J Manag Care*, 21(5), 355–362.
- Freeman, A. C., & Sweeney, K. (2001). Why general practitioners do not implement evidence: qualitative study. *BMJ*, 323(November), 1100–2.
- Freeman, G., & Hughes, J. (2010). *Continuity of care and the patient experience*.
- Freeman, G., Shepperd, S., Robinson, I., Ehrich, K., & Richards, S. (2000). Continuity of Care.
- Freeman, L. C. (1978). Centrality in social networks conceptual clarification. *Social Networks*, 1(3), 215–239. [https://doi.org/10.1016/0378-8733\(78\)90021-7](https://doi.org/10.1016/0378-8733(78)90021-7)
- Frimpong, J. A., Helleringer, S., Awoonor-williams, J. K., Aguilar, T., Phillips, J. F., & Yeji, F. (2013). The complex association of health insurance and maternal health services in the context of a premium exemption for pregnant women : a case study in Northern Ghana. *Health Policy and Planning*, (November 2013), 1043–1053. <https://doi.org/10.1093/heapol/czt086>
- Frohlich, N., Katz, A., Coster, C. De, Dik, N., Soodeen, R., & Watson, D. (2006). *Profiling Primary Care Physician Practice in*. Manitoba, Canada.
- Fruchterman, T. M. J., & Reingold, E. M. (1991). Graph drawing by force-directed placement. *Journal of Software: Practice and Experience*, 21(11), 1129–1164. <https://doi.org/10.1002/spe.4380211102>
- Gabrysch, S., Cousens, S., Cox, J., & Campbell, O. M. R. (2011). The Influence of Distance and Level of Care on Delivery Place in Rural Zambia : A Study of Linked National Data in a Geographic Information System. *PLoS Medicine*, 8(1). <https://doi.org/10.1371/journal.pmed.1000394>
- Galanter, W. L., Applebaum, A., Boddipalli, V., Kho, A., Lin, M., Meltzer, D., ... Lambert, B. L. (2013). Migration of Patients Between Five Urban Teaching Hospitals in Chicago. *Journal of Medical Systems*, 37(2), 9930. <https://doi.org/10.1007/s10916-013-9930-y>
- Gardner, K., Banfield, M., McRae, I., Gillespie, J., & Yen, L. (2014). Improving coordination through information continuity: a framework for translational research. *BMC Health Services Research*, 14(1), 590. <https://doi.org/10.1186/s12913-014-0590-5>
- Garton, L., Haythornthwaite, C., & Wellman, B. (1997). Studying Online Social Networks. *Journal of Computer- Mediated Communication*, 3(1).
- Ghana Health Service. (n.d.). Organisational Structure. Retrieved January 17, 2017, from <http://www.ghanahealthservice.org/ghs-subcategory.php?cid=5&scid=43>
- Ghana Health Service. (2012). *2012 Annual Report*. Accra, Ghana.
- Ghana Health Service. (2015). *GHANA HEALTH SERVICE 2014 ANNUAL REPORT*. Accra.
- Ghana Statistical Service. (2011). *Multiple Indicator Cluster Survey with an enhanced Malaria Module and Biomarker, 2011, Final Report*. Accra, Ghana.

- Ghana Statistical Service, Ghana Health Service, & IFC International. (2015). *Ghana Demographic and Health Survey 2014*. Accra, Ghana.
- Ghana Statistical Service, Ghana Health Service, & Macro, I. (2009). *Ghana Maternal Health Survey 2007*. Accra, Ghana.
- Gill, J., Johnson, P., & Clark, W. M. (2010). *Research Methods for Managers* (4th ed.). London: Sage Publications.
- Gobah, F. K., & Zhang, L. (2011). The National Health Insurance Scheme in Ghana: Prospects and Challenges: a cross-sectional evidence. *Global Journal of Health Science*, 3(2), 90–101. <https://doi.org/10.5539/gjhs.v3n2p90>
- Gordon, D., Milberg, J., Daling, J., & Hickok, D. (1991). Advanced maternal age as a risk factor for cesarean delivery. *Obstet Gynecol.*, 77(4), 493–7.
- Goudge, J., Akazili, J., Ataguba, J., Kuwawenaruwa, A., Borghi, J., Harris, B., & Mills, A. (2012). Social solidarity and willingness to tolerate risk- and income-related cross-subsidies within health insurance : experiences from Ghana , Tanzania and South Africa. *Health Policy Plan*. <https://doi.org/10.1093/heapol/czs008>
- Government of Ghana. Ghana Health Service and Teaching Hospitals Act (Act 525) (1996). Accra: Assembly Press.
- Gray, D. P., Evans, P., Sweeney, K., Lings, P., Seamark, D., Seamark, C., ... Bradley, N. (2003). Towards a theory of continuity of care. *J R Soc Med*, 96, 160–166.
- Grunspan, D. Z., Wiggins, B. L., & Goodreau, S. M. (2014). Understanding classrooms through social network analysis: A primer for social network analysis in education research. *CBE Life Sciences Education*, 13(2), 167–178. <https://doi.org/10.1187/cbe.13-08-0162>
- Gyasi, R. M. (2015). Relationship between Health Insurance Status and the Pattern of Traditional Medicine Utilisation in Ghana. *Evidence-Based Complementary and Alternative Medicine*, 2015. <https://doi.org/10.1155/2015/717926>
- Haggerty, J. L., Reid, R. J., Freeman, G. K., Starfield, B. H., & Adair, C. E. (2003). Continuity of care : a multidisciplinary review. *BMJ*, 327, 1219–1221.
- Hamra, J., Uddin, S., & Hossain, L. (2011). Exponential random graph modeling of communication networks to understand organizational crisis. 78: ACM.
- Hatem, M., Hodnett, E., Devane, D., Fraser, W., Sandall, J., & Soltani, H. (2004). Midwifery-led versus other models of care delivery for childbearing women. In M. Hatem (Ed.), *Cochrane Database of Systematic Reviews* (Vol. 21). Chichester, UK: John Wiley & Sons, Ltd. <https://doi.org/10.1002/14651858.CD004667>
- Health Evidence Network. (2003). *What is the efficacy / effectiveness of antenatal care and the financial and organizational implications ?*
- Hera, & Health Partners Ghana. (2013). *Evaluation of the Free Maternal Health Care Initiative in Ghana*. Accra, Ghana.
- Hilton, R. P., Serban, N., & Zheng, R. Y. (2016). Uncovering Longitudinal Healthcare Utilization from Patient-Level Medical Claims Data, 1–28.
- Hoang, H., Lê, Q., Terry, D., Kilpatrick, S., & Stuart, J. (2013). Continuity of Carer in the Public Hospital System in the Eyes of Rural Women and Maternity Health Providers in Tasmania, Australia. *Universal Journal of Public Health*, 1(1), 1–6. <https://doi.org/10.13189/ujph.2013.010101>
- Hussain, D. M. A. (2007). Destabilization of Terrorist Networks through Argument Driven Hypothesis Model. *Journal of Software*, 2(6).

- Hyman, D. A. (2010). Health Care Fragmentation. In *The Fragmentation of U.S. Health Care: Causes and Solutions*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195390131.003.002>
- IBM. (n.d.). What is Big Data Analytics? Retrieved April 30, 2015, from <http://www-01.ibm.com/software/data/infosphere/hadoop/what-is-big-data-analytics.html>
- Institute of Medicine. (1994). The New Definition and an Explanation of Terms. In *Defining Primary Care: An Interim Report*: The National Academies Press. Retrieved from <http://www.nap.edu/read/9153/chapter/5>
- Institute of Medicine. (1999). *To Err is Human: Building a Safer Health System*. Washington. Retrieved from <http://www.nap.edu/books/0309068371/html/>
- Jacomy, M., Venturini, T., Heymann, S., & Bastian, M. (2014). ForceAtlas2, a Continuous Graph Layout Algorithm for Handy Network Visualization Designed for the Gephi Software. *PLoS ONE*, 9(6). <https://doi.org/10.1371/journal.pone.0098679>
- Jee, S. H., & Cabana, M. D. (2006). Indices for continuity of care: a systematic review of the literature. *Medical Care Research and Review : MCRR*, 63(2), 158–188. <https://doi.org/10.1177/1077558705285294>
- Jehu-appiah, C., Aryeetey, G., Agyepong, I., Spaan, E., & Baltussen, R. (2012). Household perceptions and their implications for enrolment in the National Health Insurance Scheme in Ghana. *Health Policy Plan*, (April 2011), 222–233. <https://doi.org/10.1093/heapol/czr032>
- Jehu-appiah, C., Aryeetey, G., Spaan, E., Agyepong, I., & Baltussen, R. (2010). Efficiency , equity and feasibility of strategies to identify the poor : An application to premium exemptions under National Health Insurance in Ghana. *Health Policy*, 95(2–3), 166–173. <https://doi.org/10.1016/j.healthpol.2009.11.017>
- Jehu-appiah, C., Aryeetey, G., Spaan, E., Hoop, T. De, Agyepong, I., & Baltussen, R. (2011). Equity aspects of the National Health Insurance Scheme in Ghana : Who is enrolling , who is not and why ? *Social Science & Medicine*, 72(2), 157–165. <https://doi.org/10.1016/j.socscimed.2010.10.025>
- Johnson, F. A., Frempong-anguah, F., & Padmadas, S. S. (2015). Two decades of maternity care fee exemption policies in Ghana : have they benefited the poor ? *Health Policy*, (April 2015), 46–55. <https://doi.org/10.1093/heapol/czv017>
- Jones, S. G., Coulter, S., & Conner, W. (2013). Using administrative medical claims data to supplement state disease registry systems for reporting zoonotic infections. *Journal of the American Medical Informatics Association : JAMIA*, 20, 193–198. <https://doi.org/10.1136/amiainl-2012-000948>
- Kaonga, N. N., Labrique, A., Mechael, P., Akosah, E., Ohemeng-Dapaah, S., Sakyi Baah, J., ... Levine, O. (2013). Using Social Networking to Understand Social Networks: Analysis of a Mobile Phone Closed User Group Used by a Ghanaian Health Team. *Journal of Medical Internet Research*, 15(4), e74. <https://doi.org/10.2196/jmir.2332>
- Katz, A., Chateau, D., Bogdanovic, B., Taylor, C., McGowan, K.-L., Rajotte, L., & Dziadek, J. (2014). *Physician Integrated Network: A Second Look*. Winnipeg, Manitoba, Canada: Manitoba Centre for Health Policy.
- Katz, A., Coster, C. De, Bogdanovic, B., Soodeen, R., & Chateau, D. (2004). *Using Administrative Data to Develop Indicators of Quality in Family Practice*. Winnipeg: Manitoba Health.
- Kawonga, M., Blaauw, D., & Fonn, S. (2015). Exploring the use of social network analysis to measure communication between disease programme and district managers at sub-national level in South Africa. *Social Science & Medicine*, 135, 1–14. <https://doi.org/10.1016/j.socscimed.2015.04.024>
- Kim, H., Thurman, D. J., Durgin, T., Faught, E., & Helmers, S. (2015). Estimating Epilepsy Incidence and Prevalence in the US Pediatric Population Using Nationwide Health Insurance Claims Data.

- Journal of Child Neurology*, 31(6), 1–7. <https://doi.org/10.1177/0883073815620676>
- Koduah, A., Dijk, H. van, & Agyepong, I. A. (2016). Technical analysis, contestation and politics in policy agenda setting and implementation: the rise and fall of primary care maternal services from Ghanas capitation policy. *BMC Health Services Research*, 16, 1–14. <http://dx.doi.org/10.1186/s12913-016-1576-2>
- Kotoh, A. M., & Van der Geest, S. (2016). Why are the poor less covered in Ghana's national health insurance? A critical analysis of policy and practice. *International Journal for Equity in Health*, 15(1), 34. <https://doi.org/10.1186/s12939-016-0320-1>
- Krackhardt, D. (1990). Assessing the Political Landscape: Structure, Cognition, and Power in Organizations. *Administrative Science Quarterly*, 35, 342–369.
- Kruk, M. E., Leslie, H. H., Verguet, S., Mbaruku, G. M., Adanu, R. M. K., & Langer, A. (2017). Quality of basic maternal care functions in health facilities of five African countries: an analysis of national health system surveys. *The Lancet Global Health*, 4(11), e845–e855. [https://doi.org/10.1016/S2214-109X\(16\)30180-2](https://doi.org/10.1016/S2214-109X(16)30180-2)
- Kruk, M. E., Mbaruku, G., McCord, C. W., Moran, M., Rockers, P. C., & Galea, S. (2009). Bypassing primary care facilities for childbirth: a population-based study in rural Tanzania. *Health Policy and Planning*, 24(4), 279–288. Retrieved from <http://dx.doi.org/10.1093/heapol/czp011>
- Kumi-kyereme, A., & Amo-adjei, J. (2013). Effects of spatial location and household wealth on health insurance subscription among women in Ghana. *BMC Health Services Research*, 13(1), 1. <https://doi.org/10.1186/1472-6963-13-221>
- Kusi, A., Enemark, U., Hansen, K. S., & Asante, F. a. (2015). Refusal to enrol in Ghana's National Health Insurance Scheme: is affordability the problem? *International Journal for Equity in Health*, 14(1), 1–14. <https://doi.org/10.1186/s12939-014-0130-2>
- Kusi, A., Hansen, K. S., Asante, F. A., & Enemark, U. (2015). Does the National Health Insurance Scheme provide financial protection to households in Ghana ? *BMC Health Services Research*, 1–12. <https://doi.org/10.1186/s12913-015-0996-8>
- Kuuire, V. Z., Bisung, E., Rishworth, A., Dixon, J., & Luginaah, I. (2015). Health-seeking behaviour during times of illness : a study among adults in a resource poor setting in Ghana. *Journal of Public Health*, 1–9. <https://doi.org/10.1093/pubmed/fdv176>
- Landon, B. E., Keating, N. L., Barnett, M. L., Onnela, J.-P., Paul, S., O'Malley, A. J., ... Christakis, N. A. (2012). Variation in Patient-Sharing Networks of Physicians Across the United States. *JAMA: The Journal of the American Medical Association*, 308(3), 265. <https://doi.org/10.1001/jama.2012.7615>
- Landon, B. E., Onnela, J.-P., Keating, N. L., Barnett, M. L., Sudeshna, P., O'Malley, A. J., ... Christakis, N. A. (2013). Using Administrative Data to Identify Naturally Occurring Networks of Physicians. *Med Care*, 51(8), 715–721. <https://doi.org/10.1097/MLR.0b013e3182977991>
- Lee, B. Y., Mcglone, S. M., Song, Y., Avery, T. R., Eubank, S., Chang, C., ... Huang, S. S. (2011). Social Network Analysis of Patient Sharing Among Hospitals in Orange County , California, 101(4), 707–713. <https://doi.org/10.2105/AJPH.2010.202754>
- Lincetto, O., Mothebesoane-anoh, S., Gomez, P., & Munjanja, S. (2006). Antenatal Care. In *Opportunities for Africa's Newborns* (pp. 51–62).
- Liu, S., & Yeung, P. C. (2013). Measuring fragmentation of ambulatory care in a tripartite healthcare system. *BMC Health Services Research*, 13(176), 1472–6963.
- Macha, J., Harris, B., Garshong, B., Ataguba, J. E., Akazili, J., Kuwawenaruwa, A., & Borghi, J. (2012). Factors influencing the burden of health care financing and the distribution of health care benefits in Ghana , Tanzania and South Africa. *Health Policy Plan*, 46–54.

<https://doi.org/10.1093/heapol/czs024>

- Magill, M. K., & Senf, J. (1987). A new method for measuring continuity of care in family practice residencies. *J Fam Pract.*, 24(2), 165–8.
- Manitoba Centre for Health Policy. (2015). Concept: Measuring Continuity of Care. Retrieved August 23, 2016, from <http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?printer=Y&conceptID=1443>
- Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). *Big data: The next frontier for innovation, competition, and productivity*. McKinsey Global Institute. <https://doi.org/10.1080/01443610903114527>
- Max, G. (2016). Gmisc: Descriptive Statistics, Transition Plots, and More. R package version 1.4.1. CRAN. Retrieved from <https://cran.r-project.org/package=Gmisc>
- McDonald, K. M., Schultz, E., Albin, L., Pineda, N., Lonhart, J., Sundaram, V., ... Davies, S. (2014). *Care Coordination Atlas Version 4 (Prepared by Stanford University under subcontract to American Institutes for Research on Contract No. HHS290-2010-00005I). AHRQ Publication No. 14-0037-EF*. Rockville, MD. Agency for Healthcare Research and Quality. Retrieved from <http://www.ahrq.gov/professionals/prevention-chronic-care/improve/coordination/atlas2014/index.html>
- McLachlan, H. L., Forster, D. A., Davey, M. A., Farrell, T., Gold, L., Biro, M. A., ... Flood, M. (2012). Effects of continuity of care by a primary midwife (caseload midwifery) on caesarean section rates in women of low obstetric risk : the COSMOS randomised controlled trial. *BJOG*, 119, 1483–1492. <https://doi.org/10.1111/j.1471-0528.2012.03446.x>
- Mensah, J., Oppong, J. R., & Schmidt, C. (2010). Ghana's National Health Insurance Scheme In The Context of The Health MDGs: An Empirical Evaluation Using Propensity Score Matching. *Health Economics*, 19, 95–106.
- Meur, L. N., Gao, F., & Bayat, S. (2015). Mining care trajectories using health administrative information systems: The use of state sequence analysis to assess disparities in prenatal care consumption. *BMC Health Services Research*, 15(1), 200. <https://doi.org/10.1186/s12913-015-0857-5>
- Mills, A., Ataguba, J. E., Akazili, J., Borghi, J., Garshong, B., Makawia, S., ... McIntyre, D. (2012). Equity in financing and use of health care in Ghana, South Africa, and Tanzania: implications for paths to universal coverage. *The Lancet*, 380(9837), 126–133. [https://doi.org/10.1016/S0140-6736\(12\)60357-2](https://doi.org/10.1016/S0140-6736(12)60357-2)
- Mindlin, R. L., & Densen, P. M. (1969). MEDICAL CARE OF URBAN INFANTS : CONTINUITY OF CARE. *A.J.P.H.*, 59(8).
- Ministry of Health. (n.d.-a). *National E-health Strategy*.
- Ministry of Health. (n.d.-b). No Title. Retrieved January 17, 2017, from <http://www.moh.gov.gh/>
- Ministry of Health. (n.d.-c). No Title.
- Ministry of Health. (2010). *Under Five's Child Health Policy : 2007-2015*.
- Ministry of Health. (2012). *Referral Policy and Guidelines*. Accra, Ghana.
- Ministry of Health. (2014a). *Ghana National Newborn Health Strategy and Action Plan 2014–2018*.
- Ministry of Health. (2014b). *Health Sector Medium Term Development Plan 2014-2017*.
- Ministry of Health. (2016). *National Community-Based Health Planning and Services (CHPS) Policy*. Accra, Ghana.
- Nageswaran, S., Ip, E. H., Golden, S. L., O'Shea, T. M., & Easterling, D. (2012). Inter-agency collaboration in the care of children with complex chronic conditions. *Academic Pediatrics*, 12(3),

- 189–197. <https://doi.org/10.1016/j.acap.2012.02.007>
- Nassif, D., Garfink, C., & Greenfield, C. (1982). Does continuity equal quality in the assessment of well-child care? *QRB Qual Rev Bull*, 8(6), 11–8.
- National Health Insurance Authority. (2013a). *2013 Annual Report*. Accra, Ghana.
- National Health Insurance Authority. (2013b). *National Health Insurance Scheme 10 th Anniversary International Conference Report*. Accra, Ghana.
- Ngo, A. D., & Hill, P. S. (2011). The use of reproductive healthcare at commune health stations in a changing health system in Vietnam. *BMC Health Services Research*, 11, 237. <https://doi.org/10.1186/1472-6963-11-237>
- Nguyen, H. T. H., Rajkotia, Y., & Wang, H. (2011). The financial protection effect of Ghana National Health Insurance Scheme : evidence from a study in two rural districts. *International Journal for Equity in Health*, 10(1), 4. <https://doi.org/10.1186/1475-9276-10-4>
- Nsiah-boateng, E., Aikins, M., Asenso-boadi, F., & Andoh-Adjei, F.-X. (2016). Value and Service Quality Assessment of the National Health Insurance Scheme in Ghana : Evidence from Ashiedu Keteke District. *Value in Health Regional Issues*, 10, 7–13. <https://doi.org/10.1016/j.vhri.2016.03.003>
- O'Malley, A. J., & Marsden, P. V. (2009). The analysis of social networks. *Health Ser*, 8(4), 222–269. <https://doi.org/10.1007/s10742-008-0041-z>
- Odame, E. A., Akweongo, P., Yankah, B., Asenso-boadi, F., & Agyepong, I. (2013). Sustainability of recurrent expenditure on public social welfare programmes : expenditure analysis of the free maternal care programme of the Ghana National Health Insurance Scheme. *Health Policy Plan*. <https://doi.org/10.1093/heapol/czt013>
- Odoi-Agyarko, H. (2003). *Profile of Reproductive Health Situation in Ghana*.
- Ong, M.-S., Olson, K. L., Cami, A., Liu, C., Tian, F., Selvam, N., & Mandl, K. D. (2016). Provider Patient-Sharing Networks and Multiple-Provider Prescribing of Benzodiazepines. *Journal of General Internal Medicine*, 31(2), 164–171. <https://doi.org/10.1007/s11606-015-3470-8>
- Otte, E., & Rousseau, R. (2002). Social Network Analysis: A Powerful Strategy, Also for the Information Sciences. *Journal of Information Science*, 28(6), 441–453. <https://doi.org/10.1177/016555150202800601>
- Øvretveit, J. (2009). *Does improving quality save money? A review of evidence of which improvements to quality reduce costs to health service providers*. London: the Health Foundation.
- Owoo, N. S., & Lambon-quayefio, M. P. (2013). National health insurance , social influence and antenatal care use in Ghana. *Health Economics Review*, 1. Retrieved from Health Economics Review
- Pollack, C. E., Hussey, P. S., Rudin, R. S., Fox, D. S., Lai, J., & Schneider, E. C. (2015). Measuring Care Continuity: A Comparison of Claims-Based Methods, (410).
- Pollack, C. E., Weissman, G. E., Lemke, K. W., Hussey, P. S., & Weiner, J. P. (2011). Patient Sharing Among Physicians and Costs of Care : A Network Analytic Approach to Care Coordination Using Claims Data, 459–465. <https://doi.org/10.1007/s11606-012-2104-7>
- Raghupathi, W., & Raghupathi, V. (2014). Big data analytics in healthcare: promise and potential. *Health Information Science and Systems*, 2(1), 3. <https://doi.org/10.1186/2047-2501-2-3>
- Raven, M. C., Guzman, D., Chen, A. H., Kornak, J., & Kushel, M. (2016). Out-of-Network Emergency Department Use among Managed Medicaid Beneficiaries. *Health Serv Res*, 1–19. <https://doi.org/10.1111/1475-6773.12604>

- Reid, R., Haggerty, J., & McKendry, R. (2002). *Defusing the confusion: concepts and measures of continuity of healthcare*.
- Remenyi, D., Williams, B., Money, A., & Swartz, E. (2013). The Positivist Approach to Empirical Research. In *Research in Business and Management: An Introduction to Process and Method*. SAGE Publications Ltd. <https://doi.org/http://dx.doi.org/10.4135/9781446280416.n5>
- Riedel, O., Bitters, D., Amann, U., Garbe, E., & Langner, I. (2016). Estimating the prevalence of Parkinson's disease (PD) and proportions of patients with associated dementia and depression among the older adults based on secondary claims data. *Int J Geriatr Psychiatry*, 31(8), 938–43. <https://doi.org/10.1002/gps.4414>
- Rolfe, A., Cash-Gibson, L., Car, J., Sheikh, A., & McKinstry, B. (2014). Interventions for improving patients' trust in doctors and groups of doctors. *Cochrane Database of Systematic Reviews (Online)*, 3(3), CD004134. <https://doi.org/10.1002/14651858.CD004134.pub3>
- Roos, L. L., Roos, N. P., Gilbert, P., & Nicol, J. P. (1980). Continuity of care: does it contribute to quality of care? *Med Care*, 18(2), 174–84.
- RStudio Team. (2015). RStudio: Integrated Development for R. Boston, MA: RStudio, Inc. Retrieved from <http://www.rstudio.com/>.
- Saleh, K. (2013). *The Health Sector in Ghana: A comprehensive Assessment*. Washington, DC: World Bank. <https://doi.org/10.1596/978-0-8213-9599-8>
- Salisbury, C., Sampson, F., Ridd, M., & Montgomery, A. A. (2009). How should continuity of care in primary health care be assessed ?, (April), 134–141. <https://doi.org/10.3399/bjgp09X420257>
- Sandall, J. (2013). *The contribution of continuity of midwifery care to high quality maternity care*.
- Sandall, J., Soltani, H., Gates, S., Shennan, A., & Devane, D. (2016). Midwife-led continuity models versus other models of care for childbearing women. *Cochrane Database of Systematic Reviews*, (4, Art. No.: CD004667). <https://doi.org/10.1002/14651858.CD004667>
- Sandall, J., Soltani, H., Gates, S., Shennan, A., Devane, D., Sandall, J., ... Devane, D. (2013). Midwife-led continuity models versus other models of care for childbearing women (Review). *The Cochrane Collaboration*, (9), 10–13. <https://doi.org/10.1002/14651858.CD004667.pub4.Copyright>
- Sarpong, N., Loag, W., Fobil, J., Meyer, C. G., May, J., & Schwarz, N. G. (2010). National health insurance coverage and socio-economic status in a rural district of Ghana. *Trop Med Int Health*, 15(2), 191–197. <https://doi.org/10.1111/j.1365-3156.2009.02439.x>
- Saultz, J. W. (2003). Defining and Measuring Interpersonal Continuity of Care. *Ann Fam Med*, 1. <https://doi.org/10.1370/afm.23>
- Saultz, J. W., & Albedaiwi, W. (2004). Interpersonal Continuity of Care and Patient Satisfaction : A Critical Review. *Annals of Family Medicine*, 445–451. <https://doi.org/10.1370/afm.91>
- Saultz, J. W., & Lochner, J. (2005). Interpersonal Continuity of Care and Care Outcomes : A Critical Review. *Annals of Family Medicine*, 159–166. <https://doi.org/10.1370/afm.285>.
- Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students. Research methods for business students* (5th ed.). England: Pearson Education Limited. <https://doi.org/10.1007/s13398-014-0173-7.2>
- Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A.-B., Daniels, J., ... Alkema, L. (2014). Global Causes of Maternal Death: A WHO Systematic Analysis. *Lancet*, 2, e323-33.
- Scholl, I., Zill, J. M., Härter, M., & Dirmaier, J. (2014). An integrative model of patient-centeredness - a systematic review and concept analysis. *PloS One*, 9(9), e107828. <https://doi.org/10.1371/journal.pone.0107828>

- Scott, J., Tallia, A., Crosson, J. C., Orzano, a. J., Stroebel, C., DiCicco-Bloom, B., ... Crabtree, B. (2005). Social Network Analysis as an Analytic Tool for Interaction Patterns in Primary Care Practice. *Annals of Family Medicine*, 3, 443–448. <https://doi.org/10.1370/afm.344>
- Senah, K. (2003). Maternal Mortality in Ghana: The Other Side. *Research Review*, 19.1, 47–55.
- Shear, C. L., Gipe, B. T., Mattheis, J. K., & Levy, M. R. (1983). Provider Continuity and Quality of Medical Care : A Retrospective Analysis of Prenatal and Perinatal Outcome. *Medical Care*, 21(12), 1204–1210.
- Singh, K., Osei-akoto, I., Otchere, F., Sodzi-tettey, S., Barrington, C., Huang, C., ... Speizer, I. (2015). Ghana ' s National Health insurance scheme and maternal and child health : a mixed methods study, 1–13. <https://doi.org/10.1186/s12913-015-0762-y>
- Sodzi-Tettey, S., Aikins, M., Awoonor-Williams, J. K., & Agyepong, I. A. (2012). Challenges In Provider Payment Under The Ghana National Health Insurance Scheme : A Case Study of Claims, 46(4), 189–199.
- Srinivasan, U., & Uddin, S. (2015). A Social Network Framework to Explore Healthcare Collaboration, 1–28.
- Stanek, M., & Takach, M. (2010). Evaluating the Patient-Centered Medical Home: Potential and Limitations of Claims-Based Data. *State Health Policy Briefing*, 4(September), 1–7.
- Stange, K. C. (2009). The Problem of Fragmentation and the Need for Integrative Solutions. *Annals of Family Medicine*, 7(2), 100–103. <https://doi.org/10.1370/afm.971>
- Starfield, B. (1982). Continuous confusion? *Am J Public Health*, 70(2), 117–119.
- Starfield, B. H., Simborg, D. W., Horn, S. D., & Yourtee, S. A. (1976). Continuity and coordination in primary care: their achievement and utility. *Med Care*, 14(7), 625–36.
- Starfield, B., Shi, L., & Macinko, J. (2005). Contribution of primary care to health systems and health. *The Milbank Quarterly*, 83(3), 457–502. <https://doi.org/10.1111/j.1468-0009.2005.00409.x>
- Stulberg, D. B., Dahlquist, I., Jarosch, C., & Lindau, S. T. (2016). Fragmentation of Care in Ectopic Pregnancy. *Maternal and Child Health Journal*, 20(5), 955–961. <https://doi.org/10.1007/s10995-016-1979-z>
- Sturmberg, J. P. (2003). Continuity of care : A systems-based approach. *Asia Pacific Family Medicine*, 2, 136–142.
- Summerskill, W. S., & Pope, C. (2002). “ I saw the panic rise in her eyes , and evidence-based medicine went out of the door .” An exploratory qualitative study of the barriers to secondary prevention in the management of coronary heart disease, 19(6), 605–10.
- The Royal Women’s Hospital. (n.d.). Pregnancy care & birthing options. Retrieved September 2, 2016, from <https://www.thewomens.org.au/health-information/pregnancy-and-birth/now-you-are-pregnant/pregnancy-care-birthing-options/>
- Tsai, T. C., Orav, E. J., & Jha, A. K. (2015). Care Fragmentation in the Postdischarge Period. *JAMA Surgery*, 150(1), 59. <https://doi.org/10.1001/jamasurg.2014.2071>
- Turienzo, C. F., Sandall, J., & Peacock, J. L. (2016). Models of antenatal care to reduce and prevent preterm birth : a systematic review and meta-analysis. *BMJOpen*, 6. <https://doi.org/10.1136/bmjopen-2015-009044>
- Tyree, P. T., Lind, B. K., & Lafferty, W. E. (2006). Challenges of using medical insurance claims data for utilization analysis. *American Journal of Medical Quality*, 21(4), 269–75. <https://doi.org/10.1177/1062860606288774>

- Uddin, S., & Hossain, L. (2012). Effects of physician collaboration network on hospital outcomes. Australia: Melbourne.
- Uddin, S., Hossain, L., Hamra, J., & Alam, A. (2013). A study of physician collaborations through social network and exponential random graph. *BMC Health Services Research*, 13(1), 1–14. <https://doi.org/10.1186/1472-6963-13-234>
- Uddin, S., Hossain, L., & Kelaher, M. (2012). Effect of physician collaboration network on hospitalization cost and readmission rate. *Eur J Public Health*, 22. <https://doi.org/10.1093/eurpub/ckr153>
- Uddin, S., Kelaher, M., & Srinivasan, U. (2015). A framework for administrative claim data to explore healthcare coordination and collaboration. *Australia Health Review*. <https://doi.org/10.1071/AH15058>
- Uddin, S., Khan, A., & Piraveenan, M. (2015). Administrative Claim Data to Learn About Effective Healthcare Collaboration and Coordination through Social Network. In *2015 48th Hawaii International Conference on System Science* (pp. 3105–3114). IEEE Computer Society. <https://doi.org/10.1109/HICSS.2015.375>
- Van Walraven, C., Oake, N., Jennings, A., & Forster, A. J. (2010). The association between continuity of care and outcomes: A systematic and critical review. *Journal of Evaluation in Clinical Practice*, 16(5), 947–956. <https://doi.org/10.1111/j.1365-2753.2009.01235.x>
- Vanden Broeck, J., Feijen-de Jong, E., Klomp, T., Putman, K., & Beeckman, K. (2016). Antenatal care use in urban areas in two European countries: Predisposing, enabling and pregnancy-related determinants in Belgium and the Netherlands. *BMC Health Services Research*, 16(1), 337. <https://doi.org/10.1186/s12913-016-1478-3>
- Waldenstrom, U., & Turnbull, D. (1998). A systematic review comparing continuity of midwifery care with standard maternity services. *British Journal of Obstetrics and Gynaecology*, 105(November), 1160–1170.
- Weiss, L. J., & Blustein, J. (1996). Faithful patients: the effect of long-term physician-patient relationships on the costs and use of health care by older Americans. *Am J Public Health*, 86(12), 1742–1747. <https://doi.org/10.2105/AJPH.86.12.1742>
- WHO, UNICEF, UNFPA, World Bank Group, & United Nations Population Division. (2015). *Trends in Maternal Mortality : 1990 to 2015*. Geneva.
- Williams, K., Lago, L., Lainchbury, A., & Eagar, K. (2010). Mothers' views of caseload midwifery and the value of continuity of care at an Australian regional hospital. *Midwifery*, 26(6), 615–621. <https://doi.org/10.1016/j.midw.2009.02.003>
- Wilson, J., & Bock, A. (2012). *The benefit of using both claims data and electronic medical record data in health care analysis*. Retrieved from <https://www.optum.com/content/dam/optum/resources/whitePapers/Benefits-of-using-both-claims-and-EMR-data-in-HC-analysis-WhitePaper-ACS.pdf>
- Witter, S., Arhinful, D. K., Kusi, A., & Zakariah-akoto, S. (2007). The Experience of Ghana in Implementing a User Fee Exemption Policy to Provide Free Delivery Care. *Reprod Health Matters*, 15(30), 61–71.
- Witter, S., & Garshong, B. (2009). Something old or something new ? Social health insurance in Ghana. *BMC Int Health and Human Rights*, 13. <https://doi.org/10.1186/1472-698X-9-20>
- Witter, S., Garshong, B., & Ridde, V. (2013). An exploratory study of the policy process and early implementation of the free NHIS coverage for pregnant women in Ghana. *International Journal for Equity in Health*, 1–11. <https://doi.org/10.1186/1475-9276-12-16>

- Wolff, J. L., Starfield, B., & Anderson, G. (2002). Prevalence, Expenditures, and Complications of Multiple Chronic Conditions in the Elderly. *Arch Intern Med*, 162.
<https://doi.org/10.1001/archinte.162.20.2269>
- Wong, N., Browne, J., Ferguson, S., Taylor, J., & Davis, D. (2015). Getting the first birth right : A retrospective study of outcomes for low-risk primiparous women receiving standard care versus midwifery model of care in the same tertiary hospital. *Women and Birth*, 28(4), 279–284.
<https://doi.org/10.1016/j.wombi.2015.06.005>
- World Health Organization. (n.d.-a). Global Health Observatory (GHO) data: Antenatal care. Retrieved August 13, 2016, from
http://www.who.int/gho/maternal_health/reproductive_health/antenatal_care_text/en/
- World Health Organization. (n.d.-b). Health statistics and information systems: Maternal mortality ratio (per 100 000 live births). Retrieved August 12, 2016, from
<http://www.who.int/healthinfo/statistics/indmaternalmortality/en/>
- World Health Organization. (n.d.-c). Maternal Health. Retrieved August 5, 2016, from
http://www.who.int/topics/maternal_health/en/
- World Health Organization. (2002). *WHO Antenatal Care Randomized Trial: Manual for the Implementation of the New Model*.
- World Health Organization. (2005). *World Health Report 2005: Making Every Mother and Child Count*. Geneva.
- World Health Organization. (2015). *WHO Statement on Caesarean Section Rates*. Geneva.
<https://doi.org/WHO/RHR/15.02>
- World Health Organization. (2016a). Media centre: Maternal mortality. Retrieved January 10, 2018, from
<http://www.who.int/mediacentre/factsheets/fs348/en/>
- World Health Organization. (2016b). *WHO recommendations on antenatal care for a positive pregnancy experience*. Geneva.
- Yeji, F., Shibamura, A., Oduro, A., Debpuur, C., Kikuchi, K., Owusu-Agei, S., ... Kamiya, Y. (2015). Continuum of Care in a Maternal, Newborn and Child Health Program in Ghana: Low Completion Rate and Multiple Obstacle Factors. *PLoS ONE*, 10(12), 1–23.
<https://doi.org/10.1371/journal.pone.0142849>
- Yevutsey, S. K., & Aikins, M. (2010). Financial Viability of District Mutual Health Insurance Schemes of Lawra and Sissala East Districts , Upper West Region , Ghana. *Ghana Medical Journal*, 44(4).
- Yihui, X. (2016). knitr: A General-Purpose Package for Dynamic Report Generation in R. CRAN.
- Yon, G. V., La-coa, J. F., & Kunst, J. B. (2015). Build, Import and Export GEXF Graph Files. CRAN. Retrieved from <https://bitbucket.org/gvegayon/rgexf/wiki/Home; %0Ahttp://www.ggvega.com>
- Yoshioka-Maeda, K., Ota, E., Ganchimeg, T., Kuroda, M., & Mori, R. (2016). Caesarean section by maternal age group among singleton deliveries and primiparous Japanese women: a secondary analysis of the WHO Global Survey on Maternal and Perinatal Health. *BMC Pregnancy and Childbirth*, 16(1), 39. <https://doi.org/10.1186/s12884-016-0830-2>
- Zafarani, R., Abbasi, M. A., & Liu, H. (2014). *Social Media Mining: An Introduction*. Cambridge University Press.
- Zhang, J., Geerts, C., Hukkelhoven, C., Offerhaus, P., Zwart, J., & de Jonge, A. (2016). Caesarean section rates in subgroups of women and perinatal outcomes. *BJOG: An International Journal of Obstetrics & Gynaecology*, 123(5), 754–761. <https://doi.org/10.1111/1471-0528.13520>

Appendices

8.1 Appendix A1: Details of providers included in the study

Provider	Type	Number of patients with at least one visit	Number of Visits	Number of Deliveries	Number of CS deliveries	Visits				Delivery		C-Section		Delivery at New Place		CS at New Place		Provider Continuity (%)	% deliveries on first visit	% potential del – moving out
						In-Degree	Out-Degree	Weighted In-Degree	Weighted out-Degree	Weighted In-Degree	Weighted out-Degree	Weighted In-Degree	Weighted out-Degree	Weighted In-Degree	Weighted out-Degree					
Hospitals																				
M Marquart Cath Hosp	Hosp	1565	5666	1293	353	56	53	946	514	382	56	123	8	194	27	60	4	67.8	15.0	5.8
Nkwanta Dist Hosp	Hosp	759	1871	460	61	40	39	605	479	199	101	34	11	96	26	20	8	52.8	20.9	27.9
Krachi West Dist Hosp	Hosp	943	3305	616	134	18	19	450	568	114	102	33	3	20	34	5	2	69.1	3.2	16.9
Ho Mun Hosp	Hosp	1420	5935	1172	202	51	50	485	366	241	150	39	36	169	105	23	26	76.5	14.4	13.9
Volta Reg Hosp	Hosp	1334	6244	1215	286	49	41	569	243	332	49	98	8	231	25	72	5	74.6	19.0	5.3
Hohoe Mun Hosp	Hosp	1139	4967	973	144	43	45	452	287	245	97	42	32	182	62	36	21	74.7	18.7	11.8
Mary Theresa Hosp	Hosp	604	1669	517	84	26	22	478	241	236	24	48	7	95	12	22	5	62.9	18.4	7.9
Cath Hosp Anfoega	Hosp	575	1874	476	41	38	32	405	219	109	52	11	13	50	30	6	11	68.9	10.5	12.4
St Joseph Hosp	Hosp	429	990	302	39	36	30	380	238	183	21	23	4	76	13	13	4	50.5	25.2	15.0
Worawora Hosp	Hosp	501	1241	388	74	26	20	315	181	197	29	52	8	132	24	30	7	58.1	34.0	13.2
Ho Royal Hosp	Hosp	526	2522	383	118	29	30	231	198	90	48	21	13	72	22	15	8	67.4	18.8	14.1
Peki Govt Hosp	Hosp	540	1843	459	43	33	29	272	152	125	40	17	13	52	27	13	10	75.0	11.3	10.7
Keta Mun Hosp	Hosp	564	1748	523	89	31	16	299	94	155	17	30	3	80	9	13	1	74.5	15.3	4.4
Jasikan Dist Hosp	Hosp	551	1818	461	93	29	25	226	147	141	48	41	8	105	25	35	7	70.0	22.8	13.0
Sacred Heart Hosp	Hosp	494	1689	463	74	32	21	228	74	158	14	25	0	110	7	19	0	73.2	23.8	4.4
Ketu South Dist Hosp	Hosp	1101	4687	1019	157	32	27	95	105	55	44	13	18	36	30	10	15	92.6	3.5	4.4
St Anthonys Hosp	Hosp	293	1088	281	51	29	11	102	20	71	4	20	1	49	3	17	1	79.7	17.4	1.9
Akatsi Dist Hosp	Hosp	178	612	146	15	19	15	41	38	15	26	3	5	11	14	1	4	82.7	7.5	16.6
Adidome Hosp	Hosp	104	241	98	11	9	4	65	14	44	5	4	1	37	4	3	1	62.0	37.8	8.5
Aflao Central Hosp	Hosp	122	489	100	17	10	7	34	23	12	19	2	8	7	14	1	6	83.3	7.0	17.8
Sape Agbo Mem Hosp	Hosp	89	226	80	10	12	4	41	11	31	1	2	0	20	1			69.6	25.0	2.0

St Patrick Hosp	Hosp	35	50	7	7	9	11	22	29	2	0	2	0	1	0	1	0	33.7	14.3	0.0
St Pauls Hosp	Hosp	49	121	33	7	12	5	25	24	12	7	1	2	7	5	1	1	68.0	21.2	25.0
Cath Hosp Battor	Hosp	428	1794	413	61	18	11	23	16	10	8	4	2	6	3	2	0	95.9	1.5	1.9
Sogakppe Dist Hosp	Hosp	24	36	12	1	5	6	17	12	8	2	1	0	5	2			43.4	41.7	33.3
Comboni Hosp	Hosp	54	127	53	13	11	1	24	1	23	1	7	0	20	0	6	0	67.3	37.7	3.2
Health Centre																				
Kpando HC	HC	409	946	94		20	24	138	379	4	128	0	23	2	62	0	8	46.8	2.1	58.7
Kpassa HC	HC	358	889	184		17	15	208	281	45	107	0	10	23	53	0	8	57.6	12.5	43.5
Kpetoe HC	HC	419	1264	154		16	18	147	326	12	123	0	25	8	89	0	16	60.2	5.2	46.4
Dambai HC	HC	287	743	91		16	20	170	280	17	145	0	26	8	84	0	19	54.7	8.8	66.2
Ziope HC	HC	157	473	61		10	11	164	176	20	52	0	17	6	43	1	14	55.8	9.8	55.9
EP Church HC	HC	229	574	97		12	20	138	184	30	62	0	12	9	40	0	7	55.5	9.3	48.1
St. Lukes Clinic	HC	173	393	110		8	7	171	120	71	23	0	8	35	7	0	2	49.2	31.8	37.1
Kadjebi HC	HC	278	1050	135		14	18	94	196	10	101	0	30	3	57	0	15	70.7	2.2	44.7
Borae HC	HC	110	221	43		6	6	112	115	15	34	0	7	2	7			44.0	4.7	54.8
Have HC	HC	155	359	39		14	17	64	158	6	49	0	8	2	23	0	7	48.3	5.1	59.8
Dodo Amanfrom HC	HC	114	194	5		7	8	70	136	1	68	0	9	0	16	0	3	38.8	0.0	94.4
Banda HC	HC	104	262	61		5	4	114	90	10	23	1	6	2	6			52.8	3.3	31.1
Abotoase HC	HC	137	416	26		12	16	62	141	2	96	0	25	2	61	0	17	62.1	7.7	80.0
Anyinamae HC	HC	93	265	57		3	5	97	72	11	25	0	3	4	12			57.9	7.0	35.2
Katanga HC	HC	155	442	99		12	14	72	83	14	36	0	6	8	18	0	4	69.3	8.1	29.8
Tegbi HC	HC	124	251	22		3	3	32	121	7	49	0	6	3	29	0	3	49.9	13.6	76.6
Tongor Tsanakpe HC	HC	131	390	55		5	9	57	91	14	41	0	4	6	32	0	2	61.7	10.9	50.0
Ahamansu HC	HC	92	252	39		6	4	52	88	3	45	0	5	0	14	0	3	63.4	0.0	55.6
Logba Vuinta HC	HC	97	231	25		10	13	43	86	8	48	0	10	3	33	0	6	52.9	12.0	73.8
Grubi HC	HC	71	213	53		2	2	75	53	3	14	0	2	1	7			66.3	1.9	21.9
Nkonya Wurupong HC	HC	68	124	4		7	6	42	81	2	19	0	7	1	12	0	4	40.6	25.0	90.5
Anloga HC	HC	88	182	29		7	7	30	77	6	47	0	9	5	18	0	3	55.8	17.2	67.1
Waya HC	HC	54	174	33		9	6	57	48	12	10	0	2	1	9	0	2	59.0	3.0	32.3
Ehiamankyene HC	HC	48	85	25		4	2	55	44	18	7			9	0			35.5	36.0	50.0
Ve Ghad HC	HC	69	176	19		9	9	34	63	8	30	0	5	6	25	0	4	55.9	31.6	73.2

Bodada HC	HC	53	144	18		5	4	41	50	3	20	0	3	1	8	0	2	54.3	5.6	57.1
wusuta HC	HC	44	89	8		4	6	37	53	4	11	0	3	1	1			41.2	12.5	73.3
New Ayoma HC	HC	108	345	70		8	9	39	49	12	22	0	9	6	16	0	7	73.7	8.6	27.5
Afiadenyigba HC	HC	84	235	16		8	9	14	73	1	59	0	4	1	44	0	2	66.4	6.3	79.7
Dzake HC	HC	39	73	4		7	8	36	50	1	12			0	2			34.2	0.0	80.0
Agbenoxoe HC	HC	39	120	13		7	8	34	41	4	20	0	9	3	8	0	2	52.7	23.1	69.0
Likpe Bakwa HC	HC	80	273	39		10	9	25	49	3	31	0	6	2	25	0	6	74.2	5.1	46.3
Poase Cement HC	HC	42	85	6		4	5	26	46	3	11	0	3	1	5	0	1	42.5	16.7	78.6
Ave Dakpa HC	HC	42	98	7		5	8	21	40	1	27	0	5	1	18	0	4	51.7	14.3	81.8
Tokuroano HC	HC	37	75	4		7	10	21	38	1	19	0	3	1	12	0	1	47.0	25.0	86.4
Anyanui HC	HC	52	186	16		3	3	11	44	0	33	0	8	0	20	0	2	75.1	0.0	67.3
Nyive HC	HC	61	197	31		4	4	18	34	7	25	0	6	6	16	0	3	70.7	19.4	51.0
Ve Golokwati HC	HC	33	79			5	5	15	35	0	16	0	2	0	12	0	1	44.1		100.0
Lolobi HC	HC	47	155	19		5	7	15	34	3	23	0	1	0	15			71.8	0.0	59.0
Pampamwie HC	HC	24	45	2		3	3	18	31	2	10	0	4	0	6	0	2	44.1	0.0	100.0
Dzolo kpuita HC	HC	47	119	27		8	3	24	24	6	12	0	1	6	9	0	1	60.8	22.2	36.4
Fodome Ahor HC	HC	39	140	24		4	5	19	29	3	12	0	2	2	8			73.1	8.3	36.4
Kwamekrom HC	HC	30	51	7		7	7	19	29	4	13	0	3	2	7	0	1	43.8	28.6	81.3
Gbi Wegbe HC	HC	35	106			3	5	9	38	0	31	0	5	0	25	0	3	63.4		100.0
Akrofu HC	HC	32	74	9		6	7	16	29	3	14	0	1	2	11			52.4	22.2	70.0
Wegbe Kpalime HC	HC	35	109	14		6	11	14	29	2	15	0	1	0	12	0	1	65.6	0.0	55.6
Dormabin HC	HC	38	87	16		6	8	16	26	3	14	0	8	2	7	0	3	57.3	12.5	51.9
Tsito HC	HC	34	88	9		4	6	14	28	0	18	0	1	0	15	0	1	64.8	0.0	66.7
Botoku HC	HC	23	38	7		4	4	20	22	5	10	0	3	4	5	0	3	33.6	57.1	83.3
Kudzra HC	HC	19	36			2	2	15	25	0	6							31.1		100.0
Agbozome HC	HC	31	70			3	8	6	33	0	28	0	6	0	23	0	6	60.2		100.0
Tsrukpe HC	HC	18	39			4	4	13	26	0	5	0	1	0	2	0	1	37.7		100.0
Adzokoe HC	HC	28	37			1	5	4	31	0	15			0	4			32.2		100.0
Brewaniase HC	HC	18	24			3	4	14	21	0	7	0	2	0	1	0	1	28.7		100.0
Santrokofi HC	HC	24	92	2		4	2	6	24	1	21	0	2	1	18	0	2	72.8	50.0	95.5
Salvation Army	HC	18	36			4	8	10	19	0	8	0	2	0	4	0	1	39.6		100.0

Sabadu HC	HC	14	27	7		5	4	16	12	5	2			2	1			43.6	28.6	50.0
Baika HC	HC	18	53			4	2	8	19	0	11	0	1	0	9	0	1	51.5		100.0
Klikor HC	HC	41	101	23		5	4	7	19	4	16	0	5	2	11	0	3	71.8	8.7	45.7
Dodi Mempeasem HC	HC	17	21			3	2	7	19	0	3	0	1	0	2	0	1	24.9		100.0
Fodome Helu HC	HC	21	70	4		3	4	5	19	0	13			0	9			69.6	0.0	76.5
Damanko HC	HC	19	46	12		4	4	10	11	1	5			0	2			65.6	0.0	31.3
Likpe Bala HC	HC	32	93	20		5	3	6	13	4	10	0	2	3	10	0	2	77.1	15.0	38.5
Dabala HC	HC	26	86	16		1	3	5	14	0	10	0	2	0	6	0	1	80.0	0.0	38.5
Tregui HC	HC	16	42	5		4	6	7	12	2	8	0	3	0	8	0	3	63.8	0.0	72.7
Asukawkaw HC	HC	10	13			3	2	8	11	0	4			0	3			33.5		100.0
Kpalime Duga HC	HC	10	17			2	3	6	12	0	4			0	3			31.9		100.0
Leklebi Duga HC	HC	9	15			3	3	7	11	0	6	0	2	0	1	0	1	33.0		100.0
Adutor HC	HC	46	186	42		5	5	9	8	4	2			3	2			87.7	7.1	5.0
Juapong HC	HC	27	91	21		6	1	8	9	2	5	0	1	0	3	0	1	78.5	0.0	20.8
Shia HC	HC	22	74	11		6	3	6	11	1	9	0	2	1	6	0	1	72.8	9.1	47.4
Tadzewu HC	HC	15	28	6		3	3	8	9	4	4	0	1	2	4	0	1	53.2	33.3	66.7
Nsuta HC	HC	10	11			2	3	7	10	0	1							25.0		100.0
Tutukpene HC	HC	9	17			4	3	6	11	0	5	0	1	0	1			43.7		100.0
Matse HC	HC	12	26			2	3	4	12	0	6	0	3	0	5	0	2	51.0		100.0
Aveme HC	HC	11	18	2		2	4	4	12	0	5	0	1	0	1			38.6	0.0	71.4
Awate HC	HC	10	15			2	1	5	11	0	6			0	2			34.8		100.0
Afife HC	HC	18	40	11		5	3	7	8	2	5			2	3			64.6	18.2	35.7
Akporkploe HC	HC	13	28			1	3	2	13	0	11			0	8			56.1		100.0
Leklebi Kame HC	HC	8	11	1		2	2	4	8	1	3	0	1	1	1			25.7	100.0	100.0
Kedzi HC	HC	6	7			2	1	5	7	0	1							23.1		100.0
Ehi HC	HC	9	16	1		2	3	2	9	1	5			0	5			49.0	0.0	100.0
Klefe HC	HC	8	19			1	4	2	9	0	6			0	4			55.0		100.0
Dodome Awuiase HC	HC	8	26	5		2	1	5	5	0	2			0	2			69.4	0.0	28.6
Anyako HC	HC	7	11			3	3	3	7	0	4			0	2			36.0		100.0
Weta HC	HC	5	9			3	3	4	6	0	2			0	1			39.9		100.0
Koni HC	HC	5	5			4	4	5	5	0	2	0	1	0	2	0	1	24.5		100.0

Agavedzi HC	HC	7	10			2	4	2	7	0	5	0	1	0	4	0	1	42.9		100.0
Ahunda HC	HC	5	7	2		3	3	5	4	1	1			1	1			35.2	50.0	50.0
Gadza HC	HC	5	6			2	3	2	6	0	2							24.0		100.0
Kodzi HC	HC	5	10			1	1	2	5	0	3			0	2			50.7		100.0
Atorkor HC	HC	5	8			1	1	2	5	0	3			0	1			43.3		100.0
Gefia HC	HC	5	8	1		1	1	2	4	1	2			1	2			45.0	100.0	100.0
Kpotame HC	HC	7	19	2		0	3	0	5	0	5	0	2	0	4	0	2	76.2	0.0	71.4
Devego HC	HC	5	9			0	3	0	5	0	4			0	4			60.0		100.0
Penyi HC	HC	9	24	5		0	1	0	4	0	3			0	3			82.0	0.0	37.5
Asadame HC	HC	7	21	3		0	1	0	4	0	3			0	3			77.6	0.0	50.0
Clinic, CHPS and others																				
Mater Ecclesiae Clinic	Clinic	222	920	89		16	22	72	161	9	96	0	13	5	63	0	7	71.3	5.6	54.5
EP Clinic	Clinic	128	287	62		9	11	69	95	22	44	0	9	18	23	0	7	54.0	29.0	52.4
St George Clinic	Clinic	85	259	35		12	14	55	76	8	28	0	7	4	15	0	3	59.9	11.4	50.9
Pentecost Clinic Kpassa	Clinic	24	44			7	8	21	30	0	11	0	1	1	5			36.1		100.0
Afatome Clinic	Clinic	19	28			3	6	6	20	0	8			0	2			32.5		100.0
Finlandia clinic	Clinic	18	45	1		2	5	5	19	0	15	0	2	0	14	0	2	60.4	0.0	93.8
Foresight MC	Clinic	6	16			3	3	4	6	0	4			0	2			45.4		100.0
Mafe Kumase CHPS	CHPS	81	239	15		6	10	14	73	1	48	0	6	0	40	0	5	65.5	0.0	77.4
Keri CHPS	CHPS	37	81	2		4	7	27	50	0	24	0	4	0	15	0	3	44.2	0.0	92.3
Bonakye CHPS	CHPS	37	63			6	6	18	44	0	27	0	5	0	14	0	1	40.9		100.0
Aveme Danyigba CHPS	CHPS	23	52	3		6	4	21	26	1	13	0	4	0	5	0	1	41.3	0.0	86.7
Jordannu CHPS	CHPS	25	37	1		4	3	17	29	0	3			0	1			31.5	0.0	75.0
Hofedo CHPS	CHPS	22	47			3	3	12	27	0	9	0	2	0	4	0	1	38.2		100.0
Nyambong CHPS	CHPS	18	32			3	2	12	25	0	3							32.4		100.0
Agoufie CHPS	CHPS	18	41	1		4	5	12	23	0	15	0	1	0	5	0	1	52.1	0.0	93.8
Koe CHPS	CHPS	17	39	2		3	4	13	22	0	7			0	3			41.8	0.0	77.8
Kabiti CHPS	CHPS	18	35	2		3	3	10	22	1	11	0	2	0	1			40.6	0.0	91.7
Bume CHPS	CHPS	17	24			1	3	6	20	0	7	0	1	0	1			31.1		100.0
Fesi CHPS	CHPS	15	20			3	3	9	17	0	6	0	1	0	1			29.1		100.0
Alukpatsa CHPS	CHPS	14	28			3	4	8	17	0	13	0	2	0	5	0	1	44.9		100.0

Tsiyinu CHPS	CHPS	16	38			3	2	4	19	0	11	0	2	0	6	0	2	52.4		100.0
Tsibu CHPS	CHPS	10	20	4		2	3	10	11	3	0			1	0			37.7	25.0	0.0
Obanda CHPS	CHPS	10	27			3	3	7	14	0	7	0	1	0	6	0	1	52.7		100.0
Kechebi CHPS	CHPS	12	13			2	2	7	13	0	6	0	1	0	1			26.9		100.0
Azua CHPS	CHPS	12	26			3	4	7	12	0	9			0	5			48.1		100.0
Sibi Central CHPS	CHPS	11	18			2	6	6	13	0	6	0	2	0	3	0	2	40.2		100.0
Wudzedeke CHPS	CHPS	10	21			3	7	7	12	0	6			0	5			42.2		100.0
Chaiso CHPS	CHPS	8	22			2	2	7	12	0	7	0	1	0	4			50.8		100.0
Salifu CHPS	CHPS	12	15			2	2	5	13	0	5	0	1	0	1	0	1	31.5		100.0
Bontibor CHPS	CHPS	9	14			3	3	5	11	0	3	0	1	0	1			27.9		100.0
Dafor CHPS	CHPS	8	12			4	2	5	10	0	3	0	1	0	1			29.9		100.0
Ofosu CHPS	CHPS	7	11			5	4	6	9	0	2	0	1	0	1			34.3		100.0
Wadamaxe CHPS	CHPS	6	16			2	2	5	10	0	3			0	1			43.1		100.0
Gbefi CHPS	CHPS	7	9			2	1	5	9	0	1							19.5		100.0
Liatu wote CHPS	CHPS	5	6			2	2	6	6	0	1							23.9		100.0
Dededo CHPS	CHPS	8	20	2		3	2	4	7	0	3			0	3			57.5	0.0	60.0
Sibi Hilltop CHPS	CHPS	7	21			2	3	2	9	0	7	0	1	0	4	0	1	62.9		100.0
Odumase CHPS	CHPS	7	12			1	2	2	8	0	2			0	1			37.4		100.0
Tsatee CHPS	CHPS	7	14			3	4	3	7	0	3			0	2			41.3		100.0
Nabu CHPS	CHPS	7	29	4		3	5	4	5	0	2	0	1	0	2	0	1	78.4	0.0	33.3
Takla CHPS	CHPS	5	6			1	1	2	6	0	1							27.4		100.0
Likpe Agbozome CHPS	CHPS	5	10	1		2	3	2	4	0	3			0	1			51.5	0.0	75.0
Ho Polyclinic	Poly	112	288			9	11	41	135	0	53	0	5	0	17	0	1	39.4		100.0
Kpedze Polyclinic	Poly	27	60	10		3	4	9	20	1	9	0	2	1	9	0	2	63.8	10.0	50.0
Kpassa Mat Home	MH	264	663	152		13	10	241	210	71	51	0	6	26	27	0	3	53.6	17.1	38.6
Kafui Maternity	MH	32	93	5		3	3	31	50	1	14			0	6			47.9	0.0	77.8
Mattys mat home	MH	20	25			5	7	12	24	0	3	0	1	0	2			24.8		100.0
Salem Mat Home	MH	18	35	10		4	4	9	11	5	3	0	1	4	2	0	1	51.4	40.0	37.5

8.2 Appendix B: Samples of the computer codes

B1: Transforming the facilities visited

```
# Written by Samuel K. K. Dery
# University of Ghana, School of Public Health

# This code takes a series of health facilities that a patient has attended
# then transform the facilities attended into a series of "A", "B", "C" etc as follows:
# For each patient, the first facility visited and any subsequent visit to same facility
# will be labeled A. The second facility visited and any subsequent visit to same facility will
# be labeled B and third facility visited will be labeled C and so on.

# This is to help reduce the number of facilities to a manageable level at the global level since
# the label becomes a placeholder for the facility.

facility_trans <- function(ft) {

  # First get the list of facilities (ft), separated by commas (,) and assign to variable f
  f<-unlist(as.vector(ft))

  f1<-f
  # Get the distinct (unique) facilities visited and use them to loop through f

  x<-unique(f)

  for (j in 1:length(x)) {
    # for each unique facility visited, loop through f and assigned any
    # occurrence of the facility an alphabet based on the position of the unique occurrence

    for (i in 1:length(f)){

      if (f[i]==x[j]) {

        f1[i]<-LETTERS[j]

      }
    }
  }

  return(f1)
}
```

B2: Continuity of Care Indices

```
#####

# These functions take a series of health facilities that a patient has attended
# in the form of a vector e.g. "Legon hospital", "Trust hospital", "Madina clinic" etc and then
# calculate various continuity of care indices.
#####

# Most frequently visited Provider Continuity
# This function calculates the proportion of visits to the most frequently visited provider
# as described in section 3.8.1
upc_cont <- function(ft) {
  #upc = max(n1, n2,...nk)-1 divided by N-1. Where N is the total number of visits
  upc<-(max(table(ft))-1)/(length(ft)-1)
  upc # display the results
}

# *****
# modified modified continuity

# This function calculates the modified modified continuity of care index
#as described in section 3.8.2

mmci_Cont <- function(ft) {
  mmci<- (1-(length(unique(ft)))/(length(ft)+0.1))/(1-(1/(length(ft)+0.1)))
  mmci
}

# *****
# Sequential Continuity of care

# This function calculates the sequential continuity of care as described in section 3.8.4

scon_cont <- function(ft) {
  # initialize the count

  cont_x<-0
  for (i in 2:length(ft)) {
    if (ft[i]==ft[i-1])
```

```

    cont_x<-cont_x+1 # sums the count of the numbers
  }
# Divide the sum by the number of visits (length(ft) - 1)
cont_x/(length(ft)-1)
}

# *****
# Continuity of care index

# This function calculates the Bice and Boxerman continuity of care index as described in
section 3.8.3

coc_cont <- function(ft) {
  tt<-table(ft) #Get the number of visits to each provider (frequency)
  sum<-0      # Initialise the sum of the numbers
  for (i in 1:length(tt)){
    sum<- sum + (tt[i])^2 # square the number of visits to each provider and sum #them up
  }
  coc<-(sum-length(ft))/(length(ft)*(length(ft)-1)) # Calculate the COC index
  names(coc)<-NULL # Drop the name label of the calculated coc
  coc # display the coc index
}

# *****
# Place of delivery continuity

# This function calculate the place of delivery continuity as described in section 3.8.5

lpc_cont <- function(ft) {
  # initialize the count
  cont_x<-0
  for (i in 1:length(ft)) {
    if (ft[i]==ft[length(ft)])
      cont_x<-cont_x+1 # sums the count of the numbers
  }

```

```

# Divide the sum by the number of visits (length(ft)-1)
(cont_x-1)/(length(ft)-1)
}

```

B3: Function to Create Sequence Data

This programme extracts the sequence of facilities (providers) visited for each patient and
create a data frame with the sequence

```

Create_Seq <- function(mylist){
seq.data <- data.frame("NHISID"=numeric(), "provider"=character(), "visit"=numeric(),
"nproviders"=numeric())

for (i in 1: length(mylist)) {

  a<-mylist[[i]]
  fac.visit<-facility_trans(a)
  provider<-paste(fac.visit,collapse = ",") #Group the transformed providers as one string"

  visit<-length(fac.visit)  #get number of visits
  nproviders<-length(unique(fac.visit))  #get number of providers visited

  seq.data = rbind(seq.data, data.frame("NHISID"=names(mylist[i]),"visit sequence"=provider,
"visits"=visit, "providers"=nproviders))
}

# Write the resultig data frame (cont.data) to the Global Environment)
assign("seq.data", seq.data, envir = .GlobalEnv)
}

```

B4: Function to Create Continuity Data

This programme calculates the continuity scores for each patient using the functions described
above and creates a data frame with the scores for each patient

```

Create_Cont <- function(mylist) {

```

```

cont.data <- data.frame("NHISID"=numeric(), "upc"=numeric(), "mmci"=numeric(),
"coc"=numeric(), "scon"=numeric(), "lpc"=numeric())

for (i in 1: length(mylist)) {

  a<-mylist[[i]]
  upc<-upc_cont(a)
  mmci<-mmci_Cont(a)
  coc<-coc_cont(a)
  scon<-scon_cont(a)
  lpc<-lpc_cont(a)

  cont.data = rbind(cont.data, data.frame("NHISID"=names(mylist[i]), "mfpc"=upc,
"mmci"=mmci, "coc"=coc, "scon"=scon, "lpc"=lpc))
}

# Write the resultig data frame (cont.data) to the Global Environment)
assign("cont.data", cont.data, envir = .GlobalEnv)
}

```

B5: Measuring Extent of Repeat visits

This code create a cross tabulation of the patients and providers.
 # It counts the number of times a patient visited a provider. It further calculates the proportion of
 # the patient visits to each provider as described in section 3.8.6

```
setwd("~/Google Drive/PhD Work/Health Insurance/Provider Continuity")
```

```
library(reshape2) #Load the reshape2 library
```

```
library(clusterSim)
```

```
load("~/Documents/Health Insurance/Data Processing/nhisdata.Rdata")
```

Create a cross tabulation of patient visits to a provider

```

dat3<-acast(nhisdata, NHISID ~ FacilityName , value.var='NHISID',
  fun.aggregate=length, margins=TRUE)

```

Get the number of providers and add 1 to cater for the total

```

num.provider<-(length(unique(nhisdata$FacilityName))+1)
num.patient<-length(dat3[,1]) # Get the number of patients

#This code calculate the proportion of visits to each provider by each patient

dat4<-matrix(,(num.patient-1),num.provider) # Create and initialise the patient-provider matrix

for (i in 1:(num.patient-1)){ # for each patient
  for (j in 1:num.provider){ # for each provider of the patient
    if(dat3[i,j]!=0){      # excludes cells with zeros from the calculation
      dat4[i,j]<-(dat3[i,j])/(dat3[i,num.provider]) # calculate the proportion of visits to each
provider
    }
  }
}

colnames(dat4)<-colnames(dat3) # Set column names of dat4 to be same as dat3

# Reshape the structure of the data

mydat4<-melt(dat4)
mydat4<-na.omit(mydat4)

names<-c("Var","FacilityName","Prop")
colnames(mydat4)<-names

mydat4<-subset(mydat4,FacilityName!="(all)")

# get the facility details
facility<-read.csv("~/Google Drive/PhD Work/Health Insurance/Data Processing/Facilities for
Continuity.csv" , stringsAsFactors=FALSE)

provider.continuity<-join(mydat4,facility, by='FacilityName',type='left',match='all')

provider.continuity<-na.omit(provider.continuity)

```

```

fac_cont <- getDescriptionStatsBy(provider.continuity$Prop, provider.continuity$Type,digits =
2,
    statistics = TRUE,add_total_col = TRUE,total_col_show_perc = TRUE, html=TRUE)

save(provider.continuity,file="/Users/skdery/Google Drive/PhD Work/Health Insurance/Provider
Continuity/Provider Continuity Data.Rdata")

write.xlsx(x = provider.continuity, file="/Users/skdery/Google Drive/PhD Work/Health
Insurance/Provider Continuity/Final Provider Continuity Data for analysis1.xlsx",
    sheetName = "Provider Continuity", row.names = TRUE)

```

B6: Reading Data from CSV file

```

# Written by Samuel K. K. Dery
# University of Ghana, School of Public Health
#*****

setwd("~/Google Drive/PhD Work/Health Insurance/Calculate Continuity")
library(dplyr)

# Read ANC visit and delivery data
nhisdata<-read.csv("~/Google Drive/PhD Work/Health Insurance/Data Processing/Final Final
Data.csv" , stringsAsFactors=FALSE)

# Sort the data by NHIS ID and attendance date
nhisdata<- nhisdata[order(nhisdata$NHISID, nhisdata$AttendDate),]

# Select only patient with at least 3 visits

tt <- table(nhisdata$NHISID) # get number of visits per patient

nhisdata <- nhisdata[nhisdata$NHISID %in% names(tt[tt > 2]), ] # Select number of visit > 2

# Split the data by patient and provider.
# That is, for each patient (NHIS ID) get the list of providers visited

mylist <- split(nhisdata$FacilityName, nhisdata$NHISID)

```

```
# Aggreagte the cost of services and drugs per patient

detach("package:plyr", unload=TRUE) # Detach plyr package. It seem to aggregate the entire
#cost and not by PID

library(dplyr)

Cost.Data<-nhisdata %>%
  group_by(NHISID) %>%
  summarise(ServiceCost = sum(Services), DrugCost=sum(Medicines))

# Save the file
save(nhisdata,file="~/Google Drive/PhD Work/Health Insurance/Calculate Continuity/Final
Visit Data for Analysis.Rdata")
```

B7: Provider Network during delivery

```
# This program create the edges of the provider network during delivery. The edge is formed
#using the regular ANC facility and the facility of delivery In addition it creates a network graph
#that can be imported into Gephi for further manipulation as described in sections 3.8 and 3.9

setwd("~/Google Drive/PhD Work/Health Insurance/Social Networking/Delivery Max")

library(igraph)
library(rgexf)

# This section of the code get the edges of the patient movement from the health facilities
aa<-mylist # Mylist contains the ordered list of health facilities visited by the patient
bb<-NULL
cc<-matrix(,1)
for (i in 1:length(aa)){
  bb<-myedge_delMax(aa[[i]]) # call the function that makes the edges (myedge_Maxdel()) as
#one string
  cc<-rbind(cc,bb) # row combine all the edges for all patients
}

# *****
```

```

# This code splits the edges apart with LHS and RHS

nnk<-matrix(, ,2) # create a matrix with n rows and 2 columns
nk<-NULL
for (i in 1:length(cc)){
  nk<-strsplit(cc[i,1],",") [[1]]

  nnk<-rbind(nnk,nk) # row combine all the edges for all patients
  nnk<-na.omit(nnk) # Remove row with NAs
}

nnk1<-as.data.frame(nnk)

library(dplyr)
nnk2<- nnk1 %>% group_by(V1,V2) %>%
  summarize(Count = n())

prov_links <-nnk2
colnames(prov_links)[3] <- "weight"

net <- graph_from_data_frame(d=prov_links, directed=T)

net <- simplify(net, remove.multiple = F, remove.loops = T)

E(net)$width <- 1+E(net)$weight/200
E(net)$arrow.size <- .2

write.graph(net, file="All Provider_DelMax_New.graphml", format="graphml")

```

B8: Data Management

```

##### DATA MANAGEMENT #####
# This code does some basic data management of the final data created from
# the ANC Data. Some of the data management task includes: recoding, removing factors and
# changing other variables to factors

setwd("~/Google Drive/PhD Work/Health Insurance/Calculate Continuity")

delivery.data<-read.csv("~/Google Drive/PhD Work/Health Insurance/Data
Processing/Deliveries - Test.csv" , stringsAsFactors=FALSE)

```

```

Seq_Cont.Data_Merge<- merge(seq.data, cont.data, by="NHISID") # merge sequence and
#continuity data
mydata.final1<-Seq_Cont.Data_Merge

# Merge delivery and age data to mydata.final here
#mydata.final <- merge(mydata.final1,delivery.data,by="NHISID")

# Merge cost data to mydata.final here
#mydata.final <- merge(mydata.final, Cost.Data,by="NHISID")

# Converting continuous variables to categorical variables

# mfpc
mydata.final$mfpc_cat1<-cut(mydata.final$mfpc, breaks=c(-Inf,0.24,0.49,0.74,0.99,Inf),
                           labels =c("Poor (0.00-0.24)", "Low (0.25-0.49)", "Medium (0.50-0.74)", "High
(0.75-0.99)", "Perfect (1.0)"))

#mmci
mydata.final$mmci_cat1<-cut(mydata.final$mmci, breaks=c(-Inf,0.24,0.49,0.74,0.99,Inf),
                           labels =c("Poor (0.00-0.24)", "Low (0.25-0.49)", "Medium (0.50-0.74)", "High
(0.75-0.99)", "Perfect (1.0)"))

#coc
mydata.final$coc_cat1<-cut(mydata.final$coc, breaks=c(-Inf,0.24,0.49,0.74,0.99,Inf),
                           labels =c("Poor (0.00-0.24)", "Low (0.25-0.49)", "Medium (0.50-0.74)", "High
(0.75-0.99)", "Perfect (1.0)"))

#scon
mydata.final$scon_cat1<-cut(mydata.final$scon, breaks=c(-Inf,0.24,0.49,0.74,0.99,Inf),
                           labels =c("Poor (0.00-0.24)", "Low (0.25-0.49)", "Medium (0.50-0.74)", "High
(0.75-0.99)", "Perfect (1.0)"))

#lpc
mydata.final$lpc_cat1<-cut(mydata.final$lpc, breaks=c(-Inf,0.01,0.24,0.49,0.74,0.99,Inf),
                           labels =c("Poor (0.00)", "Very low (0.01-0.24)", "Low (0.01-0.49)", "Medium
(0.50-0.74)", "High (0.75-0.99)", "Perfect (1.0)"))

# Convert Age to numeric variable
mydata.final$Age<-as.numeric(mydata.final$Age)

# Age group
#mydata.final$Age_cat1<-cut(mydata.final$Age, breaks=c(10,20,30,40,Inf),
#
#                           labels =c("11-20", "21-30", "31-40", "41+"))

```

```

mydata.final$Age_cat2<-cut(mydata.final$Age, breaks=c(-Inf,17,24,34,Inf),
                           labels =c("< 18","18-24", "25-34","35+"))

mydata.final$Prov_cat1<-cut(mydata.final$providers, breaks=c(-Inf,1,2,3,Inf),
                           labels =c("1","2","3", "4+"))

mydata.final$Visit_cat1<-cut(mydata.final$visits, breaks=c(-Inf,4,6,Inf),
                             labels =c("3-4","5-6", "7+"))

# Create a variable for vaginal delivery which take the value "CS" if delivery was CS and "VD"
# if delivery was not CS

mydata.final$Vagdel<-" " # Create the vaginal delivery variable
for (i in 1: length(mydata.final$NHISID)){
  if ((mydata.final$DeliveryType[i]) == "CS") {
    mydata.final$Vagdel[i] <- "CS"
  } else
    mydata.final$Vagdel[i] <- "VD"
}

# Convert the following to a factor
mydata.final$DeliveryType <- factor(mydata.final$DeliveryType)

mydata.final$District <- factor(mydata.final$District)
mydata.final$Type <- factor(mydata.final$Type)
mydata.final$Ownership <- factor(mydata.final$Ownership)

mydata.final$Vagdel<- factor(mydata.final$Vagdel)

# Save the file
save(mydata.final,file="/Users/skdery/Google Drive/PhD Work/Health Insurance/Calculate
Continuity/Complete Final Data.Rdata")

```