

## ORIGINAL RESEARCH ARTICLE

# Fragmentation of care during pregnancy in the Volta Region of Ghana: A social network analysis approach

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## Abstract

To determine the extent of care fragmentation during pregnancy and delivery in the Volta Region of Ghana. The National Health Insurance Claims Data for the Volta Region for the period January –December 2013 was used. Pregnant women who delivered at a health facility and made at least 3 visits were included in the study. Social network analysis (SNA) approach was used to determine care fragmentation. Fragmentation of care during delivery was defined to be any delivery at a facility different from the woman's most frequently visited antenatal care (ANC) facility. Network metrics (weighted in-degree and weighted out-degree) were used to determine extent of care fragmentation and also the key facilities contributing to the fragmentation. Overall, 14,474 pregnant women were included in the study with 15% (2,185) having cesarean section (CS). A total of 6,025 (42%) of all the pregnant women visited more than one facility during ANC and delivery, out of which 960 (16%) had CS. About 26% (3,769) of all deliveries and 32% (696) of all CS deliveries were fragmented. Fragmentation among those that had CS was significantly higher compared to those that had vaginal delivery (VD) (32% versus 25%,  $\chi^2=45.88$ ,  $p<0.001$ ). Among those who visited multiple facilities, 63% (73% CS and 61% VD,  $\chi^2=49.22$ ,  $p<0.001$ ) were fragmented. In addition, 15% of all deliveries (36% among those who visited multiple facilities) and 20% of all CS deliveries (45% among those who visited multiple facilities) were performed at facilities that the pregnant women never received ANC services from. There is high level of care fragmentation during the critical period of delivery among pregnant women who visited more than one facility. This fragmentation is particularly higher among those that had CS compared to vaginal delivery. This calls for policy to ensure coordination and continuity of care during pregnancy. (*Afr J Reprod Health* 2022; 26[1]: 36-46).

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**Keywords:** Continuity of care, delivery, antenatal care, health insurance claims data

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## Résumé

Déterminer l'étendue de la fragmentation des soins pendant la grossesse et l'accouchement dans la région de la Volta au Ghana. Les données sur les réclamations de l'assurance maladie nationale pour la région de la Volta pour la période de janvier à décembre 2013 ont été utilisées. Les femmes enceintes qui ont accouché dans un établissement de santé et effectué au moins 3 visites ont été incluses dans l'étude. L'approche d'analyse des réseaux sociaux (SNA) a été utilisée pour déterminer la fragmentation des soins. La fragmentation des soins pendant l'accouchement a été définie comme tout accouchement dans un établissement autre que l'établissement de soins prénatals (CPN) le plus fréquemment visité par la femme. Les paramètres du réseau (degrés entrants pondérés et degrés sortants pondérés) ont été utilisés pour déterminer l'étendue de la fragmentation des soins ainsi que les principaux établissements contribuant à la fragmentation. Dans l'ensemble, 14 474 femmes enceintes ont été incluses dans l'étude dont 15 % (2 185) ont subi une césarienne (CS). Au total, 6 025 (42 %) de toutes les femmes enceintes ont visité plus d'un établissement pendant les soins prénatals et l'accouchement, dont 960 (16 %) ont eu une césarienne. Environ 26 % (3 769) de tous les accouchements et 32 % (696) de tous les accouchements de CS étaient fragmentés. La fragmentation parmi celles qui ont eu une césarienne était significativement plus élevée que celles qui avaient accouché par voie basse (AV) (32 % contre 25 %,  $\chi^2=45,88$ ,  $p<0,001$ ). Parmi ceux qui ont visité plusieurs établissements, 63 % (73 % CS et 61 % VD,  $\chi^2=49,22$ ,  $p<0,001$ ) étaient fragmentés. En outre, 15 % de tous les accouchements (36 % parmi ceux qui ont visité plusieurs établissements) et 20 % de tous les accouchements de césarienne (45 % parmi ceux qui ont visité plusieurs établissements) ont été effectués dans des établissements où les femmes enceintes n'ont jamais reçu de services de soins prénatals. Il existe un niveau élevé de fragmentation des soins pendant la période critique de l'accouchement chez les femmes enceintes qui ont visité plus d'un établissement. Cette fragmentation est particulièrement plus élevée chez celles qui ont eu une césarienne par rapport à l'accouchement vaginal. Cela nécessite une politique visant à assurer la coordination et la continuité des soins pendant la grossesse. (*Afr J Reprod Health* 2022; 26[1]: 36-46).

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**Mots-clés:** Continuité des soins, accouchement, soins prénatals, données sur les demandes de remboursement à l'assurance maladie

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## Introduction

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 with the CHPS compound being the lowest level of service delivery point located at the community level. The CHPS compounds among others are to provide basic maternal and reproductive health services and those without midwives are not allowed to supervise delivery services except in emergency situations. Pregnant women who seek ANC services from these 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 specialised services. These are meant to ensure that pregnant women receive the appropriate care during pregnancy. However, they do not promote longitudinal continuity of care. Furthermore, inadequate staff, resources and previous experiences at some facilities may also result in some pregnant women seeking services elsewhere and thus spreading their care among several facilities, resulting in care fragmentation.

Healthcare delivery usually involves multiple providers and if no one is responsible for coordinating the care across providers, it can result in suboptimal care and fragmentation<sup>1,2</sup>. Care seeking from multiple providers has become a challenge to the health systems in many countries. According to the Institute of Medicine, fragmentation contributes to medical errors because when patients visit multiple care providers in different situations, with none having access to the complete health information, it is easier to get things wrong<sup>3</sup>. According to evidence from the US, health insurance tends to contribute to fragmentation<sup>4,5</sup>.

In Ghana, the establishment of the National Health Insurance Scheme (NHIS) has improved access to basic healthcare services with about 82% of outpatient attendance in 2016 receiving care through the health insurance schemes<sup>6</sup>. Currently, most patients in Ghana are not required to register with a service provider (facility) as their primary

care provider as may be the case elsewhere. This means pregnant women in Ghana have a choice of where to access ANC, delivery and postnatal care services and can choose to change care provider regularly or switch between a number of providers during pregnancy. This choice of where to access ANC and delivery care can be good in situations where the woman is not satisfied with the care being provided. However, it places the responsibility for coordinating the care across the various providers on the woman or the family members who may not have the required expertise to carry on that responsibility since there is no primary care provider tasked with that responsibility. Evidence shows that some pregnant women in Ghana seek care from multiple healthcare providers during ANC<sup>7,8</sup>. This practice has the potential to fragment the care that an individual receives if not well coordinated and managed (considering the absence of integrated electronic health records system in Ghana) with implications for quality of care over time. Fragmented care can adversely affect the antenatal experience and outcomes for women and their families during pregnancy and delivery<sup>9</sup>. However, it is unclear the extent to which pregnant women change their care providers during delivery and whether those that have CS are more likely to fragment their care compared to vaginal delivery. Considering the fact that most of the maternal deaths occur during labor and delivery, determining the extent of provider switching during this critical period is crucial in providing quality maternal health services and ultimately reducing maternal mortality<sup>10</sup>. In addition, 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 delivery services. Through this study, we used an innovative approach through social network analysis to determine the extent of care fragmentation (provider switching) during pregnancy and delivery in the Volta Region of Ghana.

The health insurance claim datasets in Ghana contain a large number of claims data covering the entire country on a wide selection of medical services provided and over a long period of time. This data can reveal a lot of information about patient movements or interactions with different

health facilities (either through referrals or patient deciding to visit a different provider). These interactions 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, which requires coordination 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 provided by multiple health facilities in the course of the pregnancy and delivery. This can be used to construct provider network to reveal the central health facilities during ANC and delivery and measure care fragmentation.

A social network is a set of social entities (actors, nodes, vertices) connected by a set of social relationships (links, edges)<sup>11,12</sup>. 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, patient referrals 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 and is undirected if the interaction is reciprocated. Example of a directed link is a health facility referring a patient to another health facility and example of undirected link is a drug being prescribed with another drug. For example, if drug A is prescribed with drug B, then drug B is also prescribed with drug A as well. Therefore, the link is undirected. Health facilities can be linked to each through patients-sharing either by referrals or provider shopping by the patients<sup>13</sup>.

## Methods

### *Study design and population*

The study used retrospective cohort data from the National Health Insurance Claims Dataset for the Volta Region of Ghana from January to December 2013. The region was selected because it had comprehensive claims data for the period. The data was obtained from the National Health Insurance

Authority (NHIA) after data confidentiality and use agreement was signed between the lead author and the NHIA. Pregnant women who delivered at a health facility in the region and made at least 3 visits were included in the study. Ethical approval was obtained from the institutional review board of the Noguchi Memorial Institute for Medical Research, College of Health Sciences, University of Ghana before commencement of study (study ID: 052/15-16).

### *Data processing*

Monthly claims data (in Microsoft Excel format) for maternal related visits for each facility were merged into a single sheet for each facility with the facility name as additional variable. This was after all dates were corrected to the same formats (dd/mm/yyyy) to ensure uniformity. Facility data were subsequently merged into a district file with the name of the district as an additional variable. Microsoft Access 2010 was used to develop a database where the district files were imported and merged into a single file for data processing.

Variables used in this study included: name of facility, NHIS ID, date of visit, procedure, diagnosis, Ghana diagnostic related group (G-DRG) code, ICD10 code, type of visit, month of visit and district. A total of 242,652 antenatal and postnatal related visits were made by pregnant women to 211 health facilities accredited by the NHIA to provide services to pregnant women in the Region. Applying the inclusion criteria (delivery at a health facility and making at least 3 visits), 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 facilities. For each woman, a program was written in R that iterated the dataset and extracted the sequence of health facilities visited in the order in which they were visited.

We identified patient-sharing between facilities. For each woman, her most frequently visited ANC facility and the delivery facility were determined. A woman is said to have fragmented her care during delivery if she delivers at a facility different from her most frequently visited ANC facility. Where there was no most frequently visited ANC facility, the most recent ANC facility before delivery was used. The assumption from the point of continuity of care is that, if a woman has 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. Fragmentation during delivery was so 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 during the ANC period. For example, a visit sequence of AAAABA where the last provider is the delivery provider. This visit pattern would not be considered fragmented during delivery by the definition used in the study. However, if one were to consider only the last two visits, then it would be deemed fragmented. Again, a visit sequence of AAAABB would be considered fragmented in this study but would not be if one were to consider only the last two visits.

### **Social network analysis**

A program was written in R to identify the directed edge list for each pregnant woman. Patient sharing during delivery involves linking the most frequently visited ANC facility (source node) and the delivery facility (destination node). This approach enables the visualization of the fragmentation of care among facilities. For each pregnant woman, the source and the destination nodes were identified and appended to the source and destination matrix using row bind (rbind) command in R. The frequency of each pair of source and destination nodes was calculated to represent the weight of the connection between the nodes. Igraph package in R was used to help convert the data into a graph data and graphs were simplified by removing loops (where source and destination nodes were the same)<sup>14</sup>. The rgexf package was used to export the graph data in the graphml format to be used in Gephi for the visualization and data analysis<sup>14-16</sup>. Gephi is an open source software for graph and network analysis. The size of the node indicates the weighted degree of the node and edge weight indicates the number of women shared between the pair of nodes. Networks were visualized using the Fruchterman-Reingold and Force Atlas2 algorithms as implemented in Gephi to optimally position facilities in the network based on their patient-sharing relations<sup>17,18</sup>. Curved edges were used to indicate the direction of the edge with reading clockwise from a source node to a target node. Network metrics (weighted in-degree and weighted out-degree) were used not only to

determine extent of care fragmentation but also identify the key facilities contributing to the fragmentation.

### **Statistical analysis**

Gephi was used to generate the network and centrality measures for the various facilities. Network data was also exported to Microsoft Excel to create tables for the facilities and the various centrality measures and analyze the extent of patient sharing among facilities. We analyzed the proportion of pregnant women that were expected to deliver at a given facility but “moved out” (fragmented their delivery) to other facilities for delivery to determine the facilities whose ANC clients were more likely to move to other facilities for delivery services. The proportion that moved for cesarean sections (CS) as well as those that delivered at a health facility that they never received ANC services from were also determined for each facility.

## **Results**

### **Participant and facility characteristics**

A total of 14,474 pregnant women were studied with 2,185 (15.1%) having CS. Median number of visits per woman was 5 with the interquartile range from 3 to 6. About 99.6% (14,421) of all the women attended a hospital at least once with 83% (11,943) of them delivery in a hospital while only 6.7% (37 out of 547) that attended a CHPS at least once, delivered at CHPS (Table 1). A total of 196 health facilities were involved with health centres accounting for 57.7% (113) while hospitals account for 13.3% of the facilities. Most of the facilities (84.7%) were government owned, Christian Health Association of Ghana (8.2%) and (7.1%) privately owned. The hospitals accounted for about 73% of all the visits by pregnant women and 83% of all deliveries (100% CS and 79% vaginal) in the region. A total of 6,025 (42%) of all the pregnant women visited more than one facility during ANC and delivery, out of which 960 (15.9%) had CS.

### **Extent of fragmentation of care**

Table 2 describes the movement of pregnant women among facilities during delivery and the extent of care

**Table 1:** Distribution of participants, visits and deliveries by provider types, 2013

| Facility Type  | n   | No. of Clients* | No. of Visits | Median visit (IR) | Delivery |        | Total  | Proportion delivered (%) |
|----------------|-----|-----------------|---------------|-------------------|----------|--------|--------|--------------------------|
|                |     |                 |               |                   | CS       | VD     |        |                          |
| Hospital       | 26  | 14,421          | 52,853        | 5 (3-6)           | 2,185    | 9,758  | 11,943 | 82.82                    |
| Health Centre  | 113 | 5,854           | 15,325        | 4 (3-5)           |          | 2,130  | 2,130  | 36.39                    |
| CHPS           | 41  | 549             | 1,146         | 4 (4-5)           |          | 37     | 37     | 6.74                     |
| Clinic         | 8   | 504             | 1,603         | 4 (3-6)           |          | 187    | 187    | 37.10                    |
| Maternity Home | 6   | 338             | 820           | 4 (4-6)           |          | 167    | 167    | 49.41                    |
| Polyclinic     | 2   | 139             | 348           | 3.50 (3-5)        |          | 10     | 10     | 7.19                     |
| Total          | 196 | -               | 72,095        | 5 (3-6)           | 2,185    | 12,289 | 14,474 | -                        |

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

fragmentation among the various categories of facilities. In all, 3769 of deliveries representing 26% of all the deliveries were fragmented (delivered at a facility that was not their regular ANC facility) as shown in Table 2. Among those that had CS, 696 representing 32% of all CS deliveries were fragmented. The fragmentation among those that had CS was significantly higher compared to those that had vaginal delivery (VD) (32% versus 25%,  $\chi^2=45.88$ ,  $p<0.001$ ). However, among those who visited multiple facilities in the course of the pregnancy, 62.5% (72.5% CS and 60.7% VD) were fragmented ( $\chi^2=49.22$ ,  $p<0.001$ ). In addition, 15% of all the pregnant women (35.6% among those who visited multiple facilities) and 20% of those that had CS (44.6% among those who visited multiple facilities) delivered at facilities that they never received ANC services from.

As shown in Table 2, a total of 965 pregnant women who attended hospitals as their regular ANC facility moved from their index hospital to other facilities to deliver, with majority (73.2%) moving to other hospitals for delivery. This number (965) represents 9.9% of fragmentation at the hospital level. However, the hospitals accounts for 25.6% of the total fragmentation. Additionally, 203 (21.0%) of this number moved to other facilities for CS delivery while 528 (54.7%) delivered at facilities that they never received ANC services from (moved to deliver at new place). The results show that the health centres and the hospitals are the biggest contributors of the fragmentation in the region, accounting for 57.2% and 25.6% respectively of all the women that moved to other facilities for delivery services. In total, 696 (18.5%) of the pregnant women that moved for delivery, did so for CS. In all, about 84.5% (3190) of all the women that moved out for deliveries, went to hospitals while 57% (2147) moved to health facilities that they never received ANC services from (Table 2).

Table 3 shows the characteristics of the facilities and the extent of care fragmentation during delivery for hospitals. It shows the number of pregnant women that made at least one visit, number of deliveries, number of women that moved in or moved out during delivery (weighted in-degree or weighted out-degree) and the proportion of expected deliveries that moved out for each hospital. For example, Margaret Marquart Catholic Hospital had 1293 deliveries out of which 353 were for CS. Additionally, 382 of all the deliveries (123 CS) had their most ANC from other facilities but came to the hospital for delivery while 56 women that also had their most ANC at the same hospital also went to other facilities for delivery (8 for CS). The results further show that 15% of all the pregnant women that had their most ANC from other facilities but came to the Margaret Marquart Catholic Hospital for delivery, did so because of CS, while 34.8% of all the CS delivery at the Margaret Marquart Catholic Hospital came from other facilities with 17% coming to the hospital for the first time for the current pregnancy. The results further show that a large proportion of the women that had CS, did not get it from their regular ANC facility. For example, about 70% of all the women that had CS at the Worawora Hospital came from other facilities while 41% never had ANC from the hospital. In addition, 34% of all CS delivery at the Regional Hospital came from other facilities while 25% never attended ANC at the Regional Hospital (Table 3).

Figure 1 shows a visualization of the extent of care fragmentation during delivery based on the 26% of the pregnant women that fragmented their care during delivery (both CS and VD). The colour of the nodes indicates the community that the facility belongs to (modularity), 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 between the pair of facilities.

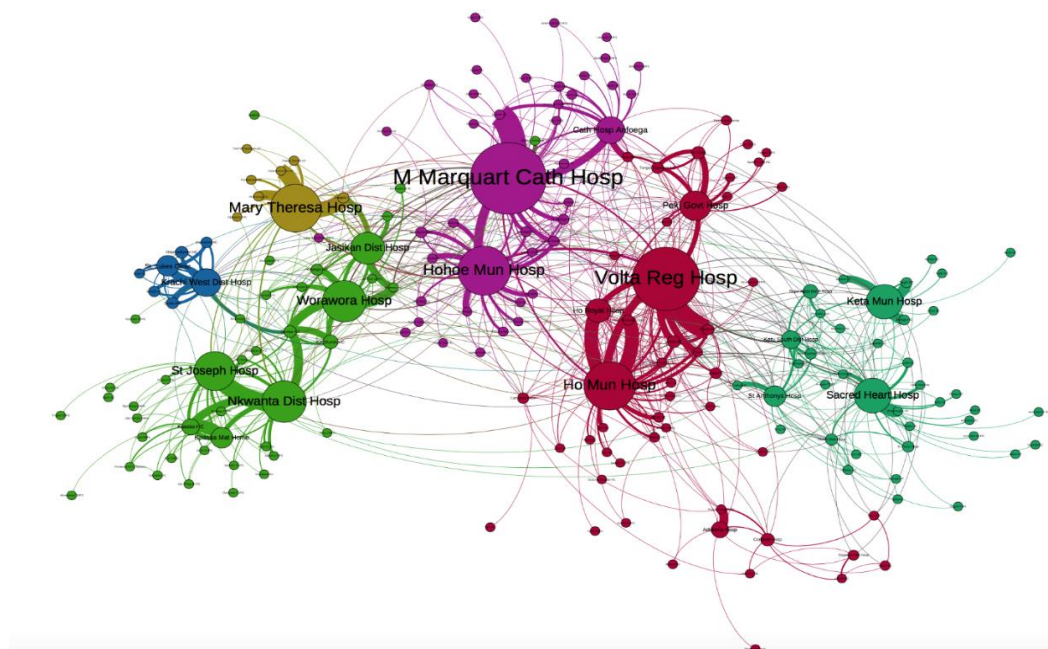
**Table 2:** Movement of pregnant women among facilities during delivery, Volta Region, 2013

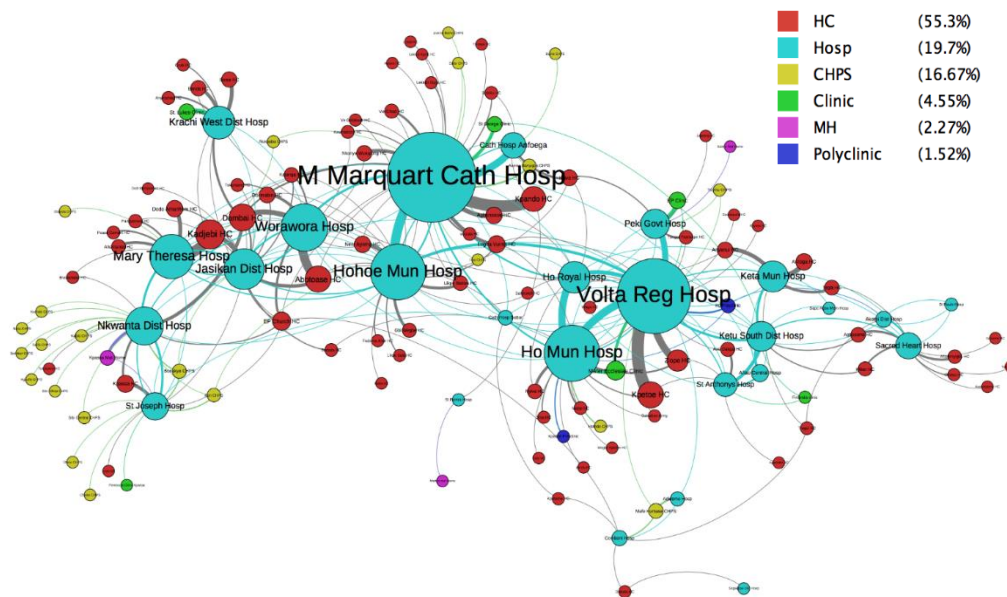
| Move to        |           |             |                    |               |                     |                 |            | Extent of fragmentation |                       |                                     |                    |  |
|----------------|-----------|-------------|--------------------|---------------|---------------------|--------------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

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

**Table 3:** Facility client sharing details during delivery and C-sections for only hospitals

| Facility Name                   | # of patients with at least one visit | Number of Deliveries | Number of CS deliveries | Delivery (all)     |                     | C-Section          |                     | Extent of fragmentation     |                             |                            |  |  | Moved out for CS (%) | CS on first visit (%) |
|---------------------------------|---------------------------------------|----------------------|-------------------------|--------------------|---------------------|--------------------|---------------------|-----------------------------|-----------------------------|----------------------------|--|--|----------------------|-----------------------|
|                                 |                                       |                      |                         | Weighted In-Degree | Weighted out-Degree | Weighted In-Degree | Weighted out-Degree | % Deliveries on first visit | % Deliveries that moved out | % CS from other facilities |  |  |                      |                       |
| Margaret Marquart Cath Hospital | 1565                                  | 1293                 | 353                     | 382                | 56                  | 123                | 8                   | 15.0                        | 5.8                         | 34.8                       |  |  | 14.3                 | 17.0                  |
| Nkwanta Dist Hospital           | 759                                   | 460                  | 61                      | 199                | 101                 | 34                 | 11                  | 20.9                        | 27.9                        | 55.7                       |  |  | 10.9                 | 32.8                  |
| Krachi West Dist Hospital       | 943                                   | 616                  | 134                     | 114                | 102                 | 33                 | 3                   | 3.2                         | 16.9                        | 24.6                       |  |  | 2.0                  | 3.7                   |
| Ho Mun Hospital                 | 1420                                  | 1172                 | 202                     | 241                | 150                 | 39                 | 36                  | 14.4                        | 13.9                        | 19.3                       |  |  | 24.0                 | 11.4                  |
| Volta Reg Hospital              | 1334                                  | 1215                 | 286                     | 332                | 49                  | 98                 | 8                   | 19.0                        | 5.3                         | 34.3                       |  |  | 16.3                 | 25.2                  |
| Hohoe Mun Hospital              | 1139                                  | 973                  | 144                     | 245                | 97                  | 42                 | 32                  | 18.7                        | 11.8                        | 29.2                       |  |  | 33.0                 | 25.0                  |
| Mary Theresa Hospital           | 604                                   | 517                  | 84                      | 236                | 24                  | 48                 | 7                   | 18.4                        | 7.9                         | 57.1                       |  |  | 29.2                 | 26.2                  |
| Cath Hospital Anfoega           | 575                                   | 476                  | 41                      | 109                | 52                  | 11                 | 13                  | 10.5                        | 12.4                        | 26.8                       |  |  | 25.0                 | 14.6                  |
| St Joseph Hospital              | 429                                   | 302                  | 39                      | 183                | 21                  | 23                 | 4                   | 25.2                        | 15.0                        | 59.0                       |  |  | 19.0                 | 33.3                  |
| Worawora Hospital               | 501                                   | 388                  | 74                      | 197                | 29                  | 52                 | 8                   | 34.0                        | 13.2                        | 70.3                       |  |  | 27.6                 | 40.5                  |
| Ho Royal Hospital               | 526                                   | 383                  | 118                     | 90                 | 48                  | 21                 | 13                  | 18.8                        | 14.1                        | 17.8                       |  |  | 27.1                 | 12.7                  |
| Peki Govt Hospital              | 540                                   | 459                  | 43                      | 125                | 40                  | 17                 | 13                  | 11.3                        | 10.7                        | 39.5                       |  |  | 32.5                 | 30.2                  |
| Keta Mun Hospital               | 564                                   | 523                  | 89                      | 155                | 17                  | 30                 | 3                   | 15.3                        | 4.4                         | 33.7                       |  |  | 17.6                 | 14.6                  |
| Jasikan Dist Hospital           | 551                                   | 461                  | 93                      | 141                | 48                  | 41                 | 8                   | 22.8                        | 13.0                        | 44.1                       |  |  | 16.7                 | 37.6                  |
| Sacred Heart Hospital           | 494                                   | 463                  | 74                      | 158                | 14                  | 25                 | 0                   | 23.8                        | 4.4                         | 33.8                       |  |  | 0.0                  | 25.7                  |
| Ketu South Dist Hospital        | 1101                                  | 1019                 | 157                     | 55                 | 44                  | 13                 | 18                  | 3.5                         | 4.4                         | 8.3                        |  |  | 40.9                 | 6.4                   |
| St Anthony's Hospital           | 293                                   | 281                  | 51                      | 71                 | 4                   | 20                 | 1                   | 17.4                        | 1.9                         | 39.2                       |  |  | 25.0                 | 33.3                  |
| Akatsi Dist Hospital            | 178                                   | 146                  | 15                      | 15                 | 26                  | 3                  | 5                   | 7.5                         | 16.6                        | 20.0                       |  |  | 19.2                 | 6.7                   |
| Adidome Hospital                | 104                                   | 98                   | 11                      | 44                 | 5                   | 4                  | 1                   | 37.8                        | 8.5                         | 36.4                       |  |  | 20.0                 | 27.3                  |
| Aflao Central Hospital          | 122                                   | 100                  | 17                      | 12                 | 19                  | 2                  | 8                   | 7.0                         | 17.8                        | 11.8                       |  |  | 42.1                 | 5.9                   |
| Sape Agbo Mem Hospital          | 89                                    | 80                   | 10                      | 31                 | 1                   | 2                  | 0                   | 25.0                        | 2.0                         | 20.0                       |  |  | 0.0                  | 0                     |
| St Patrick Hospital             | 35                                    | 7                    | 7                       | 2                  | 0                   | 2                  | 0                   | 14.3                        | 0.0                         | 28.6                       |  |  | -                    | 14.3                  |
| St Pauls Hospital               | 49                                    | 33                   | 7                       | 12                 | 7                   | 1                  | 2                   | 21.2                        | 25.0                        | 14.3                       |  |  | 28.6                 | 14.3                  |
| Cath Hospital Battor            | 428                                   | 413                  | 61                      | 10                 | 8                   | 4                  | 2                   | 1.5                         | 1.9                         | 6.6                        |  |  | 25.0                 | 3.3                   |
| Sogakope Dist Hospital          | 24                                    | 12                   | 1                       | 8                  | 2                   | 1                  | 0                   | 41.7                        | 33.3                        | 100.0                      |  |  | 0.0                  | 0                     |
| Comboni Hospital                | 54                                    | 53                   | 13                      | 23                 | 1                   | 7                  | 0                   | 37.7                        | 3.2                         | 53.8                       |  |  | 0.0                  | 46.2                  |

**Figure 1:** Facility client sharing network during delivery by network communities



**Figure 2:** Facility client sharing network during C-section delivery by facility type

The results show that there about 6 communities. 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. All facilities are connected to one another in the network with 97 strongly connected components. There were 742 links between 190 facilities with each facility sharing an average of 20 women with 4 other facilities. The central facilities (by weighted degree) that shared the most women during delivery were; Margaret Marquart Catholic, Ho Municipal, Volta Regional, Hohoe Municipal and Nkwanta District Hospitals.

Figure 2 shows the extent of care fragmentation during CS delivery. This network represents the 31.9% (696) of the clients that had CS and delivered at facilities other than their regular ANC provider. The colour of the nodes 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 between the pair of facilities. The central facilities by number of women shared (weighted degree) were: Margaret Marquart

Catholic, Volta Regional, Ho Municipal, Hohoe Municipal and Worawora Hospitals.

## Discussion

This study set out to determine the extent of care fragmentation during delivery in the Volta Region of Ghana. To the best of our knowledge, this is one of the first studies to apply social network analysis to determine the extent of care fragmentation among facilities during pregnancy and delivery. Using NHIS claims data, this study constructed facility networks based on patient sharing during delivery. Network metrics (weighted in-degree and weighted out-degree) were used not only to characterize the extent of care fragmentation but also identify key facilities contributing to the fragmentation. This approach is able to quantify the fragmentation as well as identify the facilities most influenced or contributing to the fragmentation as compared to methods that only measure the fragmentation<sup>19,20</sup>. The study found high level of care fragmentation during delivery, and it was especially higher among those that had CS compared to vaginal delivery. Additionally, a high proportion of pregnant women delivered at facilities that they never received any ANC services from. Moreover, most of the women that visited more than one facility fragmented their

care during delivery. This is an indication that, delivery was one of the main reasons they visited more than one facility. In line with the health policy of Ghana that requires CHPS compounds without midwives not to undertake delivery services except in emergency cases, almost all the women that attended CHPS compounds as their regular ANC facilities, moved to higher level facilities especially hospitals for delivery services<sup>21</sup>. This could be an indication that the policy is being followed. Similarly, 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. This is also expected as CS deliveries are to be performed in advanced level facilities. However, the health centres and the hospitals, which are required to provide vaginal delivery services, 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 type 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.

This study revealed that, there is preference for hospital during ANC and delivery (the hospitals account for 83% of all deliveries and 85% of all the women that moved in for deliveries services). This preference is supported by findings from Dako-Gyeke *et al* where participants from a focus group discussion said “for safety, especially when complication arises, it was good to deliver in the hospital”<sup>8</sup>. These women rightly viewed the hospitals as the safest place to go for delivery as compared to the other types of facilities. In another study, Kruk *et al* also found preference for hospital and mission facility delivery compared to primary care facilities located closer to the respondents in Tanzania, while Ngo & Hill reported high preference for hospital delivery in Vietnam<sup>22,23</sup>. Again, Kruk *et al* found that poor quality of the ANC and delivery care at primary level care facilities is the key reason why women prefer hospitals<sup>24</sup>. The study also found that a high proportion of pregnant women delivered at facilities that they never received any ANC services from. A key component of the continuity of maternity care and in line with the World Health Organization recommendation, is relational

continuity which requires that a pregnant woman is delivered by a known midwife or a small team of known midwives who are more familiar with her pregnancy and with whom she may have developed some mutual relationship with<sup>25</sup>. This 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<sup>26-30</sup>. However, implementation of this policy requires a well-functioning maternal health care systems at all levels of care delivery. This may be difficult to achieve in the current system where most lower-level facilities are not adequately staffed and equipped. Women who attend these lower level facilities may therefore move to relatively advanced facilities especially hospital for delivery. As noted earlier, complications during delivery account for most of the maternal deaths, and as such greater emphasis needs to be placed on labour and delivery as this period plays a critical role in safe delivery during childbirth<sup>25,31,32</sup>. Delivering at a facility that the woman never visited during ANC and by a team that is not familiar with her pregnancy could have serious implications for quality of care, considering 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. Except for emergency purposes, women who intend to deliver in a particular facility is advised during birth preparedness plans towards delivery to visit the facility at least once for ANC services. The fragmentation of care during pregnancy also has implication for care coordination to ensure continuity and smooth transition of care along the pregnancy pathway. However, pregnant women in Ghana currently are not required to have primary care providers during pregnancy. Since care provision usually involves many providers, 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 lead to suboptimal care and poor patient outcomes, provider shopping, care fragmentation and health insurance fraud<sup>1,2,33,34</sup>. This calls for policy on continuity and care coordination to reduce care fragmentation.

Additionally, this study found that hospitals in general, and Margaret Marquart Catholic Hospital

and the Volta Regional Hospital in particular, were among the most central healthcare providers 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. Reasons for the high levels of care fragmentation particularly during delivery and the effect on maternal health outcomes are not known, necessitating the need for further investigations into the following key questions or issues: (1) why a pregnant would change her regular ANC provider during delivery and what are the factors associated with such change? (2) what are the effects of care fragmentation during pregnancy on maternal health outcomes? and (3) considering the fact that access to health facilities differ across the country, how do other regions compare to the Volta Region with respect to fragmentation of care?.

## Limitations

The study used health insurance claims data and as such included only pregnant women who accessed ANC and delivery care services with accredited health insurance facilities. Additionally, the health insurance claims data did not contain the individual healthcare providers (doctor, midwife, nurse etc.) that provided services to the pregnant women. Also, the claims data do not contain information on the outcomes of the pregnancy. It was therefore not possible to link the fragmentation to the delivery outcome or measure the extent of fragmentation at the individual provider level to ascertain the pregnant women that were delivered by the midwives that took care of them during ANC.

## Conclusion

Fragmentation of care is high during the critical period of labour and delivery among pregnant women, and especially higher for CS compared to vaginal delivery. There is therefore the need for policy requiring 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, bearing in mind that inadequate staff and equipment

at the lower level facilities drives fragmentation of care.

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## Contribution of authors

Samuel K. K. Dery: Conceived and designed the study, collected and analysed the data, and drafted the manuscript.

Ernest T. Maya: Contributed to study design, reviewed the analysis and manuscript.

Moses Aikins: Contributed to study design, reviewed analysis and manuscript.

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