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ABSTRACT

This study used a geospatial methodology to estimate the influence of service readiness at health facilities on women's use of facility delivery care based on data from the 2012 Haiti Demographic and Health Survey (DHS) and the 2013 Haiti Service Provision Assessment (SPA) survey - a health facility census.

By linking DHS clusters and SPA facilities with their GPS data, we measured health facilities' service readiness to provide quality delivery care by the average and the highest readiness score of facilities within a 10 km buffer from the cluster. A facility's readiness score was computed with principal component analysis using a wide range of indicators recommended by WHO. Multilevel logistic regressions showed that in rural areas, both average and highest levels of readiness were significantly associated with use of delivery service. However, in urban areas only the highest level of readiness was statistically significant. No association was found between the total number of health facilities offering delivery services and use of facility delivery.

1. INTRODUCTION

Despite progress toward reaching the 5th Millennium Development Goal, *Improved Maternal Health—reducing the maternal mortality ratio and achieving universal access reproductive health*—Haiti is still one of the two countries outside of sub-Saharan Africa with the highest maternal mortality ratio—380 deaths per 100,000 live births (WHO 2014). Every year thousands of women in Haiti die from causes that can be prevented through access to comprehensive and skilled obstetric care during pregnancy, childbirth, and the postpartum period (Anderson et al. 2007; Kirigia et al. 2006). Use of maternal health services, especially facility delivery, remains low in Haiti. Only 36 percent of births take place in health facilities, according to the 2012 Haiti Demographic and Health Survey (DHS) (Cayemittes et al. 2013). Unless a woman delivers at a health facility, she is unlikely to have access to emergency obstetric care, which is considered the most important strategy for reducing maternal deaths (de Brouwere et al. 1998; Graham et al. 2001). Therefore, increasing utilization of facility delivery is critical for Haiti to reduce maternal mortality.

An extensive body of literature exits on factors that influence facility delivery (Exavery et al. 2014; Gabrysch and Campbell 2009; Kitui et al. 2013; Montagu et al. 2011; Moyer et al. 2013). The majority of studies have focused on the *demand side*, for example, the characteristics of women and their families. A few have looked at community-level factors such as community norms, media access, and the level of local development (Moyer and Mustafa 2013; Tey and Lai 2013; Thind et al. 2008). The *supply side*—delivery care offered in health facilities—has received less attention (Gabrysch and Campbell 2009; Moyer et al. 2013). One of the main reasons for limited research on the effects of service provision is the lack of suitable data. The supply-side data typically come from health facilities. The supply information needs to be linked to data on individual women in order to explore the relationship between service provision and women's use of delivery care.

With the availability of geographic data from both household surveys and health facility surveys, it becomes possible to link population data and health facility data within a geographic information system (GIS). A few studies in sub-Saharan Africa have linked DHS data and facility census data to assess how distance to the closest facility affects women's use of reproductive health services (Kyei et al. 2012; Lohela et al. 2012; Nesbitt et al. 2014). In Malawi and Zambia, by

linking DHS clusters and facilities (from the facility census), the authors found that, in Zambia, a longer straight-line distance from the DHS cluster to the closest facility offering emergency obstetric care significantly reduced the likelihood of facility delivery—by 65 percent for every 10 kilometers increase in distance. However, such a relationship was not observed in Malawi (Lohela et al. 2012). Another study in Zambia with the same methodology but focusing on antenatal care found that distance to the closest facility had a significant effect on the content of antenatal care women received but had no effect on number of ANC visits and timing of the first visit (Kyei et al. 2012). In a rural setting in Ghana, Nesbitt et al. (2014) linked health facility census data and health and demographic surveillance data from about 600 villages and found a significant association between distance to the closest delivery facility and women's likelihood of delivering in a health facility (Nesbitt et al. 2014). While these studies contributed to establishing a geospatial methodology to assess the relationship between service provision and use, linking DHS clusters and closest facilities is subject to certain levels of misclassification errors. Because DHS clusters' coordinates are displaced before release; the closest facility identified based on the released geographic data may not actually be the nearest facility in reality (Skiles et al. 2013).

While physical access is important, another key determinant of service utilization is the quality of care. Families may bypass the nearest health facility when quality is at stake (Choulagai et al. 2013; Kinney et al. 2010; Yaffee et al. 2012). In examining the effect of the quality of care on use of services, some studies looked at the quality of care from the user's perspective (Karkee et al. 2014; Thind et al. 2008). While this is indicative, it is subject to respondent's level of knowledge about the services provided at health facilities, which can be biased. Among the limited research based on linked population data and facility data, few looked at service provision in health facilities. The Zambia study measured level of care using an index that combined several process and structural aspects of antenatal care provided at facilities. Level of service provision at the closest health facility was found to be significantly associated with the content of antenatal care received (Kyei et al. 2012). In Nepal, when quality of care was measured solely in structural terms (e.g., infrastructure, availability of medicine, number of staff, etc.) a significant effect was also seen on the utilization of antenatal care and immunization services (Acharya and Cleland 2000).

Because of Haiti's mountainous terrain, physical accessibility remains one of the biggest barriers to health care utilization (Alexandre et al. 2005; Babalola 2014; Gage and Guirlene Calixte 2006). In an effort to bring care closer to home and solve the issue of accessibility, Haiti, like most

developing countries, has implemented a hierarchical system of health care provision in which small facilities are located in villages or small communities and more equipped facilities are located in cities. However, there is a dearth of information on how prepared these facilities are to provide quality delivery care and how their service preparedness affects utilization. The 2013 Service Provision Assessment (IHE and ICF International 2014) and the 2012 Demographic and Health Survey (Cayemittes et al. 2013) in Haiti provide an opportunity to link facilities and DHS clusters in order to explore the influence of service readiness on use of facility delivery care.

2. METHODS

2.1 Setting

The health system in Haiti is organized into three levels of care: primary, secondary, and tertiary. The primary level consists of three components: 1) community health centers and dispensaries located in a neighborhood or a communal ward; 2) health centers (with or without beds) located in a commune; and 3) communal referral hospitals located in the urban center of the district. The primary-level facilities are not mandated to provide delivery services. The secondary-level facilities include departmental hospitals, which serve as reference health care facilities at the department level. The tertiary-level facilities refer to specialized and university health facilities, which serve as reference facilities at the national level. The secondary- and tertiary-level facilities provide inpatient services including delivery care.

Health facilities in Haiti are managed by government entities, private entities, and entities that are a mixture of government and private. The majority of health facilities in Haiti are owned by the government. The private sector includes private for-profit and non-profit facilities. The for-profit facilities most often belong to a corporation involving individuals and investment capital through which physicians practice medicine. The non-profit facilities are administered primarily by associations, foundations, or religious groups. Another group of health facilities in Haiti is characterized by mixed management; these are private non-profit facilities that also receive subsidies or salaried regular staff from the government.

2.2 Data

Data used in this study come from the 2012 Haiti Demographic and Health Survey (HDHS) and the 2013 Haiti Service Provision Assessment (HSPA) survey (Cayemittes et al. 2013; IHE and ICF International 2014). The HDHS provides data on women's use of facility-based delivery care as well as their socio-demographic characteristics. The HSPA provides information on the availability of delivery care at health facilities and facilities' readiness to provide good-quality services. Geographic data collected in both surveys are used to link DHS clusters and SPA facilities.

HDHS data

The 2012 HDHS is a population-based household survey that provides representative estimates for both urban and rural areas and for the 10 administrative departments of Haiti. The survey used a two-stage cluster sampling design. At the first stage, 445 clusters were selected with probability proportional to their population size from a national master sample frame. At the second stage, a systematic sample of households was drawn in each of the selected clusters. All women age 15-49 in the sampled households were eligible for individual interview. Of the 14,472 women eligible for interview, 14,287 were successfully interviewed.

The HDHS georeferenced the locations of the sampled clusters by using Global Positioning System (GPS) receivers to collect the coordinates of the center of the populated areas of the clusters. Prior to release of the geographic dataset, the cluster coordinates were verified and geographically displaced (Burgert et al. 2013). Coordinates of urban clusters were displaced up to a maximum distance of 2 km. In rural areas, the displacement distance was up to 5 km with a further, randomly selected, 1 percent of rural clusters displaced up to 10 km. Eight clusters could not be georeferenced and were classified as “missing” in the geographic dataset.

This study used data on 5,515 women who had a live birth in the five years preceding the survey in 437 clusters with GPS data. Table 1 shows the background characteristics of these women. Around two-thirds of women had their most recent birth at age 20-34, while fewer than 15 percent were younger than age 20 at the time of their most recent birth. For one-third of women, the most recent birth was their first child with one-third already having had three or more children at that time. Over 60 percent of women lived in rural areas, with 37 percent residing in the Ouest department, where the capital of Port-au-Prince is situated. Most of the women reported having completed primary education and 39 percent had secondary or higher education.

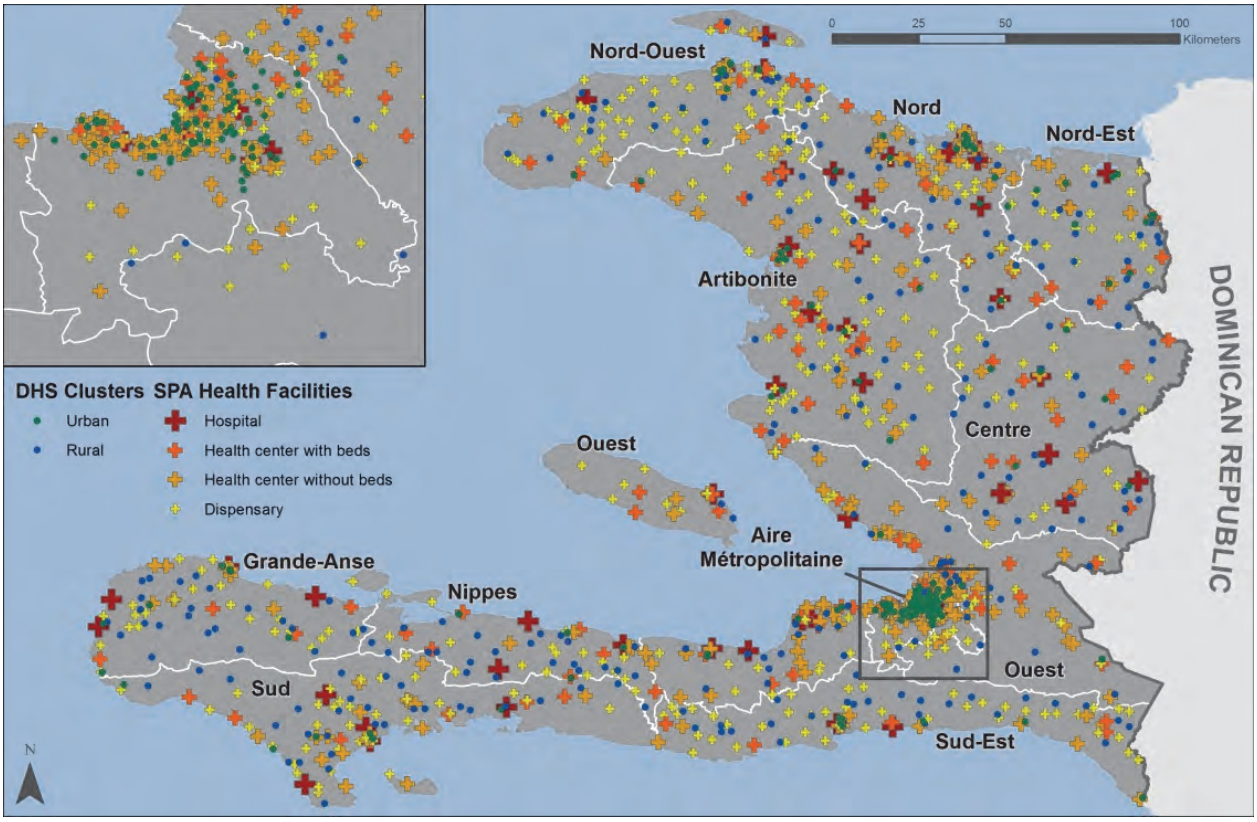
Table 1. Background characteristics of women who had a live birth in the five years preceding the survey, Haiti DHS 2012

Background characteristics	%	Number of women
Mother's age at birth		
<20 years	14.4	741
20-34	67.5	3,479
35-49	18.2	936
Birth order		
1	33.0	1,702
2-3	36.3	1,870
4-5	16.5	852
6+	14.2	730
Residence		
Urban	38.7	1,996
Rural	61.3	3,159
Department		
Ouest	36.5	1,884
Sud-est	4.2	216
Nord	9.8	503
Nord-est	3.9	201
Artibonite	15.0	773
Centre	7.7	399
Sud	7.3	377
Grand'anse	3.7	189
Nord-ouest	4.6	239
Nippes	2.7	140
Camps	4.5	234
Mother's education		
None	19.2	991
Primary	41.8	2,157
Secondary or higher	38.9	2,007
Wealth quintile		
Lowest	20.3	1,046
Second	19.9	1,023
Middle	21.7	1,119
Fourth	21.7	1,118
Highest	16.5	848
Total	100.0	5,155

HSPA data

The 2013 HSPA is a health facility census that provides data on availability and readiness to provide key health services in 907 public and private health facilities, from hospitals at the highest level to dispensaries at the lowest level. Data were collected from each facility through the use of a combination of survey instruments including the inventory questionnaire, the health provider interview questionnaire, observation of consultations, and provider and client exit interviews. The HSPA also georeferenced the locations of the health facilities using GPS receivers. Unlike the DHS data, facilities' coordinates are not displaced. Figure 1 shows the location of DHS clusters (displaced) and SPA facilities.

Figure 1. Geographic distribution of HDHS clusters and HSPA facilities



Data on 389 facilities that offer normal delivery services were used in this analysis. A facility's preparedness to provide quality obstetric services was assessed primarily using the inventory questionnaire and the health provider interview questionnaire. The inventory questionnaire was administered to the most knowledgeable person for the obstetric services. Table 2 shows the distribution of the facilities analyzed by type of facility, managing authority, and regional location. Around a quarter of facilities offering normal delivery were hospitals, with dispensaries making up a third of the total. Half of the facilities were managed by the government, while over 20 percent had a mixed managing authority. Over a quarter of facilities offering delivery services were situated in the Ouest department (26 percent)—where the capital, Port-au-Prince, is situated—the department with the fewest facilities was in Nippe (4 percent).

Table 2. Sample distribution of health facilities providing delivery services, by background characteristics, Haiti SPA 2013

Background characteristics	Number of facilities	%
Type of facility		
Hospital	94	24.1
Health center with beds	101	25.9
Health center without beds	66	17.0
Dispensary	128	33.0
Managing authority		
Government	195	50.2
NGO/private not-for-profit	47	12.1
Private for-profit	65	16.7
Mixed	82	21.1
Department		
Ouest	102	26.2
Sud-Est	35	9.0
Nord	36	9.2
Nord-Est	27	6.9
Artibonite	53	13.6
Centre	23	5.9
Sud	24	6.2
Grand-Anse	21	5.4
Nord-Ouest	52	13.3
Nippes	17	4.4
Total	389	100.0

2.3 Definition of Key Variables

The outcome variable of this analysis is dichotomous, indicating whether a woman used facility delivery care for the most recent birth in the five years preceding the survey. The key independent variable is facility readiness in providing good-quality delivery care. It was measured by a readiness score that was created with principal component analysis based on a set of service readiness indicators defined by WHO (WHO 2013). For each indicator—according to whether it met the criteria for availability—facilities were assigned a binary variable: 1-available, 0-unavailable. A total of 37 readiness indicators were constructed; their definitions are presented in Table 3[1]. The readiness score was computed based on the first component resulting from the principal component analysis, which explained the largest proportion of the total variance. We used a factor loading cut-off of 0.4 to determine whether an indicator remained in the final score computation. The readiness score is a relative summary indicator of how ready a health facility is to provide good-quality delivery services. A higher score indicates better readiness and a lower score indicates poorer readiness compared with other facilities.

Given the importance of basic and comprehensive emergency obstetric care (BEmOC and CEmOC) in reducing maternal mortality, we also looked at the availability of BEmOC and CEmOC at health facilities. According to the latest definition (WHO et al. 2009), a BEmOC facility should be able to implement the following six signal functions: administration of antibiotics, administration of uterotonic drugs/oxytoxics, administration of anticonvulsants, manual removal of placenta, assisted vaginal delivery, and removal of retained products. A full package of CEmOC includes all six BEmOC functions plus caesarean section and blood transfusion.

[1] A few indicators were defined somewhat differently from the definitions shown in the SARA manual; this was done so they could be constructed using the available SPA data. For example, the SARA manual includes a laryngoscope among the list of equipment necessary for administering anesthesia; however, the HSPA questionnaire did not ask about the availability of laryngoscopes. In addition to the SARA indicators, “regular reviews of maternal or newborn deaths” was added to the list of readiness indicators.

Table 3. Operational definitions of basic and comprehensive obstetric care indicators

Indicator	Operational definition	Questionnaire	Note
Basic obstetric care			
Parenteral administration of antibiotics	Respondent reports that intervention has been carried out at least once during the past 3 months by providers as part of their work in that facility	Inventory	
Parenteral administration of oxytocic drug	Respondent reports that intervention has been carried out at least once during the past 3 months by providers as part of their work in that facility	Inventory	
Parenteral administration of anticonvulsants	Respondent reports that intervention has been carried out at least once during the past 3 months by providers as part of their work in that facility	Inventory	
Assisted vaginal delivery	Respondent reports that intervention has been carried out at least once during the past 3 months by providers as part of their work in that facility	Inventory	
Manual removal of placenta	Respondent reports that intervention has been carried out at least once during the past 3 months by providers as part of their work in that facility	Inventory	
Manual removal of retained products	Respondent reports that intervention has been carried out at least once during the past 3 months by providers as part of their work in that facility	Inventory	
Neonatal resuscitation	Respondent reports that intervention has been carried out at least once during the past 3 months by providers as part of their work in that facility	Inventory	
Guidelines for IMPAC	Guidelines for Integrated Management of Pregnancy and Childbirth observed by interviewer in the service site	Inventory	
Staff trained in IMPAC	Respondents reports having received in-service training or training updates in Integrated Management of Pregnancy and Childbirth in the past 24 months	Provider interview	
Emergency transportation	Respondent reports that the facility has a functional ambulance or other vehicle for emergency transportation for clients stationed at and operating from that facility or has access one stationed at or operating from another facility and fuel is available for that vehicle on the day of interview	Inventory	
Sterilization equipment	Sterilization equipment observed by interviewer anywhere in the facility and reported functioning by respondent. Equipment may be electric (autoclave, dry heat sterilizer, boiler or steamer) or non-electric (autoclave or pot for boiling). If non-electric, facility must have a stove or cooker as a heat source.	Inventory	

(Continued...)

Table 3. – *Continued*

Indicator	Operational definition	Questionnaire	Note
Examination light	Functioning spotlight source that can be used for patient examination observed by interviewer in delivery area and reported functioning by respondent	Inventory	
Delivery pack	Delivery pack (or all of the following: cord clamp, episiotomy scissors, scissors or blade to cut cord, suture material and needle holder) observed by interviewer in delivery area	Inventory	
Suction apparatus (mucus extractor)	Suction bulb or suction apparatus with catheter observed by interviewer in delivery area and reported functioning by respondent	Inventory	
Manual vacuum extractor	Manual vacuum extractor observed by interviewer in delivery area and reported functioning by respondent	Inventory	
Vacuum aspirator or D&C kit	Vacuum aspirator or D&C kit observed by interviewer in delivery area and reported functioning by respondent	Inventory	
Newborn bag & mask	Newborn bag & mask observed by interviewer in delivery area and reported functioning by respondent	Inventory	
Delivery bed	Delivery bed observed by interviewer in delivery area	Inventory	
Partograph	Blank partographs observed by interviewer in delivery area	Inventory	
Gloves	Disposable latex gloves observed by interviewer in delivery area	Inventory	The SARA manual specifies that they be sterile. The SPA questionnaire does not.
Antibiotic eye ointment for newborns	Tetracycline or other antibiotic eye ointment for newborn observed by interviewer in delivery area or in the main location in the facility where medicines and commodities are routinely stored	Inventory	
Injectable uterotonic	Oxytocin or other injectable uterotonic observed by interviewer in delivery area or in the main location in the facility where medicines and commodities are routinely stored	Inventory	The SARA manual specifies oxytocin, but the SPA questionnaire allows "other injectable uterotonic"
Injectable antibiotics	Injectable antibiotic (gentamycin, Benzathine Benzylpenicillin, Ceftriaxone, ampicillin or metronidazole injection) observed by interviewer in delivery area or in the main location in the facility where medicines and commodities are routinely stored	Inventory	The SARA manual specifies Procaine Benzylpenicillin, but the SPA questionnaire asks about Benzathine Benzylpenicillin
Injectable magnesium sulphate	Injectable magnesium sulphate observed by interviewer in delivery area or in the main location in the facility where medicines and commodities are routinely stored	Inventory	

(Continued...)

Table 3. – *Continued*

Indicator	Operational definition	Questionnaire	Note
Skin disinfectant	Skin disinfectant observed by interviewer in delivery area or in the main location in the facility where medicines and commodities are routinely stored	Inventory	
Intravenous solution with infusion set observed by interviewer in delivery area or in the main location in the facility where medicines and commodities are routinely stored	Intravenous solution (plasma expanders) with infusion set (Normal saline or Ringers Lactate, or Dextrose 5%) observed by interviewer in delivery area or in the main location in the facility where medicines and commodities are routinely stored	Inventory	
Regular reviews of maternal or newborn deaths	Respondent reports that facility participates in regular reviews of maternal or newborn deaths of 'near misses'	N/A	Indicator not in SARA
Comprehensive obstetric care		Inventory	
Caesarean section services	Respondent reports that the facility offers cesarean section	Inventory	
Blood transfusion	Respondent reports that the facility offers blood transfusion services	Inventory	
Guidelines for CEmOC adapted for Haiti	Guidelines for comprehensive emergency obstetric care observed by interviewer in the delivery area	Inventory	
Staff member providing delivery trained in CEmOC	Respondents reports having received in-service training or training updates in Comprehensive Emergency Obstetric Care in the past 24 months	Provider interview	
Anesthesia equipment	Anesthesia equipment (all of the following: anesthesia machine, tubings and connectors to connect to the endotracheal tube, stylet, pediatric and adult resuscitator bag and mask, oropharyangeal airway, endotracheal tubes, Magill's forceps) observed by interviewer in the delivery area and reported functioning by respondent	Inventory	The SARA manual includes a laryngoscope in the list of equipment, but the SPA does not ask about this
Incubator	Incubator observed by interviewer in delivery area and reported functioning by respondent	Inventory	

(Continued...)

Table 3. – *Continued*

Indicator	Operational definition	Questionnaire	Note
Blood typing	Blood group tests (Anti-A, Anti-B and Anti-D reagents) and centrifuge for CSF microscopy observed by interviewer in facility and reported functioning by respondent	Inventory	The SARA manual specifies that the facility must have ABO and Rhesus blood group test, but the SPA asks about Anti-A, B and D reagents
Cross matching test	Blood group tests (Anti-A, Anti-B and Anti-D reagents), centrifuge for CSF microscopy, Coomb's reagent and incubator observed by interviewer in facility and reported functioning by respondent	Inventory	The SARA manual says "grouping sera", but the SPA questionnaire specifies "Coomb's reagent"
Blood supply sufficiency	Respondent reports that the facility offers blood transfusion services and has not run out of blood for more than one day at any time during the past 3 months	Inventory	
Blood supply safety	Respondent reports that the facility offers blood transfusion services and either obtains blood only from national or regional blood banks or obtains blood from other sources but screened for HIV, syphilis, hepatitis B and hepatitis C	Inventory	

2.4 Linking Clusters and Health Facilities

The steps to link DHS clusters and SPA facilities are illustrated in Figure 2. First, within a GIS[2], a matrix was created with the direct distance measurement from every DHS cluster location to every health facility. Second, the facility-level data on service provision (i.e., availability of BEmOC and CEmOC, readiness scores) were linked to each cluster in the "long" table. Finally, the facility data were summarized to the cluster level to measure cluster access to health services. The distances were operationalized, creating three groups of facilities within a 5-, 10-, and 15-kilometer buffer distance from a cluster. For BEmOC and CEmOC, the *aggregation indicator at the cluster level was whether there was a BEmOC or CEmOC facility within the buffer*. For service readiness, we constructed two measurements at the cluster level: the *average readiness score of the facilities within the specified distance from the cluster* and the *highest score among the facilities within the buffer*.

2.5 Analysis

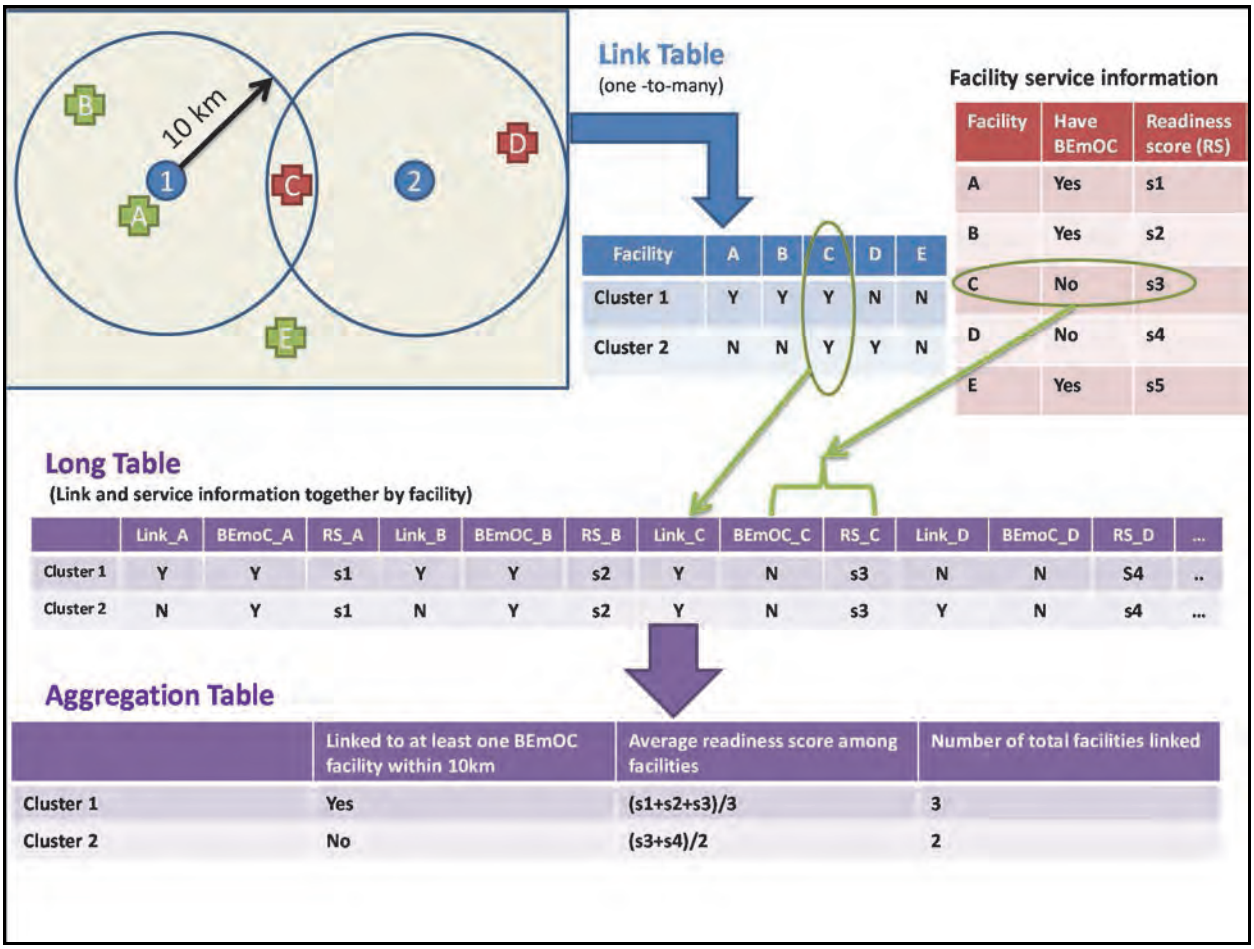
In the descriptive analysis we describe 1) the levels of individual service readiness indicators and 2) the availability of BEmOC and CEmOC at health facilities that offer normal delivery services. As indicated earlier, access to health services was assessed at the DHS cluster level. We estimated the percentages of DHS clusters linked to a BEmOC or CEmOC facility within the buffer. Given that the readiness score is a relative measurement, we divided the average and the highest scores of facilities in the specific buffer of the cluster into low-, medium-, and high-level groups based on the score terciles for all facilities. DHS clusters' access to different levels of service readiness was assessed for all three buffers: 5 km, 10 km, and 15 km. We stratified the analysis by urban and rural residence because of the differences in access to health services between urban and rural areas.

Multilevel (individual- and cluster-level) logistic regression models were used to investigate the association between service readiness and women's use of facility-based delivery care. The outcome was whether a woman had her most recent birth at a health facility. The key predictor was service readiness measured at the cluster level, with two continuous variables: the average readiness score of facilities in a specified buffer and the highest readiness score within the

[2] "Near Table" tool in ArcInfo (ESRI, Redlands, CA)

buffer. We fitted two models for each buffer: one estimating the effect of the average readiness score and the other estimating the effect of the highest readiness score. The multivariate analysis was stratified by urban and rural, and conducted for all three buffers: 5 km, 10 km, and 15 km. As an indicator of service availability, the number of facilities offering delivery care within the buffer could potentially affect women's use of facility delivery services; therefore it was controlled for in the regression. Other variables adjusted for included women's age at birth, birth order, mother's education, household wealth quintile, number of antenatal care visits, and region (department).

Figure 2. Illustration of linking DHS clusters and SPA facilities



Facility	A	B	C	D	E
Cluster 1	Y	Y	Y	N	N
Cluster 2	N	N	Y	Y	N

Facility	Have BEmOC	Readiness score (RS)
A	Yes	s1
B	Yes	s2
C	No	s3
D	No	s4
E	Yes	s5

	Link_A	BEmoC_A	RS_A	Link_B	BEmOC_B	RS_B	Link_C	BEmOC_C	RS_C	Link_D	BEmoC_D	RS_D	...
Cluster 1	Y	Y	s1	Y	Y	s2	Y	N	s3	N	N	S4	..
Cluster 2	N	Y	s1	N	Y	s2	Y	N	s3	Y	N	s4	...

	Linked to at least one BEmOC facility within 10km	Average readiness score among facilities	Number of total facilities linked
Cluster 1	Yes	(s1+s2+s3)/3	3
Cluster 2	No	(s3+s4)/2	2

3. RESULTS

3.1 Facilities' Readiness in Providing Delivery Services

Among the 389 facilities offering delivery services in Haiti, the majority are dispensaries (128) followed by health centers with beds (101) and hospital (94) (Table 4). The availability of basic obstetric care items on the day of the survey varied widely by type of facility, with hospitals generally having many of the items and dispensaries having few. Some items were commonly available across facility types, such as suction apparatus (81.5 percent) and gloves (94.1 percent); while other items were rare such as manual vacuum extractor (10.0 percent) (Table 4). Only 22.6 percent of facilities providing delivery services also provided caesarean section services; this includes a majority of hospitals. With the exception of having a staff member providing delivery who was trained in CEmOC, the availability of comprehensive obstetric care items did not exist in dispensaries or in health centers without beds. Hospitals were more likely to have the comprehensive obstetric care items but cross matching test was present in only 10 percent. Blood transfusion was available in 73.4 percent of hospitals.

Table 4. Among facilities offering delivery services, percentage with the indicated items available

	Hospital	Health center with beds	Health center without beds	Dispensary	Total
Basic obstetric care					
Parenteral administration of antibiotics	90.4	66.3	41.1	29.7	55.8
Parenteral administration of oxytocic drug	98.9	85.1	57.7	38.3	68.4
Parenteral administration of anticonvulsants	71.3	36.6	9.1	7.8	30.8
Assisted vaginal delivery	94.7	88.1	68.1	50.8	74.0
Manual removal of placenta	70.2	64.4	41.1	30.5	50.6
Manual removal of retained products	72.3	54.5	45.5	27.3	48.3
Neonatal resuscitation	66.0	55.4	30.2	19.6	41.9
Guidelines for IMPAC	23.4	24.8	18.3	22.6	22.6
Staff trained in IMPAC	58.5	42.6	28.9	11.7	33.9
Emergency transportation	47.9	22.8	9.1	0.0	19.0
Sterilization equipment	92.6	71.3	47.0	23.5	56.5
Examination light	52.1	41.6	31.7	23.4	36.5
Delivery pack	94.7	85.1	80.4	63.3	79.4
Suction apparatus	92.6	93.1	86.4	61.8	81.5
Manual vacuum extractor	28.7	8.9	3.0	0.8	10.0

(Continued...)

Table 4. – *Continued*

	Hospital	Health center with beds	Health center without beds	Dispensary	Total
Vacuum aspirator or D&C kit	35.1	22.8	21.1	4.7	19.5
Newborn bag & mask	75.5	40.6	27.2	7.8	35.9
Delivery bed	97.9	98.0	94.0	86.7	93.6
Partograph	40.4	32.7	28.7	3.9	24.4
Gloves	92.6	93.1	95.3	87.5	91.5
Antibiotic eye ointment for newborns	79.8	68.3	72.6	53.1	66.8
Injectable uterotonic	79.8	56.4	48.3	36.0	53.9
Injectable antibiotics	96.8	87.1	80.4	52.3	76.8
Injectable magnesium sulphate	85.1	57.4	48.3	21.9	50.8
Skin disinfectant	75.5	64.4	63.4	56.2	64.2
Intravenous solution with infusion set	84.0	76.2	72.8	67.1	74.5
Regular reviews of maternal or newborn deaths	44.7	22.8	12.1	5.5	20.5
Comprehensive obstetric care					
Caesarean section services	83.0	9.9	0.0	0.0	22.6
Blood transfusion	73.4	12.9	0.0	0.0	21.0
Guidelines for CEmOC adapted for Haiti	20.2	2.0	0.0	0.0	5.4
Staff member providing delivery trained in CEmOC	47.9	39.6	27.4	7.8	29.0
Anesthesia equipment	29.8	3.0	0.0	0.0	8.0
Incubator	35.1	3.0	0.0	0.0	9.2
Blood typing	68.1	5.9	0.0	0.0	18.0
Cross matching test	10.6	0.0	0.0	0.0	2.6
Blood supply sufficiency	30.9	4.0	0.0	0.0	8.5
Blood supply safety	62.8	5.0	0.0	0.0	16.4
Number of facilities providing delivery services	94	101	66	128	389

Table 5 shows the availability of comprehensive obstetric care items in the 88 facilities providing caesarean section services. Of these, less than half had staff trained in CEmOC in the last two years and less than one-fourth had available guidelines for CEmOC adapted in Haiti (Table 5). Blood group test and centrifuge along with blood supply safety were available in the majority of facilities (79.5 percent and 72.7 percent, respectively) (Table 5).

Table 5. Among facilities providing caesarean section services, percentage with the indicated items available

	%
Guidelines for CEmOC adapted in Haiti	23.9
Staff trained in CEmOC in last 2 years	46.6
Anesthesia equipment	35.2
Incubator	40.9
Blood group tests and centrifuge	79.5
Cross match testing	11.4
Blood supply sufficiency	37.5
Blood supply safety	72.7
Number of facilities providing caesarean section services*	88

* Including 78 hospitals and 10 health centers with beds

Figure 3 shows the availability of basic and comprehensive emergency obstetric care at health facilities by type of facility. Overall, availability of BEmOC and CEmOC was limited at health facilities in Haiti (18 percent and 9 percent, respectively). Higher-level facilities—hospitals and health centers with beds—were more likely to provide BEmOC and CEmOC than lower-level health facilities including health centers without beds and dispensaries. Very few health centers without beds and dispensaries provided BEmOC and none provided CEmOC. By managing authority, the percentage providing BEmOC and CEmOC was the highest among NGO/private not-for-profit facilities (Figure 4). Despite government facilities being the major providers of delivery care, only 20 percent were BEmOC facilities and 10 percent were CEmOC facilities. Facilities with a mixed managing authority had the lowest emergency obstetric care capacity.

Figure 3. Percentage of facilities providing BEmOC and CEmOC, by type of facility

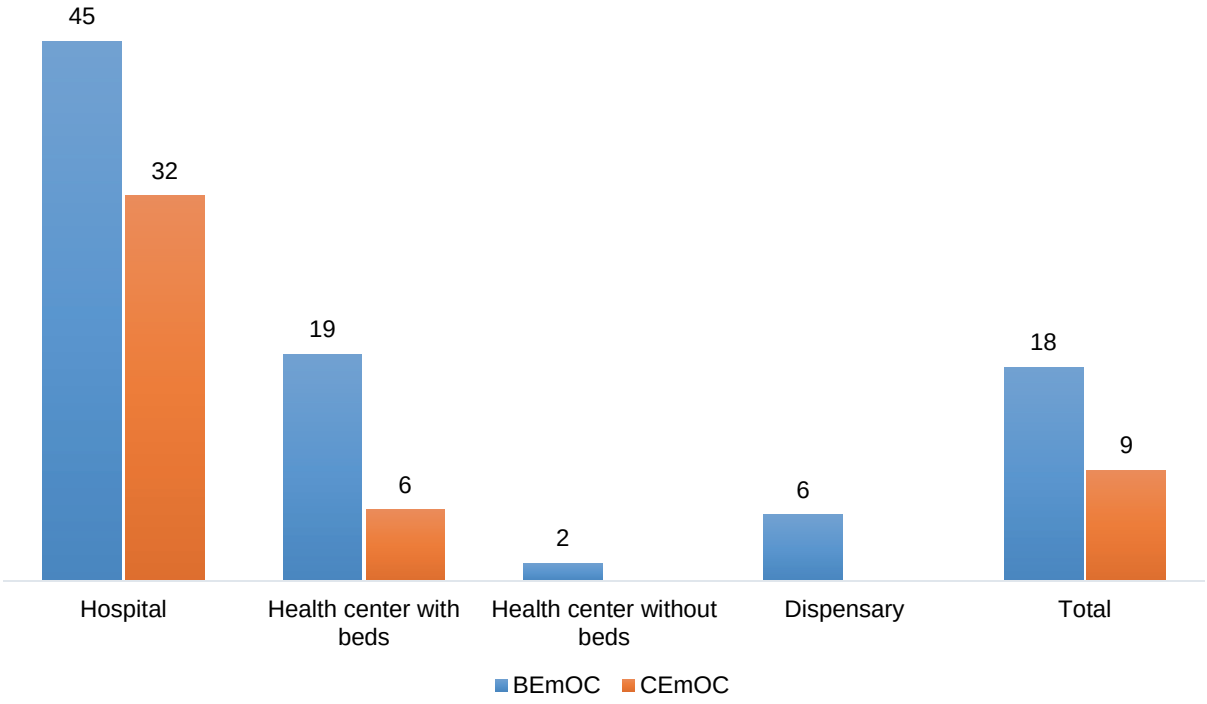
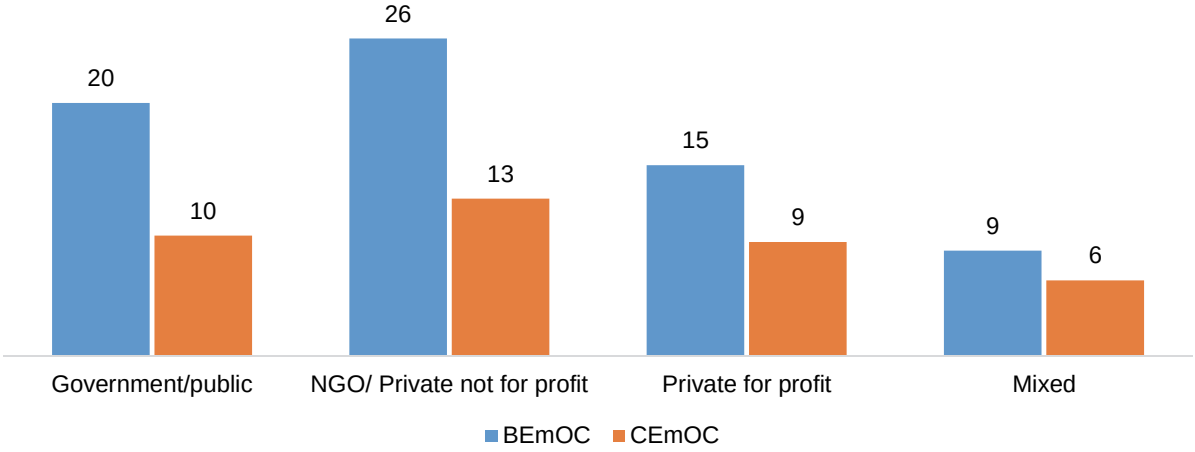


Figure 4. Percentage of facilities providing BEmOC and CEmOC, by managing authority



3.2 DHS Clusters' Access to Bemoc and Cemoc Facilities

DHS clusters located near any health facility is dependent on population and facility density, with urban areas generally having greater access than rural areas. DHS clusters in urban areas are likely to be located near a BEmOC facility, with 86 percent of clusters linked to a BEmOC facility within 5 km (Figure 5). Rural clusters, on the other hand, are much less likely to be located near a BEmOC facility, with only 55 percent within 10 km of a BEmOC facility. In other words, 45 percent of rural clusters do not have access to a BEmOC facility within 10 km. Overall, the percentage of DHS clusters near a CEmOC facility is lower than the percentage near a BEmOC facility, with only 38 percent of DHS clusters having access to a CEmOC facility within 5 km (71 percent urban and 14 percent rural) (Figure 6).

Figure 5. Percentage of DHS clusters having a BEmOC facility within the specified distance, by residence

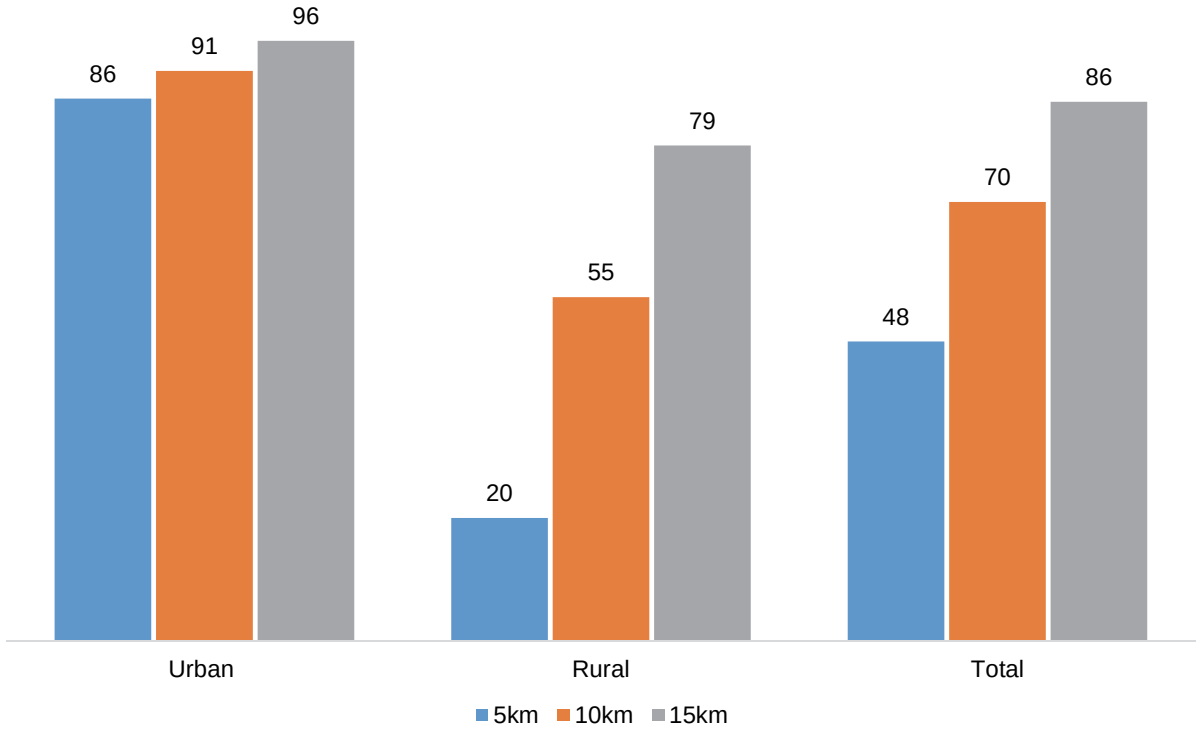
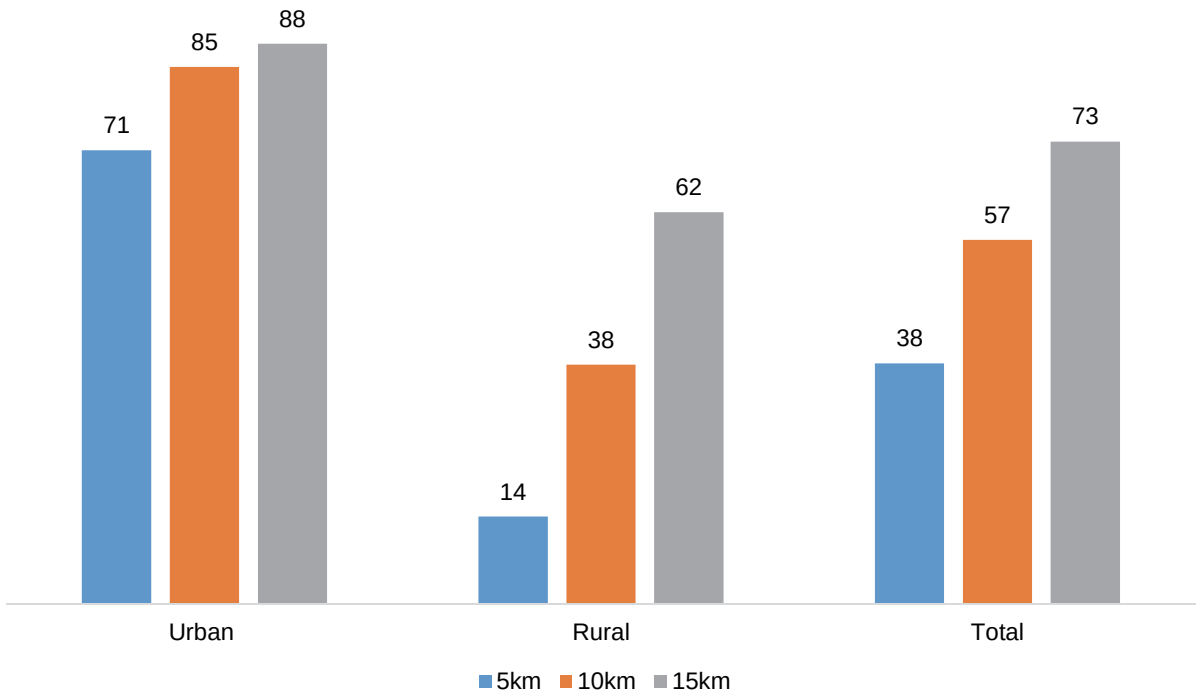


Figure 6. Percentage of DHS clusters having a CEmOC facility within the specified distance, by residence



3.3 DHS Clusters' Access to Different Levels of Service Readiness

Figures 7 and 8 show the percent distribution of DHS clusters by various levels of readiness in providing basic and comprehensive obstetric care services. Figure 7 shows the levels of average score of facilities providing the services within a given distance of the DHS cluster while Figure 6 shows the levels of readiness score of the facility with the highest score. The average score for facilities located near the majority of DHS clusters in urban areas is high while the majority of rural clusters have facilities with scores that average to a medium level. Figure 8, however, shows that when looking only at the highest score for a facility many more urban and rural clusters have access to facilities with high scores. For example, more than half of rural clusters are within 5 km of a facility with a high-level score and 79 percent are within 10 km of such a facility. In urban areas more than 90 percent of clusters have access to a facility with a high-level readiness score.

Figure 7. Percent distribution of DHS clusters by levels of readiness in providing basic and comprehensive obstetric care services at facilities within the specified distance, urban and rural areas

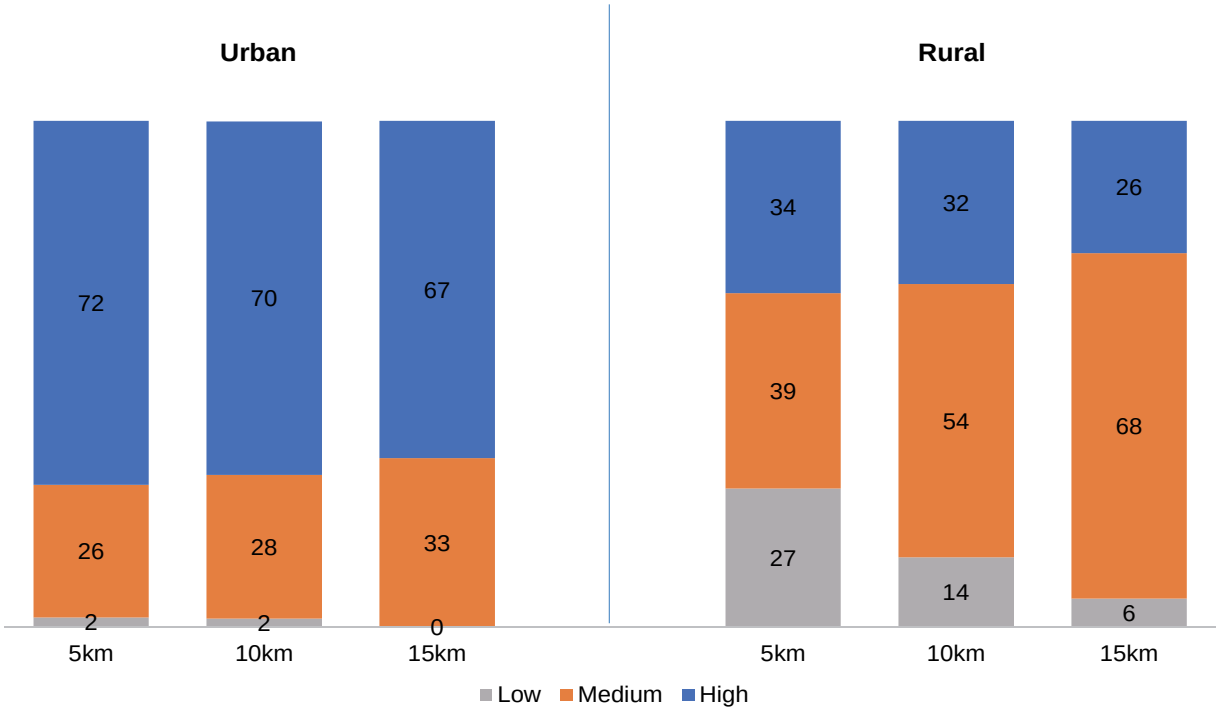
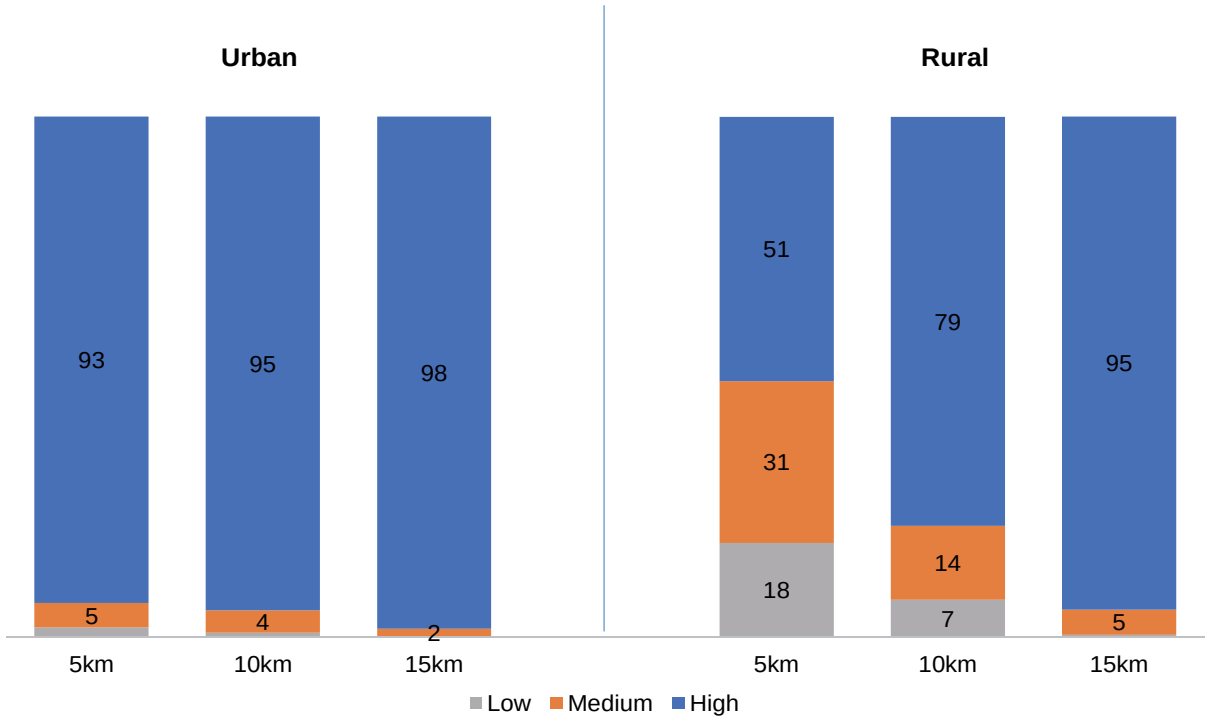


Figure 8. Percent distribution of DHS clusters by levels of readiness in providing basic and comprehensive obstetric care services at the facility with the highest readiness score within the specified distance, urban and rural



3.4 Utilization of Facility-Based Delivery and Determinants

Of the 5,155 women for whom data are available, 40 percent delivered their most recent birth at a health facility (Table 6). As expected, younger women, women with fewer children, women with more education, and women in wealthier households were more likely to deliver at a heath facility. A substantial difference in facility delivery is observed between urban and rural areas. Women in urban areas were more than twice as likely to give births at health facilities as their counterparts in rural areas. There was also great variation among regions (departments), with delivery at a health facility ranging from 19 percent in Grand Anse to 48 percent in Ouest. Facility delivery was also associated with a greater number of antenatal care visits.

Table 6. Percentage of women who delivered the most recent birth at a health facility by background characteristics, Haiti DHS 2012

Background characteristics	%	Number of women
Mother's age at birth		
< 20 years	43.8	741
20-34	41.2	3,479
35-49	30.0	936
Birth order		
1	58.3	1,702
2-3	38.3	1,870
4-5	25.7	852
6+	15.2	730
Residence		
Urban	59.9	1,996
Rural	26.7	3,159
Department		
Ouest	48.1	1,884
Sud-est	24.3	216
Nord	43.2	503
Nord-est	41.1	201
Artibonite	33.3	773
Centre	28.4	399
Sud	37.5	377
Grand'anse	19.2	189
Nord-ouest	28.9	239
Nippes	31.1	140
Camps	50.7	234

(Continued...)

Table 6. – *Continued*

Background characteristics	%	Number of women
Mother's education		
None	14.5	991
Primary	30.2	2,157
Secondary or higher	62.0	2,007
Antenatal care visits		
None	9.6	484
1	24.3	191
2-3	23.5	978
4+	48.9	3,468
Don't know/missing	60.8	34
Wealth quintile		
Lowest	9.7	1,046
Second	21.6	1,023
Middle	41.4	1,119
Fourth	53.2	1,118
Highest	77.6	848
Total	39.5	5,155

Using multilevel models, we assessed how women's utilization of facility delivery is associated with service readiness at health facilities within a specified buffer of the cluster. We ran two multilevel models for each of the three buffers separately for urban and rural areas. The description of the results focuses on the 10-km buffer (Tables 7 and 8). Results for the other two buffers can be found in the appendices (Appendix Tables A and B).

Table 7. Results of multivariate regression of use of facility delivery on the average readiness score, Haiti 2012-2013

	Urban		Rural	
Variables	**OR**	**95% CI**	**OR**	**95% CI**
Average readiness score of facilities within 10 km	1.463	0.896 - 2.388	1.780***	1.391 - 2.276
Number of facilities offering delivery care within 10 km	1.002	0.985 - 1.019	1.026	0.998 - 1.055
Department (ref.=Ouest)				
Sud-est	1.417	0.465 - 4.311	1.280	0.677 - 2.420
Nord	1.602	0.793 - 3.236	1.340	0.811 - 2.213
Nord-est	1.687	0.661 - 4.309	2.485*	1.226 - 5.040
Artibonite	1.523	0.701 - 3.312	1.473	0.971 - 2.234
Centre	1.514	0.567 - 4.045	1.763*	1.035 - 3.004
Sud	1.111	0.387 - 3.188	1.583	0.955 - 2.624
Grand'anse	0.780	0.262 - 2.319	1.008	0.478 - 2.122
Nord-ouest	0.930	0.349 - 2.482	1.405	0.765 - 2.581
Nippes	2.281	0.471 - 11.032	1.495	0.751 - 2.973
Camps	1.320	0.785 - 2.220	1.255	0.466 - 3.377
Wealth quintile (ref.=highest)				
Lowest			0.201***	0.115 - 0.352
Second	0.260**	0.100 - 0.672	0.371***	0.220 - 0.626
Middle	0.353***	0.245 - 0.509	0.674	0.411 - 1.104
Fourth	0.415***	0.316 - 0.545	0.965	0.591 - 1.574
Education (ref.=none)				
Primary	1.381	0.916 - 2.082	1.507**	1.107 - 2.052
Secondary or higher	2.358***	1.542 - 3.607	2.306***	1.632 - 3.259
Birth order (ref.=1)				
2-3	0.418***	0.319 - 0.548	0.293***	0.226 - 0.380
4-5	0.359***	0.239 - 0.539	0.130***	0.087 - 0.193
6+	0.248***	0.141 - 0.436	0.086***	0.052 - 0.142
Antenatal care visits (ref.=none)				
1	2.292*	1.065 - 4.929	4.326***	2.062 - 9.075
2-3	2.039**	1.193 - 3.485	3.792***	2.114 - 6.803
4+	3.974***	2.457 - 6.429	5.954***	3.413 - 10.387
Mother's age at birth	1.047***	1.024 - 1.070	1.072***	1.050 - 1.095
Observations (unweighted)	1,954		3,304	
Number of DHS clusters	175		257	

*p<0.05 **p<0.01 ***p<0.001

Table 7 presents odds ratios and 95% confidence intervals for the average readiness score as well as for the covariates adjusted for in the models. All of the urban clusters (175) and most of the rural clusters (257 of 262) were linked to a health facility offering delivery care within 10 km of the cluster. In rural areas the average readiness score of the facilities is positively and significantly associated with women's use of facility delivery care after controlling for the number of facilities available within the distance and women's characteristics. The odds ratio is 1.78, which means that an increase of one unit in the average score among these facilities corresponds to a 78 percent increase in women's odds of going to a facility for delivery. In urban areas, however, the positive relationship between service readiness score and women's use of facility delivery was not observed. Among the factors controlled for, the total number of facilities offering delivery care within the buffer was not significantly associated with use of facility delivery. We also found no significant associations between utilization and the number of certain types of facilities, for example, hospitals or health centers with beds (data not shown). Women's individual characteristics and number of antenatal care visits were found to be associated with utilization of facility delivery, in the expected direction.

Looking at the highest readiness score among the facilities within 10 km of the cluster, we found it is significantly associated with women's likelihood of delivering at a health facility in both urban and rural areas (Table 8). Women's odds of giving birth at health facilities increases by 36 percent in urban areas and 53 percent in rural areas with every unit of increase in the highest score among the facilities within 10 km, after controlling for other covariates.

Table 8. Results of multivariate regression of use of facility delivery on the highest readiness score, Haiti 2012-2013

	Urban		Rural	
Variables	**OR**	**95% CI**	**OR**	**95% CI**
Highest readiness score among facilities within 10 km	1.363*	1.007 - 1.843	1.527***	1.293 - 1.804
Number of facilities offering delivery care within 10 km	0.994	0.974 - 1.014	1.000	0.970 - 1.031
Departement (ref.=Ouest)				
Sud-est	1.315	0.436 - 3.967	1.139	0.610 - 2.126
Nord	1.229	0.595 - 2.540	1.265	0.769 - 2.080
Nord-est	1.291	0.519 - 3.214	2.564**	1.272 - 5.168
Artibonite	1.166	0.545 - 2.495	1.231	0.818 - 1.852
Centre	1.480	0.557 - 3.932	1.843*	1.088 - 3.121
Sud	1.135	0.404 - 3.190	1.781*	1.085 - 2.924
Grand'anse	0.608	0.198 - 1.865	1.009	0.482 - 2.114
Nord-ouest	0.634	0.244 - 1.646	1.121	0.620 - 2.028
Nippes	1.845	0.390 - 8.738	1.433	0.723 - 2.839
Camps	1.325	0.791 - 2.222	1.450	0.547 - 3.839
Wealth quintile (ref.=highest)				
Lowest	NA	NA	0.200***	0.115 - 0.350
Second	0.263**	0.102 - 0.680	0.354***	0.210 - 0.595
Middle	0.360***	0.250 - 0.519	0.627	0.382 - 1.027
Fourth	0.417***	0.318 - 0.548	0.941	0.577 - 1.534
Education (ref.=none)				
Primary	1.387	0.920 - 2.091	1.530**	1.124 - 2.083
Secondary or higher	2.367***	1.548 - 3.621	2.285***	1.617 - 3.228
Birth order (ref.=1)				
2-3	0.417***	0.318 - 0.548	0.291***	0.224 - 0.377
4-5	0.358***	0.238 - 0.537	0.127***	0.086 - 0.189
6+	0.242***	0.138 - 0.426	0.083***	0.050 - 0.137
Antenatal care visits (ref.=none)				
1	2.287*	1.064 - 4.914	4.311***	2.057 - 9.033
2-3	2.051**	1.200 - 3.505	3.786***	2.110 - 6.792
4+	3.954***	2.444 - 6.396	5.976***	3.426 - 10.424
Mother's age at birth	1.047***	1.024 - 1.070	1.074***	1.052 - 1.097
Observations (unweighted)	1,954		3,304	
Number of DHS clusters	175		257	

*p<0.05 **p<0.01 ***p<0.001

4. DISCUSSION AND CONCLUSION

This study estimated the influence of service readiness on women's use of facility delivery care by linking facility census data and household survey data in a geographic information system (GIS).

The Haitian government considers hospitals and health centers to be the major providers of delivery services; dispensaries and health centers without beds are not mandated to provide delivery services (MSPP 2000). Nevertheless, our results show that half of the facilities offering delivery services are dispensaries and health centers without beds. These lower-level facilities are poorly prepared to provide delivery services. Not only is there almost no capacity to provide emergency obstetric care these lower-level facilities also lack essential equipment and supplies for normal delivery care. Only 9 percent of health centers without beds and none of the dispensaries have functional emergency transportation. As a result, there is high risk of death for mother and newborn when an obstetrical emergency occurs.

Access to basic and comprehensive emergency care is key to reducing maternal mortality (WHO 2014; Wildman and Bouvier-Colle 2004). One of the goals of the 2013-2016 Haiti health strategic plan is to provide BEmOC in 108 facilities by 2015 (MSPP 2012). Our results indicate progress has been slow in meeting this goal. When the 2013 HSPA was implemented only 70 facilities provided BEmOC and among hospitals where half of the births occur only 45 percent provide BEmOC. Availability of CEmOC is even more limited—offered at less than 10 percent of facilities nationwide. Given that BEmOC facilities (i.e., hospitals and health centers) are located primarily in urban areas, most urban clusters are within 5 km of a BEmOC facility. In rural areas, however, access to BEmOC facilities is more limited: only one in five DHS clusters in rural areas is located within 5 km of a BEmOC facility. More program effort is needed to expand BEmOC access in rural areas where 60 percent of the Haitian population resides.

Delivery at a health facility can reduce maternal mortality only if women are assisted by a skilled birth attendant (SBA) who is capable of managing common life-threatening obstetric complications (Harvey et al. 2007). However, less than half of the facilities offering caesarean section services have staff trained in CEmOC in last two years. Guidelines for CEmOC were not commonly available in service areas.

Our study found that better service environment in health facilities within a 10-km radius is significantly associated with greater probability of women delivering at a health facility. This finding agrees with that of previous research that service provision is a strong determinant of delivery service use (Karkee et al. 2014; Moyer and Mustafa 2013; Stekelenburg et al. 2004). As indicated in the introduction, because of methodological constraints in linking population data and health service data, most previous studies were limited to measuring service provision from the client's perspective. Several recent studies took advantage of geographic data to associate health facilities and DHS clusters. These studies focused primarily on distance to the closest facility or the service in the closest facility; however, this approach can be problematic because DHS cluster locations have been displaced. Gabrysch et al. (2011) linked facility data and population data and examined the influence of level of care at the closest facility on use of delivery care. The authors found that an increase in service provision—measured by the availability of BEmOC and CEmOC functions—was associated with 26 percent higher odds of facility delivery. Our study improved on this methodology: instead of looking at the closest facility—where estimates may be subject to misclassification errors—our analysis measured *the effect of a service environment within a reasonable distance*.

Our findings indicate that both the average level of service readiness and the highest level of service readiness can affect the use of delivery care. In rural areas, both average and highest levels of readiness are significantly associate with use of delivery service. However, in urban areas only the highest level of readiness was statistically significant. In urban areas where there are more facilities, more accessible transportation, and more financial resources, women may be able to choose to deliver at facilities with the highest quality of care. In rural areas, the average level of quality of care in an area can substantially increase usage of delivery care and the effect size is stronger than the highest level of readiness. However, it should be noted that the data available in this study did not allow for linking directly to the facility used by the woman for delivery; it only allows for understanding the service environment where the woman lives.

It is interesting that no association is found between the total number of health facilities offering delivery services and use of facility delivery. We also found no significant associations between utilization and the number of certain types of facilities, for example, hospitals or health centers with beds. All DHS clusters are located within 10 km of a facility offering delivery services. The findings appear to suggest increasing number of facilities in the area does not

improve service utilization, after controlling for service readiness and other cofounders. The number of facilities is just one aspect of access to delivery services. Financial resources and cultural factors can also hinder women from going to a facility for delivery. We used 10 km to define the service environment because of the displacement of DHS clusters. It is possible that physical access to health facilities within 10 km is still challenging for some families, especially in mountainous rural areas. Increasing the density of health facilities does not necessarily improve utilization if the facilities are not reachable.

Service provision measures used in existing research included facility infrastructure, obstetric equipment, number of staff, availability of drugs, provision of maternal and child health, and provision of BEmOC and CEmOC. In addition to these aspects, our study also captured a wide range of other items identified by WHO that are essential for providing quality delivery services. Signal functions considered in our study have been performed during the last three months; however, the difference in time between the two surveys may limit the association if quality of care changed in a location over the five-year period of the deliveries studied.

In addition to the methodological improvement of measuring the service environment, some of other strengths of our study lie in the use of facility census data and nationally representative household data, which together have led to more generalizable results. Additionally, the use of observation during facility data collection increases the robustness of the readiness indicators and thus the accuracy of the relationship between service provision and delivery service utilization. Also, controlling for demographic confounding factors and the number of facilities in a service environment strengthens the findings on the association between service readiness and delivery care seeking. However, there are some limitations to this study. First, cause-effect association cannot be established because of the descriptive nature of the survey. Second, the facilities data were collected a year after the household data. Third, it would be helpful to include indicators reflecting the actual process of service delivery, for example, indicators on providers' adherence to standards of care. However, this information was not available from the 2013 HSPA in Haiti.

The use of a 10-kilometer buffer to create the service environment reduces misclassification errors from DHS GPS displacement. Linking all facilities within a 10-kilometer buffer creates a service environment that permits analysis of a woman's use of a facility for

delivery, without directly linking her to the facility she used, by *linking her to all the facilities she was likely to have used*. However, the straight-line buffer approach does not take into account the mountainous terrain or the impassibility of roads during the rainy season, which may limit a woman's access to a linked facility. Nesbitt et al. (2014) compared six different measures of spatial access and found that the straight-line linkage yields results similar to other geospatial algorithms in a developing-country setting (Nesbitt et al. 2014).

This study shows that service readiness at health facilities has a strong influence on the use of these services by woman living in the facilities service environment. Most facilities in rural Haiti are poorly equipped and not yet ready to provide quality delivery services. Our results suggest that efforts and resources should focus on improving the service environment in rural areas. This may require changing the actual mandate of lower-level facilities to account for the local reality and health needs.

Further research is needed to examine the factors impeding use of delivery care services in urban areas. Although health facilities in urban area are better equipped and more able to provide quality delivery services, 40 percent of women still deliver at home. Cost of care was the most frequently cited barrier to care seeking by women, according to the results of the 2012 Haiti DHS. Other social and cultural factors may also play a role.

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APPENDIX

Appendix Table A. Results of multivariate regression of use of facility delivery on the average readiness score: 5 km and 15 km, Haiti 2012-2013

	5 km				15 km			
	Urban		Rural		Urban		Rural	
Variables	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Average readiness score of facilities within 5 km	1.558**	1.176 - 2.064	1.228*	1.027 - 1.469				
Number of facilities offering delivery care within 5 km	0.993	0.972 - 1.014	1.034	0.938 - 1.141				
Average readiness score of facilities within 15 km					3.060**	1.390 - 6.737	2.428***	1.618 - 3.644
Number of facilities offering delivery care within 15 km					0.994	0.978 - 1.010	1.003	0.988 - 1.018
Department (ref.=Ouest)								
Sud-est	1.089	0.402 - 2.948	0.904	0.449 - 1.822	1.953	0.597 - 6.385	1.606	0.826 - 3.123
Nord	1.294	0.743 - 2.255	0.938	0.516 - 1.706	1.814	0.843 - 3.903	1.507	0.908 - 2.502
Nord-est	1.100	0.497 - 2.433	1.448	0.640 - 3.278	2.160	0.787 - 5.931	3.031**	1.472 - 6.241
Artibonite	0.976	0.533 - 1.788	1.100	0.677 - 1.786	1.537	0.668 - 3.535	1.415	0.936 - 2.139
Centre	1.215	0.515 - 2.866	1.663	0.885 - 3.125	1.281	0.459 - 3.574	1.607	0.935 - 2.761
Sud	0.845	0.336 - 2.122	2.409**	1.256 - 4.620	0.705	0.223 - 2.231	1.269	0.748 - 2.152
Grand'anse	0.445	0.160 - 1.233	0.475	0.152 - 1.481	0.704	0.228 - 2.171	1.079	0.512 - 2.275
Nord-ouest	0.681	0.289 - 1.602	0.847	0.440 - 1.632	1.168	0.425 - 3.215	1.834	0.969 - 3.473
Nippes	1.444	0.332 - 6.278	1.377	0.604 - 3.141	2.327	0.488 - 11.099	1.534	0.768 - 3.063
Camps	1.318	0.785 - 2.213	1.181	0.455 - 3.069	1.412	0.845 - 2.358	1.550	0.576 - 4.170
Wealth quintile (ref.=highest)								
Lowest	NA	NA	0.195***	0.107 - 0.356	NA	NA	0.184***	0.105 - 0.322
Second	0.273**	0.105 - 0.708	0.382***	0.222 - 0.660	0.255**	0.098 - 0.658	0.342***	0.203 - 0.577
Middle	0.364***	0.251 - 0.528	0.699	0.418 - 1.169	0.355***	0.246 - 0.511	0.641	0.391 - 1.053
Fourth	0.431***	0.327 - 0.569	1.035	0.616 - 1.738	0.419***	0.319 - 0.550	0.969	0.594 - 1.580

(Continued...)

Appendix Table A. – *Continued*

	5 km				15 km			
	Urban		Rural		Urban		Rural	
Variables	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Education (ref.=none)								
Primary	1.403	0.924 - 2.131	1.371	0.968 - 1.942	1.365	0.907 - 2.056	1.501**	1.105 - 2.038
Secondary or higher	2.488***	1.616 - 3.832	2.178***	1.479 - 3.208	2.305***	1.508 - 3.523	2.326***	1.651 - 3.278
Birth order (ref.=1)								
2-3	0.400***	0.304 - 0.528	0.334***	0.248 - 0.450	0.417***	0.318 - 0.547	0.295***	0.228 - 0.383
4-5	0.336***	0.222 - 0.507	0.160***	0.101 - 0.252	0.353***	0.235 - 0.530	0.129***	0.087 - 0.192
6+	0.250***	0.141 - 0.443	0.090***	0.050 - 0.161	0.244***	0.139 - 0.429	0.085***	0.051 - 0.141
Antenatal care visits (ref.=none)								
1	2.562*	1.175 - 5.588	5.184***	2.259 - 11.893	2.375*	1.107 - 5.096	3.890***	1.891 - 8.004
2-3	2.236**	1.291 - 3.874	4.080***	2.095 - 7.945	2.072**	1.214 - 3.537	3.514***	2.009 - 6.148
4+	4.369***	2.666 - 7.161	6.495***	3.437 - 12.273	3.987***	2.468 - 6.441	5.572***	3.278 - 9.470
Mother's age at birth	1.049***	1.026 - 1.072	1.066***	1.041 - 1.092	1.047***	1.024 - 1.070	1.072***	1.050 - 1.095
Observations (unweighted)	1,934		2,214		1,954		3,383	
Number of DHS clusters	173		172		175		262	

*p<0.05 **p<0.01 ***p<0.001

Appendix B. Results of multivariate regression of use of facility delivery on the highest readiness score: 5 km and 15 km, Haiti 2012-2013

	5 km				15 km			
	Urban		Rural		Urban		Rural	
Variables	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Highest readiness score among facilities within 5 km	1.271	0.999 - 1.618	1.098	0.934 - 1.291				
Number of facilities offering delivery care within 5 km	0.991	0.969 - 1.015	1.016	0.912 - 1.132				
Highest readiness score among facilities within 15 km					2.067***	1.384 - 3.089	1.784***	1.392 - 2.287
Number of facilities offering delivery care within 15 km					0.985	0.968 - 1.002	0.997	0.982 - 1.013
Department (ref.=Ouest)								
Sud-est	1.207	0.437 - 3.329	0.825	0.405 - 1.683	1.596	0.512 - 4.980	1.367	0.718 - 2.604
Nord	1.249	0.710 - 2.198	0.899	0.488 - 1.656	1.071	0.504 - 2.278	1.243	0.753 - 2.052
Nord-est	1.255	0.560 - 2.811	1.459	0.637 - 3.343	1.291	0.505 - 3.301	2.911**	1.419 - 5.972
Artibonite	1.048	0.569 - 1.931	1.075	0.657 - 1.757	0.879	0.383 - 2.017	0.981	0.642 - 1.498
Centre	1.586	0.660 - 3.808	1.728	0.913 - 3.269	1.231	0.444 - 3.415	1.752*	1.027 - 2.987
Sud	1.112	0.445 - 2.775	2.512**	1.298 - 4.861	0.871	0.294 - 2.580	1.514	0.912 - 2.515
Grand'anse	0.617	0.228 - 1.668	0.445	0.141 - 1.407	0.461	0.146 - 1.458	0.975	0.462 - 2.055
Nord-ouest	0.648	0.272 - 1.542	0.812	0.418 - 1.578	0.658	0.258 - 1.677	1.299	0.713 - 2.366
Nippes	1.628	0.360 - 7.355	1.344	0.583 - 3.100	1.327	0.277 - 6.364	1.314	0.655 - 2.635
Camps	1.317	0.778 - 2.231	1.239	0.469 - 3.270	1.369	0.825 - 2.272	1.513	0.564 - 4.055
Wealth quintile (ref.=highest)								
Lowest	NA	NA	0.192***	0.105 - 0.351	NA	NA	0.186***	0.106 - 0.325
Second	0.269**	0.103 - 0.701	0.376***	0.217 - 0.649	0.262**	0.102 - 0.677	0.331***	0.197 - 0.558
Middle	0.363***	0.250 - 0.528	0.693	0.414 - 1.160	0.365***	0.253 - 0.525	0.605*	0.369 - 0.993
Fourth	0.433***	0.328 - 0.571	1.037	0.617 - 1.745	0.420***	0.320 - 0.551	0.957	0.587 - 1.560
Education (ref.=none)								
Primary	1.419	0.934 - 2.156	1.372	0.968 - 1.945	1.353	0.899 - 2.038	1.473*	1.084 - 2.001
Secondary or higher	2.526***	1.639 - 3.892	2.183***	1.481 - 3.219	2.307***	1.510 - 3.525	2.197***	1.558 - 3.097

(Continued...)

Appendix Table B. – *Continued*

	5 km				15 km			
	Urban		Rural		Urban		Rural	
Variables	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Birth order (ref.=1)								
2-3	0.400***	0.304 - 0.527	0.333***	0.247 - 0.448	0.419***	0.320 - 0.550	0.293***	0.226 - 0.380
4-5	0.334***	0.221 - 0.504	0.158***	0.100 - 0.250	0.357***	0.238 - 0.536	0.127***	0.086 - 0.189
6+	0.247***	0.139 - 0.437	0.089***	0.049 - 0.160	0.246***	0.140 - 0.433	0.082***	0.050 - 0.136
Antenatal care visits (ref.=none)								
1	2.529*	1.159 - 5.516	5.223***	2.277 - 11.980	2.341*	1.092 - 5.021	3.871***	1.881 - 7.966
2-3	2.193**	1.266 - 3.798	4.077***	2.093 - 7.940	2.036**	1.193 - 3.473	3.448***	1.970 - 6.033
4+	4.304***	2.627 - 7.053	6.532***	3.457 - 12.342	3.928***	2.433 - 6.341	5.520***	3.247 - 9.384
Mother's age at birth	1.049***	1.026 - 1.072	1.066***	1.041 - 1.092	1.046***	1.024 - 1.069	1.073***	1.051 - 1.096
Observations (unweighted)	1,934		2,214		1,954		3,383	
Number of DHS clusters	173		172		175		262	

*p<0.05 **p<0.01 ***p<0.001