MOMENTUM

Private Healthcare Delivery

Technical Report

UNDERSTANDING THE DYNAMICS BEHIND CESAREAN SECTION PROCEDURES IN PRIVATE AND PUBLIC SECTOR HEALTH FACILITIES: MULTI-COUNTRY SECONDARY ANALYSIS OF DATA FROM SERVICE PROVISION ASSESSMENTS AND DEMOGRAPHIC AND HEALTH SURVEYS

USAID FROM THE AMERICAN PEOPLE

MOMENTUM A Global Partnership for Health and Resilience

MOMENTUM works alongside governments, local and international private and civil society organizations, and other stakeholders to accelerate improvements in maternal, newborn, and child health services. Building on existing evidence and experience implementing global health programs and interventions, we help foster new ideas, partnerships, and approaches and strengthen the resiliency of health systems.

MOMENTUM Private Healthcare Delivery is funded by the U.S. Agency for International Development (USAID) as part of the MOMENTUM suite of awards and implemented by PSI with partners Jhpiego, FHI 360, Avenir Health, and ThinkWell, under USAID cooperative agreement #7200AA20CA00007. For more information about MOMENTUM, visit usaidmomentum.org. The contents of this technical report are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

@USAID_MOMENTUM @USAIDMOMENTUM USAID MOMENTUM USAID MOMENTUM

Cover photo: A woman undergoes a cesarean section in the surgical unit of Eastern Regional Hospital in Accra, Ghana. Credit: Kate Holt|2016.

Suggested Citation: Proma Paul, Louise T Day, Isabelle Lange, Diane Duclos, Veronique Filippi, Hannah Tappis, and Gaurav Sharma.2024. *Understanding the Dynamics Behind Cesarean Section Procedures in Private and Public Sector Health Facilities: Multi-country secondary analysis of data from Service Provision Assessments and Demographic and Health Surveys*; **Washington, DC: USAID MOMENTUM.**

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

We are deeply grateful to our partners and colleagues around the globe who are working to improve the lives of women and children every day. We would like to thank Professor Oona Campbell for discussing the methodological approach and reviewing the results of the study. We would like to give special thanks to our colleagues: Robyn Churchill, Malia Boggs, Clancy Broxton, Nancy Bolan and Lily Kak from the United States Agency for International Development. They contributed broadly to this report with thoughtful guidance throughout the duration of the activity including supporting previous presentations and contributions to this report. We would also like to acknowledge the many contributions of John Varallo, Michaela Scott, and Angela Nash Mercado at Jhpiego.

ABBREVIATIONS AND GLOSSARY

ANC	Antenatal care
BEmONC	Basic Emergency Obstetric and Newborn Care
CEmONC	Comprehensive Emergency Obstetric and Newborn Care
CROSS	Checklist for Reporting Survey Studies
CS	Cesarean section
CSR	Cesarean section rate
CS-QRI	Cesarean Section - Quality Readiness Index
DHS	The Demographic and Health Survey Program
EBF	Exclusive breastfeeding
EmONC	Emergency Obstetric and Newborn Care
FBO	Faith-based organization
HMIS	Health management information system
ICF	Organization that implements the DHS programs
IRB	Institutional Review Board
Jhpiego	Nonprofit organization for international health affiliated with Johns Hopkins University
LAC	Latin America and the Caribbean
LMIC	Low- and middle-income countries
LSHTM	London School of Hygiene & Tropical Medicine
MOMENTUM	MOMENTUM Private Healthcare Delivery
NGO	Non-governmental organization
PPFP	Postpartum family planning
QoC	Quality of care
SPA	Service Provision Assessment
SSA	sub-Saharan Africa
USAID	United States Agency for International Development
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization

KEY FINDINGS AND IMPLICATIONS

WHAT IS ALREADY KNOWN?

- Cesarean section (CS) when indicated prevents maternal and neonatal mortality and morbidity. CS is major surgery requiring high-quality obstetric surgery and anesthesia to avoid adverse consequences for women and newborns, including increased risks of complications in subsequent pregnancies.
- Global CS rates are rising rapidly—currently constituting 21% of all live births and estimated to be 29% by 2030.[*]
- There is limited understanding regarding the dynamics of CS operations across public and private sector facilities in low- and middle-income countries (LMICs) and the relative contribution of the private sector in driving CS rates in LMICs.
- The World Health Organization (WHO) recommends reducing unnecessary and non-medically indicated CS.

WHAT DID WE DO AND WHAT ARE THE NEW FINDINGS?

- MOMENTUM Private Healthcare Delivery and the London School of Hygiene & Tropical Medicine conducted a multi-country secondary analysis of CS births using publicly available nationally representative survey data: Demographic and Health Survey (DHS) household data in the last 10 years (n=20 countries) and Service Provision Assessment (SPA) health facility data within two years of DHS (n=5 countries: Bangladesh, Haiti, Malawi, Nepal, and Tanzania).

DHS analysis from 20 countries:

- Population CS rates varied widely by region, with lower rates in sub-Saharan Africa (2.3%–16.8%), and higher rates in Asia (10.0%–33.8%). Private sectors' relative contribution to population CS rates showed large differences by country: lowest at 5.3% in Burundi and highest at 79.7% in Bangladesh. Although WHO no longer recommends an optimal population CS rate, the persistent large differences in CS rates by region, country, and health sector suggest ongoing under- and overuse of CS.
- We explored the associations between CS birth in private and public sectors for women and infants. We found no differences in newborn and infant mortality rates among CS births between the public and private sectors. However, recommended maternal and newborn care practices among private sector compared to public sector CS births were substantially lower for birth spacing and significantly lower for voluntary postpartum family planning and early and exclusive breastfeeding.

SPA analysis from five countries:

- We designed a novel cesarean section quality readiness index (CS-QRI) composite measure using 45 SPA data items across four WHO quality-of-care domains (evidence-based practices, actionable information systems, competent human resources, and essential physical resources) to categorize public and private sector health facilities into high, medium, and low CS quality readiness.

[*] Betran AP et al. 2021. "Trends and projections of cesarean section rates: global and regional estimates." *BMJ Global Health* 6:e005671.

- In general, health facility CS-QRI was low: high-quality readiness only 0%–11% and medium-quality readiness 0%–48%.
- Private and public sectors both contribute to the CS readiness quality gap.
- The drivers for lower CS quality across all countries and sectors included the extent to which there was consistent availability of electricity, access to blood transfusion services, health professional training in the last 24 months, and availability of personal protection equipment especially eye protection.
- A gap was identified to track CS births conducted in the private for-profit sector due to low use of routine health management information systems (HMIS), except in Tanzania.

Combined DHS and SPA analysis from five countries:

- The probability that a CS birth was at a facility with high or medium CS quality readiness varied among these countries: 28% in Malawi, 13% in Tanzania, 7% in Haiti, 4% in Nepal, and 1% in Bangladesh.

WHAT DO THE NEW FINDINGS IMPLY?

Implications for programs:

- As institutional births increase worldwide, multi-sectoral health system strengthening approaches are needed across both private and public sectors to improve quality of care before, during, and after birth to improve maternal and perinatal outcomes.
- Population CS rates in 20 LMICs explored in this study, showed wide variation, with the private sector acting as a major driver for the increasing rates. Focused efforts are urgently needed to optimize CS rates to ensure they are not “too much, too soon” and “too little, too late.”
- When birth by CS is indicated, health facilities need to be ready across all domains of quality to ensure optimal safety, experience, and outcome for women and newborns. This study has found that most health facilities providing CSs, in both private and public sectors, have major gaps for readiness across multiple quality domains.
- Action is needed to strengthen recommended postnatal care practices of family planning, birth spacing, and early and exclusive breastfeeding after CS birth—all of which are substantially lower in the private sector.

Implications for future research:

- This report highlights novel analyses for CS births that can be achieved using data in the public domain and replicated for other country settings.
- Our CS-QRI composite measure captures four quality domains related to CS births, captured in SPA Phase 1 surveys. It could be adjusted for future SPA Phase 2 surveys, ideally to include all eight quality domains.
- Maternal and newborn process and outcome measures in DHS are limited, highlighting the importance of strengthening routine data sources, both provision and experience of care, including referrals, and equity.
- Further implementation research is needed to identify effective ways to optimize high-quality CS in both private and public sectors. Previous research has indicated some promising approaches including

mentorship and supervision, use of the safe surgery checklist, review and audits of labor and birth records, setting of institutional targets and goals, and health financing interventions.

- Special in-depth studies are also recommended to explore the nuanced complexity of CS births such as the ongoing linked study in Indonesia.

BACKGROUND

The MOMENTUM Private Healthcare Delivery (MOMENTUM) project is funded by the U.S. Agency for International Development (USAID) and aims to harness the potential of the private sector in mixed health systems, where healthcare is offered through both the public and private sectors. To strengthen the private sector's contributions to vital healthcare, MOMENTUM addresses challenges and leverages opportunities in supply and demand to expand access to and use of evidence-based, high-quality health information, products, and services [1].

Rising Cesarean section rates:

Cesarean section (CS) is a major obstetric surgery indicated for the woman and/or fetus when specific complications develop during pregnancy and childbirth [2,3]. While debate remains on the appropriate CS rate at the population level, the World Health Organization (WHO) considers a population CS rate of around 10%–15% is associated with improved maternal and newborn outcomes [4–6].

CS must be conducted in a health facility equipped for obstetric surgical, anesthetic and newborn care. In some countries, these health facilities are designated comprehensive emergency obstetric and newborn care (CEmONC) based on their ability to conduct CS and give blood transfusion along with the seven basic emergency obstetric and newborn care (BEmONC) interventions (i.e., parenteral antibiotics and anticonvulsants, uterotonic drugs, manual removal of placenta and retained products, assisted vaginal delivery, and neonatal resuscitation) [7].

Increasing access to BEmONC and CEmONC) for women and newborns when complications arise has been a programmatic strategy over recent decades to reduce maternal and neonatal mortality and stillbirth. CS is now the most common surgical procedure performed globally. Recent estimates using data from 2010–2018 suggest that 38 million births by CS occur annually. By 2030, estimates show that nearly 30% of all births will be CS births—ranging from 7.1% in sub-Saharan Africa (SSA) to 63.4% in Eastern Asia [8].

Under and over-use of cesarean section

Although national CS rates are increasing, especially in low- and middle-income countries (LMICs) [8], CS inequities within countries and among population groups are common including for both underuse (too few CS) and overuse (too many CS) [9,10]. Overuse of CS has substantial resource implications, wasting scarce human and financial resources [11].

Complex factors affecting the frequency of CS use are conceptualized into four overlapping and interacting groups: (1) obstetric and clinical factors; (2) women and community; (3) health professionals; and (4) organizational and systems (See Figure 1 below) [9].

Cesarean section across public and private sectors:

Previous studies have found CS rates in the private sector exceed those in the public sector in most regions of the world [3,12–17]. The private sector refers to all facilities or institutions that are beyond the purview of national governments including for-profit and not-for-profit (e.g., non-governmental organizations [NGOs], faith-based organizations [FBOs] and other charitable institutions). Women are reported to often use the private sector for childbirth because it is perceived to be clean, timely, and patient-centric [18]. Variations in CS rates within these private sector subgroups are typical. The higher CS rates in the private

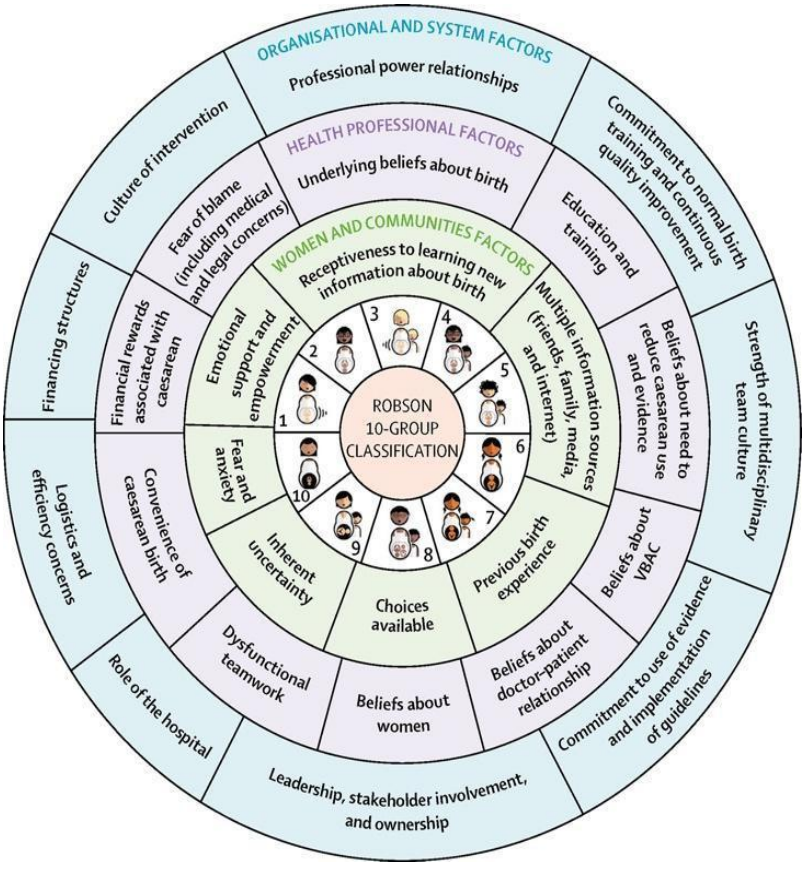
sector are predominantly due to the hospital culture, physician incentives, maternal request, and payment schemes [19]. However, in most settings, detailed and contextualized information around the dynamics of CS in the private sector are limited.

Cesarean section and quality-of-care

The readiness and capacity of health facilities to provide high quality midwifery and obstetric care may be associated with CS, especially in the private for-profit sector compared to non-government and government sectors [20]. For example, lack of trained midwives providing high-quality care may lead to increased CSs as a risk-mitigation strategy.

Poor-quality care, including unsafe surgery and anesthesia, is a major contributor to preventable maternal and perinatal mortality and morbidity [11]. A recent systematic review and meta-analysis found high levels of maternal and perinatal mortality after CS in LMICs; the prevalence of maternal death in women after CS was 7.6 per 1,000 procedures (95% CI 6.6, 8.6), prevalence of stillbirth was 56.6 per 1,000 procedures (95% CI 46.1, 66.3), and perinatal death rate was 84.7 per 1,000 procedures (95% CI: 70.5, 100.2) [22]. These high mortality rates are linked to high morbidity rates likely associated with poor-quality care, exacerbated by the double burden of the use of CS both "too much, too soon" and "too little, too late" [21–24].

FIGURE 1: SCHEMATIC REPRESENTATION OF WOMEN, SOCIETAL, PROVIDERS, AND ORGANIZATION FACTORS AFFECTING CS RATES



Source: Betrán AP et al. 2018. Interventions to reduce unnecessary cesarean sections in healthy women and babies. *The Lancet.* *(*Corresponding author verbally granted permission to reproduce image using WHO license on 30 Jan 2024)

High-quality care for pregnant women and newborns is operationally defined as *safe, effective, timely, efficient, equitable,* and *people-centered* [25]. In 2009, WHO published safe surgery guidelines, including for CS, and recommended preoperative use of the WHO surgical safety checklist, which has been shown to reduce morbidity and mortality [26]. In 2016, WHO published standards to improve quality of maternal and newborn care in health facilities, linked to the quality-of-care framework [27,28]. The quality-of-care framework articulates eight interconnected domains of quality organized by two dimensions: provision and experience of care. This quality standards guidance includes quality measures for antenatal, intrapartum, and postnatal care specifically relevant for women requiring CS [28]. When CS is performed in health facilities not meeting these minimum structures and processes for surgical and childbirth safety and quality, women and newborns lives are put at risk.

Service readiness for CS

Service readiness measures structures and processes within a health system that enable delivery of high-quality care [29,30]. The concept of service readiness is based on the Donabedian three-component approach for evaluating quality of care (structure, process, and outcome) [29]. Previous research has measured service readiness for CS in a limited number of LMIC settings [31–33]. Among these studies, one in Tanzania used publicly available Service Provision Assessment (SPA) health facility assessment data, which found that less than half of CSs were performed in facilities meeting the three readiness indicators of having consistent electricity availability, 24 hour schedule for CS and anesthesia providers, and all general anesthesia equipment [32].

Contribution of CS to maternal and newborn health

Global progress in reducing maternal, newborn deaths and stillbirths during the last decades has stagnated and without higher annual rates of reduction the targets of the Global Strategy for women and children's health and the Sustainable Development Goals will not be met [34]. As CS rates continue to rise globally, it is important to understand the contribution of poor-quality care and unsafe CS to this slow progress toward reducing preventable mortality and morbidity for women and newborns.

This report summarizes multi-country secondary analyses of publicly available national data sources regarding CS births in public and private sectors in LMIC. This report forms one of a two-part project for MOMENTUM Private Healthcare Delivery entitled: Understanding the dynamics behind CS procedures in private and public sector health facilities. The second part includes an in-depth mixed methods case study at health facilities in Indonesia.

AIMS AND OBJECTIVES

AIMS

The aim of this secondary analysis of nationally representative data is to explore the quality and outcomes for CS in the private and public sectors across multiple countries.

OBJECTIVES

1. To estimate the relative contribution of private and public health facilities to population CS rates.
2. To design a cesarean section quality readiness index (CS-QRI) from publicly available nationally representative health facility assessment data.

3. To measure CS quality readiness in private and public sector health facilities in different countries.
4. To examine the association of health facility characteristics with high-quality CS service-readiness in different countries.
5. To estimate the average proportion of women whose CS was conducted in a health facility with high-or medium quality CS service-readiness in the private and public sectors in different countries.
6. To assess the association between CS birth in the private and public sectors with maternal (6.1) and child (6.2) health outcomes.

METHODS

Data sources

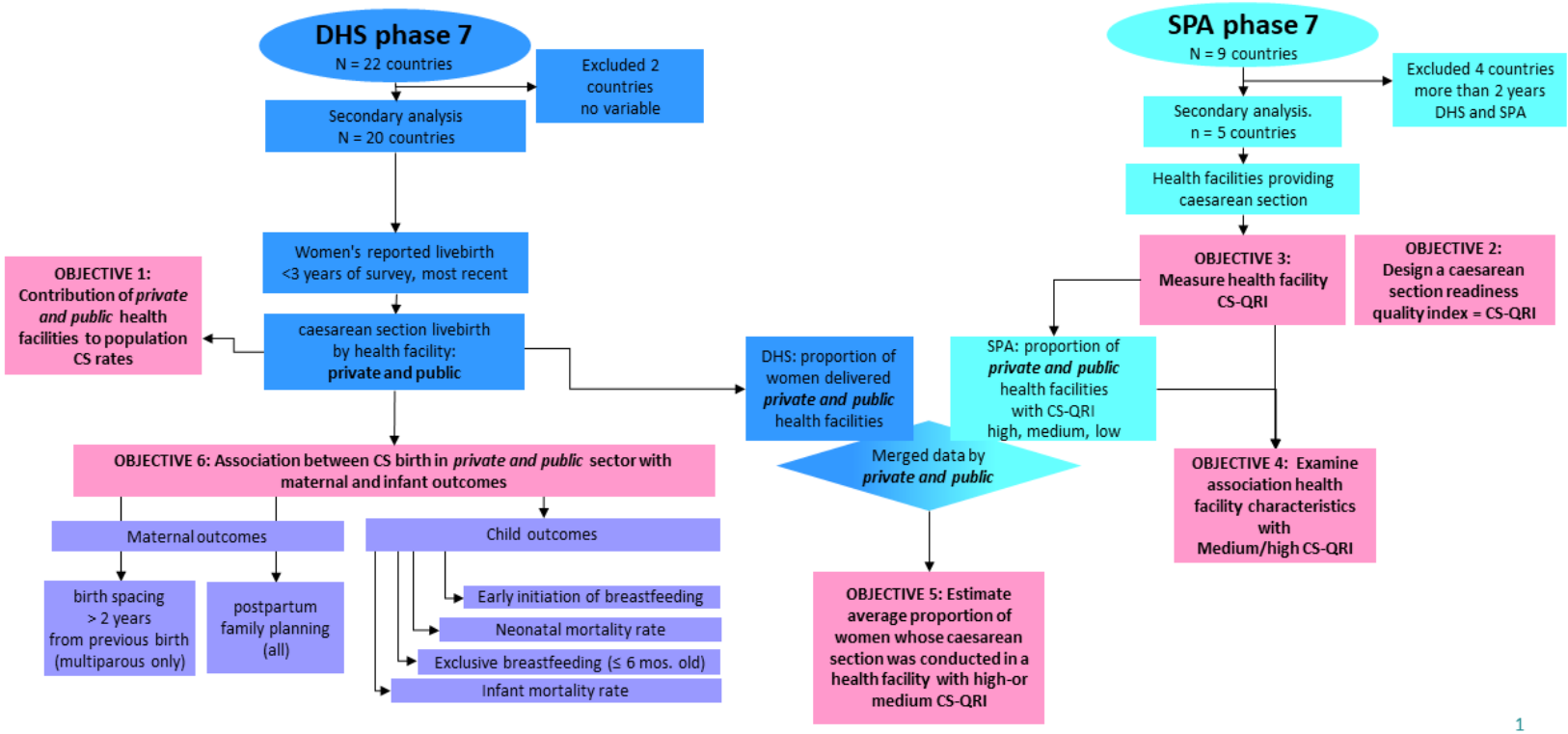
We identified two nationally representative cross-sectional data sources with data on CS births in LMICs. Both were publicly available from the Demographic and Health Survey (DHS) Program [35].

1. **Individual level: Demographic and Health Surveys Phase 7 (2013–2018) [36].**
   These nationally representative, population-based household surveys use a cluster sampling design based on available census information, typically including 5,000–30,000 households. DHS Phase 7 included four primary types of questionnaires: household, women, man, and biomarker. Phase 8 surveys were not used as datasets because they were not publicly available at the time of analysis. In this analysis, we used data collected from the Woman's Questionnaire, where interviews with women of reproductive age (15–49 years) included questions on fertility, voluntary family planning, maternal and child health, and most recent live birth reported by women in the three years preceding the survey (age of most recent live birth 0–36 months).
2. **Health Facility Level: Service Provision Assessment Surveys [37].**
   These health facility assessments captured the availability and readiness of health services at different facilities type/level (e.g., primary, district hospital, national referral) and health sector (private, public, mixed). For national representation, health facilities are selected randomly, either from a national sampling list or a complete census typically including 400–700 facilities. This secondary analysis regarding CS used data collected from two questionnaires: Inventory and health worker interviews.

We selected all available DHS and SPA Phase 7 data within the last 10 years. Study Objectives 1 and 6 used DHS data alone; Objectives 2, 3, and 4 used SPA data alone. Objective 5 linked DHS and SPA survey datasets and to minimize the effect of changing health facility dynamics over time, we selected paired DHS/SPA datasets conducted within two years of each other. We categorized health sector by:

- Private for-profit
- NGO and FBO, representing private not-for-profit
- Public
- Mixed public-private

FIGURE 2: FLOWCHART OF SPA AND DHS DATA INCLUDED BY STUDY OBJECTIVE FOR SECONDARY ANALYSIS TO UNDERSTAND THE DYNAMICS BEHIND CS PROCEDURES IN PRIVATE AND PUBLIC SECTOR HEALTH FACILITIES.



Abbreviations: CS-QRI = cesarean section quality readiness index; DHS = the Demographic and Health Survey; SPA = Service Provision Assessment

METHODS BY OBJECTIVE

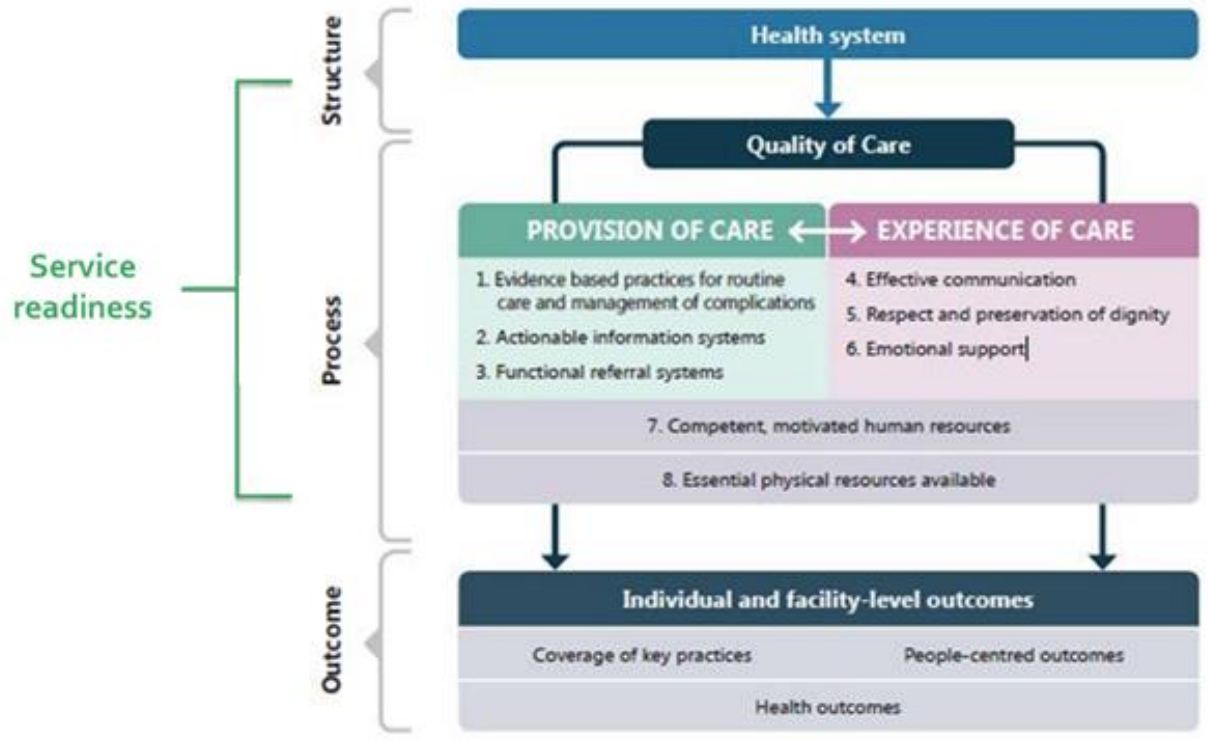
OBJECTIVE 1: TO ESTIMATE THE CONTRIBUTION OF PRIVATE AND PUBLIC HEALTH FACILITIES TO POPULATION CESAREAN SECTION RATES.

Within each country, we calculated the population and institutional CS rates for the individual DHS datasets. We stratified by health sector (public, private, mixed) to estimate the relative contribution of each health sector to the overall population CS rate.

OBJECTIVE 2: TO DESIGN A CESAREAN SECTION QUALITY READINESS INDEX FROM PUBLICLY AVAILABLE NATIONALLY REPRESENTATIVE HEALTH FACILITY ASSESSMENT DATA.

We defined high-quality CS service-readiness as the availability of components of structure and process, in SPA surveys, based on the WHO maternal and newborn quality-of-care framework (Figure 3) [28].

FIGURE 3: DESCRIPTION OF SERVICE READINESS WITHIN THE WHO QUALITY-OF-CARE FRAMEWORK FOR MATERNAL AND NEWBORN HEALTH (ADAPTED FROM [28,29])



Using principles from previous research [31–33], we designed a novel approach to calculate a CS-QRI within each WHO quality domain. The index was designed stepwise beginning from a review of the 2016 **WHO publication**, *Standards for improving quality of maternal and newborn care in health facilities*, linking quality statements to the framework and **listed all quality measures pertinent to CS.**

Step 1: We mapped this list of WHO standards quality measures to SPA survey questions (detailed in Appendix Table A1) as proxy measures of quality available as dichotomous data elements (0 = no and 1= yes). Hereafter, these are called "CS individual quality readiness items."

Step 2: We grouped the "CS individual quality readiness items" by quality domain, hereafter called "CS quality item set." We categorized the item set for quality Domain 1 (evidence-based practices) into three subsets relating to the clinical procedure of CS:

- Clinical decision-making for CS
- Surgical procedure of CS
- Complications of CS

Step 3: We defined the CS-QRI at health-facility level as the sum of all available items in the "CS quality item set," specific for each quality domain, ranging from 0 for zero items to 1 for the whole item set available.

Step 4: We defined the overall CS-QRI at health facility level as the sum of all quality domain specific CS-QRI, using a weighted additive method to apply equal weights [38] among the quality standards (adapted from [39]). Health facilities are categorized by overall CS-QRI:

High-quality readiness for overall CS-QRI = 1
Medium-quality readiness for overall CS-QRI ≥0.8–0.99
Low-quality readiness for overall CS-QRI <0.08

OBJECTIVE 3: TO MEASURE CESAREAN SECTION QUALITY READINESS IN PRIVATE AND PUBLIC SECTOR HEALTH FACILITIES IN DIFFERENT COUNTRIES.

Using SPA data, we calculated at facility level the CS individual quality item readiness (Step 2), the CS quality item set (Step 2), the CS-QRI domain-specific (Step 3), and overall CS-QRI (Step 4).

OBJECTIVE 4: TO EXAMINE THE ASSOCIATION OF HEALTH FACILITY CHARACTERISTICS WITH MEDIUM/HIGH-QUALITY READINESS FOR CESAREAN SECTION SERVICES IN DIFFERENT COUNTRIES.

We pooled SPA datasets for the five countries, weighting the five surveys by rescaling so that each health facility assessment counts equally.

We examined the association between "medium/high quality" (CS-QRI ≥0.8) CS readiness and health facility characteristics: location of the health facility (urban, rural); type or health facility (hospital, lower-level facility); and meeting comprehensive EmONC level.

OBJECTIVE 5. TO ESTIMATE THE AVERAGE PROPORTION OF WOMEN WHOSE CESAREAN SECTION WAS CONDUCTED IN A HEALTH FACILITY WITH HIGH OR MEDIUM-QUALITY CS SERVICE-READINESS IN THE PRIVATE AND PUBLIC SECTORS IN DIFFERENT COUNTRIES.

For the linkable DHS and SPA datasets conducted within two years of each other, we harmonized the type of health facilities (adapted from [40], Appendix Table A2) to ensure comparability of health sector. We merged the DHS CS rate in each health sector stratum with the summary statistics of the CS-QRI at country level (Figure 2).

OBJECTIVE 6: TO ASSESS THE ASSOCIATION BETWEEN CESAREAN BIRTH IN THE PRIVATE/PUBLIC SECTOR WITH MATERNAL AND INFANT OUTCOMES.

The exposure of interest was the health sector, categorized as public or private (including private for-profit and NGO/FBO representing private not-for-profit). None of the women in the DHS survey reported CS birth in a mixed public-private facility and therefore this was not included as a health sector category.

We reviewed DHS questionnaires for maternal and childcare practices and outcomes relevant to CS birth of the index pregnancy captured in the DHS household survey (Figure 2). We identified two maternal and four infant related questions. Notably, the maternal care outcomes identified can also improve child outcomes.

Maternal care outcomes (6.1)

1. *Recommended birth spacing (≥24 months):*
   WHO recommends a birth interval of at least 24 or more months after a live birth [41] to avoid complications—including premature membrane rupture, placenta abruption and placenta previa, and uterine rupture—among women with previous CS [42].

   We categorized the multiparous women based on the age of their previous child as short birth interval <24 months as "0" and recommended interval *(≥24 months) as "1"*.

2. *Uptake of postpartum family planning (PPFP) with modern methods:*
   Family planning reduces maternal and child mortality by preventing unplanned and unwanted pregnancies and by improving birth spacing [43].

   We categorized all women (nulliparous and multiparous) by uptake of family planning used in the first 12 months after this live birth (i.e., PPFP): no contraceptive method or only traditional method (periodic abstinence, withdrawal) as "0" and using modern methods (female and male sterilization, oral contraceptives, intrauterine contraceptive device, injectable and implants, male and female condom, lactational amenorrhea method, or standard days method) as "1."

Child outcomes (6.2)

1. *Newborn survival*: We categorized the most recent live birth that died within one month as "0" and being alive beyond one month as "1."
2. *Infant survival*: We categorized the most recent live birth that died within 12 months as "0" and being alive beyond 12 months as "1."
3. *Early initiation of breastfeeding:* WHO recommends the baby is put to the breast within one hour of birth to facilitate maternal-newborn bonding and improve exclusive breastfeeding (EBF). We categorized all most recent births who initiated early breastfeeding yes as "1" and no as "0."
4. *Exclusive breastfeeding:* WHO recommends infants are exclusively breastfed until six months of age, which is associated with protection against infections, reduced child mortality, and improved cognition. A child six months or younger who is currently living with their mother was considered

EBF "1" if was currently breastfeeding and has had nothing else in the 24 hours preceding the interview, otherwise was considered not EBF "0."

Covariates as potential confounders were selected based on previous known associations with the outcome of interest:

1. *Sociodemographic characteristics (women-level):* Woman's age at birth of the index child (≤19, 20–24, 25–29, 30–34, 35–39, ≥40 years); highest education (none, primary, secondary, higher); self-reported problems accessing healthcare in general (no, yes).
2. *Sociodemographic characteristics (household-level):* Place of residence (urban, rural); wealth index (poorest, poor, middle, richer, richest; [44]).
3. *Obstetric history (pre-pregnancy covariates):* birth order (1, 2, ≥3); previous CS for multiparous women (no, yes).
4. *Pregnancy care covariates*: Number of antenatal care visits (<4, ≥4 visits); location of antenatal care visits (public, private, other—not specified, combination of health sectors); antenatal content (blood pressure measured, blood sample taken [unspecified], urine sample given, iron tablets/syrup given, and pregnancy complication information counseled).
5. *Intrapartum care covariate:* Emergency CS, defined as timing for CS after labor started.
6. *Newborn characteristics:* sex of baby (male, female); multiple birth (singleton = no, twin/triplet/higher = yes); low birthweight <2,500 grams (no, yes).

Description of all exposure variables are presented in Appendix Table A3.

ANALYSIS BY OBJECTIVES

Data were analyzed using Stata version 15.1 statistical software.

Objective 1: Population CS rate, institutional CS rate, and relative contribution of the private health facility to population CS rate were calculated for each country from the DHS datasets.

Objective 3: Percentage availability of individual item, item set readiness, and CS quality readiness indices by quality domain and overall, at each health facility categorized as "high quality" (CS-QRI=1), "medium quality" (CS-QRI ≥0.8 to 0.99), and "low quality" CS-QRI <0.8), were computed from the SPA datasets. The mean CS-QRI was calculated for the overall CS quality readiness. CS item set readiness cascade graphs were used to show the cumulative availability of each item. We stratified all Objective 3 analyses by health sector (private for-profit, NGO/FBO, and public).

Objective 4: Logistic regression was used to explore the association of "high" and "medium" quality service readiness as measured by CS-QRI with health facility characteristics (location of health facility, type of facility, and EmONC level), adjusted by country using the pooled re-weighted SPA dataset.

Objective 5: Using SPA and DHS datasets merged by health sector, women were categorized into two groups based on the probability their CS birth was at a health facility that was categorized as CS-QRI "high quality" or "medium quality." The CS quality gap was defined as the proportion of women who did not receive high or medium quality CS (i.e., low quality). The relative contribution of each health sector (public, private for-profit, NGO/FBO) on the CS quality gap for population CS births was calculated.

Objective 6: Using the individual country DHS datasets, descriptive proportions for the two maternal and four infant care practices and outcomes were calculated by country. Using the pooled re-weighted DHS datasets, we examined differences in the covariates and health sector calculating chi-square, adjusting for country. Univariate analysis between each covariate (sociodemographic, previous obstetric history, ANC, emergency/elective CS, newborn characteristics) and each maternal and infant outcome using Rao-Scott chi-square. A covariate was considered a potential confounder for the multivariable logistic regression model if the p-value was <0.20. Multivariable logistic regression analysis was conducted to examine additional factors that were associated with each outcome, and they are presented stratified by private and public sector. Variables with a p-value <0.05 were considered statistically significant.

Results were reported in accordance to the consensus-based checklist for reporting survey studies (CROSS) (Appendix Table A4) [45].

ETHICS

Data for this study was used in accordance with the requirements of the DHS Program [46]. The original DHS survey protocol and questionnaires were approved by the ICF Institutional Review Board. The London School of Hygiene & Tropical Medicine ethics committee granted approval to conduct this secondary analysis (LSHTM ethics reference 28261).

RESULTS

DEMOGRAPHIC AND HEALTH SURVEY DATA SOURCE

We identified 22 countries that conducted a DHS Phase 7 during the last decade, but two surveys were excluded because country adaptations had removed variables of interest. (Figure 2). The remaining 20 countries represented three regions: six from Asia, one from Latin America and the Caribbean (LAC), and 13 from SSA (Table 1).

SERVICE PROVISION ASSESSMENT DATA SOURCES

We identified nine countries had conducted a phase 7 SPA survey and selected the five of which within two years of a DHS Phase 7: Bangladesh, Haiti, Nepal, Malawi, and Tanzania (Figure 2, Table 1).

BACKGROUND CHARACTERISTICS OF WOMEN IN DEMOGRAPHIC AND HEALTH SURVEY

The pooled unweighted DHS dataset of the 20 countries included 249,953 women, resulting in 277,333 live births. The largest proportion of women in the sample were from India (136,214 women, 49.1%), followed by Nigeria (19,462 women, 7.0%) and then Kenya (12,267 women, 4.4%). The remaining 17 countries contributed 1.1%–3.8% of the sample size, with the smallest contribution from Nepal (2,977, 1.1%). Among the live births, 215,761 births were at a health facility and 39,895 were CS births. The proportion of institutional birth varied within countries in the regions: Asia (range: 46%–90%); LAC (39%); and Africa (range: 40%–93%) (Table 1).

TABLE 1: DESCRIPTION OF DHS AND SPA SURVEYS DATASETS INCLUDED IN SECONDARY ANALYSIS TO UNDERSTAND THE DYNAMICS BEHIND CS PROCEDURES IN PRIVATE AND PUBLIC SECTOR HEALTH FACILITIES. (N=20 DHS AND 5 SPA COUNTRIES)

[a] Live birth within three years of survey date; [b] Includes women with multiples; [c] Includes all public, private, NGO, and FBO; [d]Excludes 51 HIV stand-alone testing centers in Nepal.

		DHS Survey				SPA Survey	
Region	Country	Survey year	Number of women with live births [a]	Number of live births reported [b]	Institutional deliveries [c] (weighted %)	Year	Number of facilities sampled
Asia	Bangladesh	2017–18	5,012	5,249	45.5%	2017	1,524
	India	2019–21	122,426	136,214	90.0%		
	Indonesia	2017	9,999	10,529	81.1%		
	Nepal	2016	2,761	2,977	58.0%	2015	912[d]
	Pakistan	2017–18	6,272	7,453	69.8%		
	Philippines	2017	5,425	6,055	81.2%		
Africa	Benin	2017–18	7,216	8,037	84.8%		
	Burundi	2016–17	6,988	7,876	82.5%		
	Cameroon	2018	5,021	5,726	67.2%		
	Ghana	2014	3,235	3,528	75.1%		
	Kenya	2014	10,996	12,267	64.0%		
	Malawi	2015–16	9,572	10,117	92.5%	2013–2014	977
	Mali	2018	5,141	5,842	68.2%		
	Nigeria	2018	17,285	19,462	40.4%		
	Rwanda	2019–20	4,465	4,817	93.4%		
	Sierra Leone	2019	5,481	5,862	85.0%		
	Tanzania	2015–16	5,558	6,274	61.0%	2014–2015	1,188
	Uganda	2016	7,998	9,199	75.1%		
	Zambia	2018	5,530	5,964	85.0%		
Latin America and Caribbean	Haiti	2016–17	3,572	3,885	38.9%	2017–2018	1,007

BACKGROUND CHARACTERISTICS OF HEALTH FACILITIES IN SPA SURVEY

Among the total 4,538 health facilities assessed in the five SPA surveys, <30% reported having CS services: 12.8% in Bangladesh, 16.3% in Haiti, 7.6% Malawi, 7.4% in Nepal, and 27.2% in Tanzania. Mixed public-private facilities were only assessed in Haiti.

Public facilities offering CS ranged 2.3%–24.3%, compared to 3.9%–97.1% of private facilities and 9.9%–44.4% of NGO/FBO facilities. Seven percent of the mixed public-private facilities in Haiti offered CS. There were large differences in different geographies: in Bangladesh 97.1% of the private for-profit facilities provided CS, compared to 4.2% in public facilities (Table 2). Although lower than in Bangladesh, the private sector in Nepal had more CS facilities compared to the public sector. In contrast, a similar proportion of private and public facilities provided CS services in Tanzania (22.9% in public; 23.4% in private); however, 44.4% of the NGO/FBO facilities provided CS. Haiti had a slightly higher proportion of facilities in the public sector (24.3%) rather than private sector (19.2%) that provide CS. Less than 10% of mixed public-private facilities were CS facilities.

TABLE 2: PROPORTION OF CS HEALTH FACILITIES AMONG ALL HEALTH FACILITIES, BY SECTOR, SPA DATASETS INCLUDED IN SECONDARY ANALYSIS (N=5 COUNTRIES)

	All health facilities*	Public facilities	Private for-profit facilities	NGO/FBO	Mixed public-private facilities
Bangladesh	12.8%	4.2%	97.1%	11.2%	-
Haiti	16.3%	24.3%	19.2%	9.9%	7.1%
Malawi	7.6%	7.8%	3.9%	12.3%	-
Nepal	7.4%	2.3%	52.6%	28.2%	-
Tanzania	27.2%	22.9%	23.4%	44.4%	-

*Includes hospitals and lower-level health facilities (e.g., health center, clinic, maternity clinic) but excludes community clinics that do not have infrastructure and personnel to support CS births

Most of the CS facilities reported having performed the operation within the three months preceding the SPA survey: 93.8%–98.3% in the public sector, 72.6%–100% in private for-profit, 82.2%–100% in NGO/FBO, and 88.9% in mixed public-private CS facilities in Haiti (Table 3).

The provision of other maternal and newborn care services among CS health facilities is shown in Table 3: ANC (ranging from 84.6%–100%), normal delivery (ranging from 81.5%–100%), and blood transfusion services (ranging from 69.3%–100%).

Despite providing CS, many health facilities were not fully functioning CEmONC facilities as defined by performing all nine signal functions in the last three months. For example, only 20.2%–28.6% in Bangladesh, 20.3%–61.5% in Haiti, 8.8%–69.6% in Malawi, 16.6%–45.5% in Nepal, and 20.2%–46.7% in Tanzania reported performing all nine signal functions. The highest proportion of CS facilities that functioned as a CEmONC facility was in the public sector in Malawi (69.6%) and the NGO/FBO sector in Haiti (61.5%). The lowest proportion of CEmONC facilities was among the CS facilities in the private for-profit sector in Malawi (8.8%) (Table 3). The largest gap in CEmONC intervention was blood transfusion (25.6% of the health facilities did not perform in last three months), followed by removal of retained products of conception (12.6%). Less than 5% of the facilities did not perform at least one or more of the remaining CEmONC interventions in the last three months (parenteral administration of antibiotics,

provision of anticonvulsants, parenteral administration of oxytocin, assisted vaginal delivery, manual removal of placenta, and/or neonatal resuscitation).

TABLE 3: DESCRIPTION OF TYPES OF MATERNAL AND NEWBORN CARE SERVICES PROVIDED AT CS FACILITIES WITHIN SPA DATASETS INCLUDED IN SECONDARY ANALYSIS (N=5 COUNTRIES)

Sector	Country	CS in last 3 months	Maternal and newborn care services reported as provided by health facilities			Functioning as CEmONC (All 9 interventions performed in last 3 months)
			ANC	Normal delivery	Blood transfusion	
Public	Bangladesh	98.0%	100%	100%	71.1%	28.6%
	Haiti	95.1%	100%	100%	92.7%	41.4%
	Malawi	93.8%	100%	100%	96.9%	69.6%
	Nepal	95.5%	100%	98.5%	98.5%	45.4%
	Tanzania	98.3%	95.4%	100%	91.4%	46.7%
Private for-profit	Bangladesh	100%	97.7%	97.4%	69.3%	28.5%
	Haiti	86.3%	90.9%	97.7%	95.0%	20.3%
	Malawi	72.9%	81.5%	81.5%	90.8%	8.8%
	Nepal	80.3%	99.3%	90.2%	95.0%	16.6%
	Tanzania	84.6%	90.0%	98.2%	77.7%	20.2%
NGO/FBO	Bangladesh	82.2%	100%	100%	80.3%	14.6%
	Haiti	84.6%	84.6%	100%	100%	61.5%
	Malawi	92.7%	100%	100%	100%	40.9%
	Nepal	100%	100%	100%	100%	25.6%
	Tanzania	100%	100%	100%	88.2%	36.9%
Mixed	Haiti	88.9%	100%	100%	88.9%	22.2%

Abbreviations: ANC = antenatal care; CEmONC = comprehensive emergency obstetric and newborn care; CS = cesarean section; NGO = nongovernmental organization; FBO = faith-based organization

RESULTS BY OBJECTIVE

OBJECTIVE 1: TO ESTIMATE THE RELATIVE CONTRIBUTION OF PRIVATE AND PUBLIC HEALTH FACILITIES TO POPULATION CESAREAN SECTION RATES.

There was heterogeneity of population and institutional CS rates within and between regions. Population CS rates are highest in Asia (10.0%–33.8%), compared to SSA (2.3%–16.8%) and LAC (Haiti) (5.6%). (Table 5). The institutional CS rates were 15.5%–66.1% in Asia, 13.9% in Haiti, and 3.4%–16.9% in SSA. Many of these countries have substantial home birth rates and over half of the countries had similar population and institutional CS rates. Private facilities contribute the most to the population CS rate in Asia (37.2%–79.7%), compared to Haiti (21.9%) and SSA (5.3%–55.3%). In Asia, the private contribution was the lowest in Nepal (37.1%) and highest in Bangladesh (79.7%). The private contribution in Africa was lowest in Burundi (5%) and highest in Nigeria (55.3%) (Table 4).

TABLE 4: COUNTRY FACILITY BIRTH RATES, POPULATION AND INSTITUTIONAL CS RATES, AND PRIVATE SECTOR RELATIVE CONTRIBUTION WITHIN DHS DATASETS INCLUDED IN SECONDARY ANALYSIS (N=20 COUNTRIES)

Region	Country	Survey year	Institutional deliveries (weighted %)	Population CSR*	Institutional CSR*	Private health facility relative contribution to population CSR
Asia	Bangladesh	2017–18	45.9%	33.8%	66.1%	79.7%
	India	2019–21	90.0%	23.3%	25.2%	58.7%
	Indonesia	2017	81.1%	19.0%	22.3%	63.5%
	Nepal	2016	58.9%	10.0%	15.5%	37.2%
	Pakistan	2017–18	81.2%	15.3%	16.8%	44.6%
	Philippines	2017	69.8%	25.9%	34.9%	75.1%
Africa	Benin	2017–18	84.8%	5.0%	6.0%	19.9%
	Burundi	2016–17	82.5%	5.3%	5.7%	5.3%
	Cameroon	2018	67.2%	4.1%	5.9%	36.7%
	Ghana	2014	75.1%	12.5%	16.4%	10.7%
	Kenya	2014	64.0%	8.8%	13.7%	35.0%
	Malawi	2015–16	68.2%	6.7%	6.8%	8.9%
	Mali	2018	92.7%	2.3%	3.4%	18.2%
	Nigeria	2018	40.4%	2.9%	6.7%	55.3%
	Rwanda	2019–20	93.4%	16.8%	16.9%	7.8%
	Sierra Leone	2019	85.0%	4.9%	5.4%	8.3%
	Tanzania	2015–16	62.5%	6.6%	10.0%	27.2%
	Uganda	2016	75.1%	7.2%	8.6%	29.4%
	Zambia	2018	85.0%	6.0%	6.1%	16.4%
Latin America and Caribbean	Haiti	2016–17	39.8%	5.6%	13.9%	21.9%

Abbreviations: CSR = Cesarean section rate

OBJECTIVE 2: TO DESIGN A CESAREAN SECTION QUALITY READINESS INDEX FROM PUBLICLY AVAILABLE NATIONALLY REPRESENTATIVE HEALTH FACILITY ASSESSMENT DATA.

We found "CS quality items" in the SPA questionnaire for four of the eight quality standards in the WHO quality-of-care framework: evidence-based practice (Standard 1), actionable information systems (Standard 2), competent human resources (Standard 7), and essential physical resources (Standard 8).

We did not identify CS quality items aligning with the remaining four quality domains: functional referral systems (Standard 3), effective communication (Standard 4), respect and preservation of dignity (Standard 5), and emotional support (Standard 6).

These will be discussed in the following section in reverse order beginning with Standard 8 (infrastructure), Standard 7 (human resources), Standard 2 (information systems), and then Standard 1 (clinical processes).

OBJECTIVE 3: TO MEASURE CESAREAN SECTION QUALITY READINESS IN PRIVATE AND PUBLIC SECTOR HEALTH FACILITIES IN DIFFERENT COUNTRIES.

Quality of CS Service Readiness by standards according to Service Provision Assessment

ESSENTIAL PHYSICAL RESOURCES (WHO QUALITY DOMAIN/STANDARD 8)

We found 17 SPA CS quality items related to readiness of essential physical resources for CS (Table 5) for the woman and the newborn.

TABLE 5: MAPPING OF SECTIONS RELEVANT QUALITY MEASURES FOR WHO QUALITY STANDARD 8, ESSENTIAL PHYSICAL RESOURCES, WITH SPA CS QUALITY ITEMS (N=17), INCLUDED IN SECONDARY ANALYSIS

WHO quality standard	Quality domain related to CS			SPA CS quality items	
	Relevant for CS	Quality statement category	WHO quality measure		
Availability of essential physical resources (Standard 8)	Operation Room	Infrastructure Input 6	"A facility offering surgical services has an adequately equipped operating theater located close to and easily accessible from the labor and childbirth areas." MNH Quality Statement 8.2	Infrastructure	Consistent electricity Piped running water
				Equipment and supplies	Anesthesia equipment and supplies (9 items): • tubings and connectors, • oropharyngeal airways (adult and pediatric) • Magill's forceps (adult and pediatric) • endotracheal tube (cuffed size 3.0 – 5.0; size 5.5 – 9.0) • incubating stylet • spinal needle Newborn bag and mask Suction Infant scale Thermometer
		Supplies Input 9	"The health facility has a safe, uninterrupted oxygen source and delivery supplies (nasal prongs, catheters, and masks), including nasal continuous positive airway pressure, available at all times in labor, childbirth and neonatal areas and the operating theater (when available)." MNH Quality Statement 8.3	Drugs	Oxygen

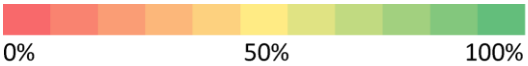
Abbreviations: CS = cesarean section; MNH = maternal and newborn health; SPA = Service Provision Assessment

CS individual item readiness for essential physical resources is shown in Figure 4. Consistent electricity was a problem in all health sectors and countries (ranging 26%–89%). Oxygen availability was notably limited in Nepal health facilities, ranging from 33% in NGO/FBO to 56% in private for-profit.

Smaller/pediatric anesthesia equipment (i.e., Magill's forceps and endotracheal tubes which are typically used for the anesthetic emergency of failed maternal intubation) was more available in the private for-profit health facilities, but only 54%–82%. For the CS item set analyses, Magill's forceps adult and pediatric were combined into a single item and small and large endotracheal tubes were combined into a single item reducing the number of items to 15.

FIGURE 4: FREQUENCY OF CS ITEM READINESS FOR WHO QUALITY DOMAIN/STANDARD 8: PHYSICAL RESOURCES, STRATIFIED BY COUNTRY AND HEALTH SECTOR SPA SECONDARY ANALYSIS (N=5 COUNTRIES)

	Public					Private for-profit					NGO/FBO					Mixed
	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	HT
Consistent electricity	58%	45%	42%	34%	46%	55%	45%	45%	27%	48%	53%	69%	26%	33%	51%	89%
Piped running water	99%	92%	100%	95%	97%	96%	95%	100%	97%	95%	100%	92%	100%	100%	98%	100%
Anesthesia machine	92%	85%	94%	71%	67%	97%	98%	91%	99%	93%	88%	92%	96%	92%	75%	78%
Tubings and connectors	90%	98%	100%	79%	80%	96%	98%	100%	99%	91%	98%	92%	96%	100%	86%	89%
Oropharyngeal airways (adult)	86%	51%	88%	88%	83%	94%	89%	100%	89%	98%	90%	92%	96%	100%	92%	89%
Oropharyngeal airways (pediatric)	58%	90%	82%	82%	69%	82%	95%	82%	85%	83%	51%	100%	96%	100%	86%	100%
Magill's forceps (adult)	84%	68%	85%	70%	63%	96%	89%	73%	87%	71%	66%	69%	85%	83%	83%	100%
Magill's forceps (pediatric)*	56%	66%	76%	53%	30%	81%	75%	82%	54%	66%	39%	69%	74%	49%	54%	78%
Endotracheal tube (cuffed size 3.0-5.0)*	75%	51%	79%	86%	69%	92%	61%	91%	92%	86%	66%	54%	96%	100%	82%	78%
Endotracheal tube (cuffed size 5.5 – 9.0)	67%	75%	87%	82%	65%	86%	91%	91%	95%	92%	48%	92%	100%	100%	76%	89%
Intubating stylet	61%	78%	88%	74%	62%	65%	93%	91%	91%	87%	67%	92%	100%	100%	78%	89%
Spinal needle	89%	83%	91%	98%	77%	93%	91%	100%	99%	94%	92%	77%	96%	100%	89%	100%
Newborn bag and mask	97%	81%	100%	100%	98%	93%	84%	100%	100%	88%	70%	92%	96%	100%	98%	100%
Suction	99%	100%	100%	98%	97%	100%	98%	100%	96%	97%	100%	100%	100%	100%	99%	100%
Infant scale	66%	100%	100%	95%	100%	69%	91%	81%	90%	98%	93%	92%	96%	100%	100%	100%
Thermometer	93%	85%	91%	94%	87%	95%	79%	72%	89%	85%	100%	100%	100%	91%	89%	100%
Oxygen	98%	66%	94%	36%	90%	99%	75%	73%	56%	80%	93%	85%	96%	33%	92%	100%

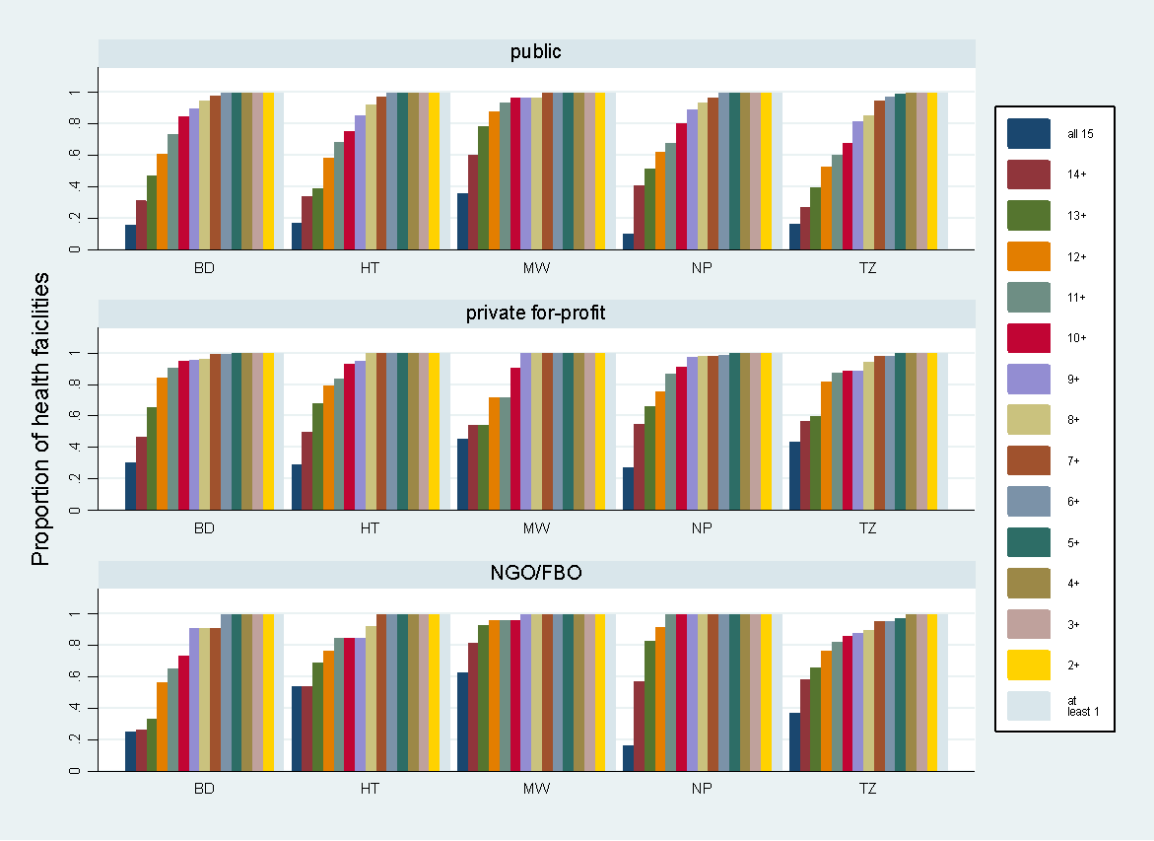


Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

*Pediatric Magill's forceps were combined with adult into a single item; endotracheal tubes small cuff size combined with large cuff size into a single item, reducing the total number of physical resources from 17 items to 15.

Figure 5 illustrates the item set readiness cascades for the physical resources for CS item set. Overall, private (for-profit and NGO/FBO) facilities have more physical resources compared to facilities in the public sector. NGO/FBO facilities had higher physical resources item readiness index compared to facilities in the private for-profit sector.

FIGURE 5: CESAREAN SECTION ITEM SET QUALITY READINESS CASCADE FOR WHO QUALITY DOMAIN/STANDARD 8: PHYSICAL RESOURCES, IN SECONDARY ANALYSIS STRATIFIED BY COUNTRY AND HEALTH SECTOR, SPA SECONDARY ANALYSIS (N=5 COUNTRIES)



Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

Generally, CS-QRI domain-specific scores for readiness of essential physical resources in a specific country identified that more of the health facilities in the private for-profit (ranging from 27% in Nepal to 46% in Malawi) and NGO/FBO facilities (ranging from 16% in Nepal to 63% in Malawi) are categorized high-quality readiness compared to public facilities (ranging from 10% in Nepal to 36% in Malawi), with large between-country heterogeneity (Appendix Table A5).

Medium-quality readiness by domain-specific CS-QRI for physical resources ranged from 26% (in Nepal) to 54% (in Bangladesh) in private facilities, 23% (in Haiti) to 76% (in Nepal) in NGO/FBO facilities, and 37% (in Tanzania) to 52% (in Nepal and Malawi) in public sector facilities (Appendix Table A5).

Low-quality readiness by CS-QRI for physical resources was highest in public facilities (12% in Malawi to 47% in Tanzania), followed by private for-profit (15% in Bangladesh to 25% in Nepal) and NGO/FBO (<10% in Malawi and Nepal to 43% in Bangladesh) (Appendix Table A5).

COMPETENT MOTIVATED HUMAN RESOURCES (WHO QUALITY DOMAIN/STANDARD 7)

We found three SPA CS readiness quality items mapped to competent, motivated human resources WHO quality measures (Table 6).

TABLE 6: MAPPING OF SECTIONS RELEVANT QUALITY MEASURES FOR WHO QUALITY STANDARD 7, COMPETENT MOTIVATED HUMAN RESOURCES, WITH SPA CS QUALITY ITEMS (N=3), INCLUDED IN SECONDARY ANALYSIS

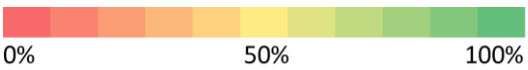
WHO quality standard	Quality domain related to CS			SPA CS quality criteria	
	Relevant for CS	Quality statement category	WHO quality measure		
Competent human resources (Standard 7)	Human resources conduct CS operation	Prolonged labor interventions Input 4	The health facility has an adequate number of staff skilled in performing CS, 24 hours a day. MNH Quality Statement 1.4	Human resources	24-hour CS provider work schedule 24-hour anesthetist work schedule
				Training	Health workers involved in labor and delivery were trained in last 24 months

Abbreviations: CS = cesarean section; MNH = maternal and newborn health; SPA = Service Provision Assessment

Figure 6 shows the CS individual item readiness for competent motivated human resources. Facilities with 24-hour CS surgical provider schedule ranged 60%–100% but a 24-hour anesthetist was less common ranging 44%–91%. Facilities with health workers who received training in the last 24 months ranged from <15% in private for-profit facilities in Bangladesh and Nepal to >80% in public and mixed public-private facilities in Haiti.

FIGURE 6: FREQUENCY OF CS ITEM READINESS FOR WHO QUALITY DOMAIN/STANDARD 7: HUMAN RESOURCES, STRATIFIED BY COUNTRY AND HEALTH SECTOR SPA SECONDARY ANALYSIS (N=5 COUNTRIES)

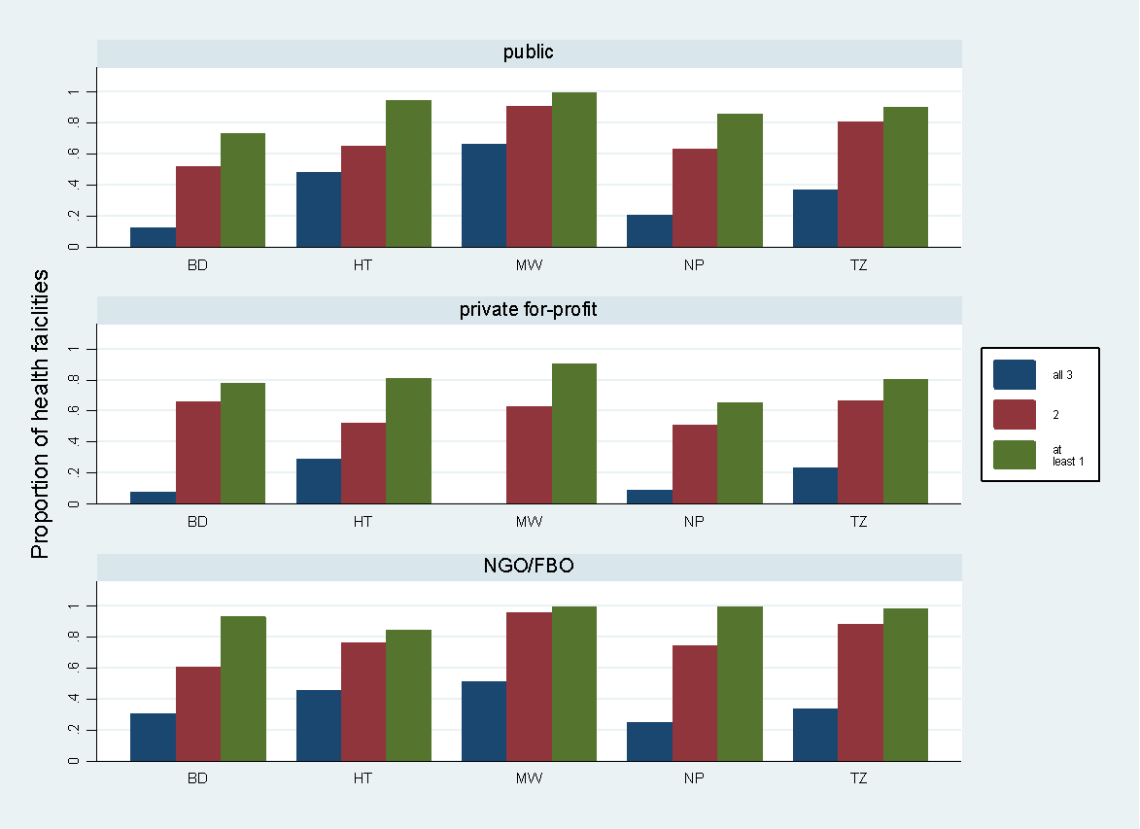
	Public					Private for-profit					NGO/FBO					Mixed
	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	HT
24-hour CS provider work schedule	60%	71%	91%	68%	82%	77%	61%	81%	63%	76%	69%	77%	100%	83%	94%	78%
24-hour anesthetist work schedule	48%	66%	91%	55%	77%	66%	52%	36%	52%	62%	61%	77%	81%	75%	83%	44%
Health workers trained in last 24 months	30%	81%	76%	50%	50%	11%	58%	45%	14%	38%	56%	54%	67%	42%	44%	89%



Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

The item set readiness cases are shown in Figure 7. Overall, private for-profit facilities had the lowest number of competent human resources items, except in Bangladesh where the private for-profit facilities had the highest number.

FIGURE 7: CS ITEM SET QUALITY READINESS CASCADE FOR WHO QUALITY DOMAIN/STANDARD 7: HUMAN RESOURCES, IN SECONDARY ANALYSIS STRATIFIED BY COUNTRY AND HEALTH SECTOR, SPA SECONDARY ANALYSIS (N=5 COUNTRIES)



Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

The CS-QRI human resource specific index identified that facilities in the public sector (ranging from 12% in Bangladesh to 67% in Malawi) and NGO/FBO sector (ranging from 25% in Nepal to 52% in Malawi) had higher proportion of high-quality ready human resources compared to private for-profit sector (ranging from 0% in Malawi to 30% in Haiti) (Appendix Table A5).

Low-quality readiness by CS-QRI for human resources ranged from 70% percent in Haiti and 76% in Tanzania to >90% in Bangladesh, Malawi, and Nepal in the private for-profit sector ranges. In NGO/FBO facilities, low-quality readiness by CS-QRI for human resources ranged from 48% in Malawi to 69% in Bangladesh. Public sector low-quality readiness by CQ-QRS for human resources ranged from 33% in Malawi to 87% in Bangladesh facilities (Appendix Table A5).

ACTIONABLE INFORMATION SYSTEMS FOR CS READINESS (WHO QUALITY DOMAIN/STANDARD 2)

We found one SPA CS quality item mapped to readiness of actionable information systems WHO quality measures: monthly reports of maternal and newborn services using health management information system (HMIS) (Table 7).

TABLE 7: MAPPING OF SECTIONS RELEVANT QUALITY MEASURES FOR WHO QUALITY STANDARD 2, ACTIONABLE INFORMATION SYSTEMS, WITH SPA CS QUALITY ITEMS (N=1), INCLUDED IN SECONDARY ANALYSIS

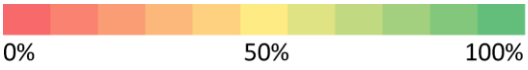
	Quality domain related to CS			SPA CS quality criteria	
WHO quality standard	Relevant for CS	Quality statement category	WHO quality measure		
Actionable information systems	CS information	Routine health information systems	Every health facility has a mechanism for data collection, analysis, and feedback as part of its activities for monitoring and improving performance around the time of childbirth. MNH Quality Statement 2,2	Infrastructure	HMIS reporting

Abbreviations: HMIS = Health management information systems; CS = cesarean section; MNH = maternal and newborn health; SPA = Service Provision Assessment

Most of the private for-profit facilities were found not to be reporting into monthly HMIS (ranging from 9% in Malawi to ~60% in Haiti and Nepal), except in Tanzania (97%) (Figure 8). Approximately 90% of the health facilities in the public and NGO/FBO sector in Bangladesh, Malawi, and Tanzania and mixed public-private facilities in Haiti had HMIS reporting and therefore considered high-quality readiness for actionable information systems by CS-QRI for actionable information systems (Appendix Table A5).

FIGURE 8: FREQUENCY OF CS ITEM READINESS FOR WHO QUALITY DOMAIN/STANDARD 2: ACTIONABLE INFORMATION SYSTEMS, STRATIFIED BY COUNTRY AND HEALTH SECTOR SPA SECONDARY ANALYSIS (N=5 COUNTRIES)

	Public					Private for-profit					NGO/FBO					Mixed
	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	HT
Have HMIS**	87%	71%	91%	70%	97%	26%	61%	9%	63%	97%	92%	54%	89%	74%	96%	89%



Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

EVIDENCE-BASED PRACTICES (WHO QUALITY DOMAIN/STANDARD 1)

A) CS DECISION-MAKING

We found seven SPA CS quality items mapped to readiness for evidence-based practice for CS decision-making readiness (Table 8), including availability of emergency obstetric and newborn care guidelines, use of partograph, and essential equipment and supplies.

TABLE 8: MAPPING OF SECTIONS RELEVANT QUALITY MEASURES FOR WHO QUALITY STANDARD 1, EVIDENCE-BASED PRACTICES FOR CS DECISION-MAKING, WITH SPA CS QUALITY ITEMS (N=7), INCLUDED IN SECONDARY ANALYSIS

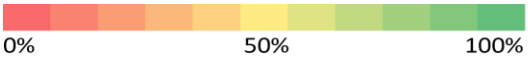
WHO quality standard	Quality domain related to CS			SPA CS quality criteria	
	Relevant for CS	Quality statement category	WHO quality measure		
Evidence-based practice for routine care and management (Standard 1)	Make decision for CS	Prolonged labor interventions Input 1	The proportion of all women who gave birth in the health facility whose progress in labor was correctly monitored and documented with a partograph and a 4-h action line. MNH Quality Statement 1.4	Guidelines	BEmONC guidelines CEmONC guidelines
				Routine practice	Always use partograph
				Equipment and supplies	thermometer stethoscope blood pressure machine fetal stethoscope

Abbreviations: BEmONC = Basic emergency obstetric and newborn care; CEmONC = Comprehensive emergency obstetric and newborn care; CS = cesarean section; MNH = maternal and newborn health; SPA = Service Provision Assessment

CS individual item readiness for evidence-based practice for CS decision-making is shown in Figure 9. Availability of guidelines was low in all sectors: private for-profit (<5% in Bangladesh and Nepal to 27% in Malawi), NGO/FBO sector (0% in Nepal to 52% in Malawi), public (<25% in Bangladesh and Nepal to 61% in Malawi), and mixed public-private in Haiti (44%–56%). Use of partograph was lower in Bangladesh (11%–57%) and Haiti (23%–49%) compared to the other countries (>80%). The majority of health facilities in all sectors have supplies and equipment; however, slightly lower in the private for-profit sector (72%–100%) compared to public (85%–100%) and NGO/FBO (89%–100%) sectors (Figure 9).

FIGURE 9: FREQUENCY OF CS ITEM READINESS FOR WHO QUALITY DOMAIN/STANDARD 1: EVIDENCE-BASED PRACTICE FOR CS DECISION-MAKING, STRATIFIED BY COUNTRY AND HEALTH SECTOR SPA SECONDARY ANALYSIS (N=5 COUNTRIES)

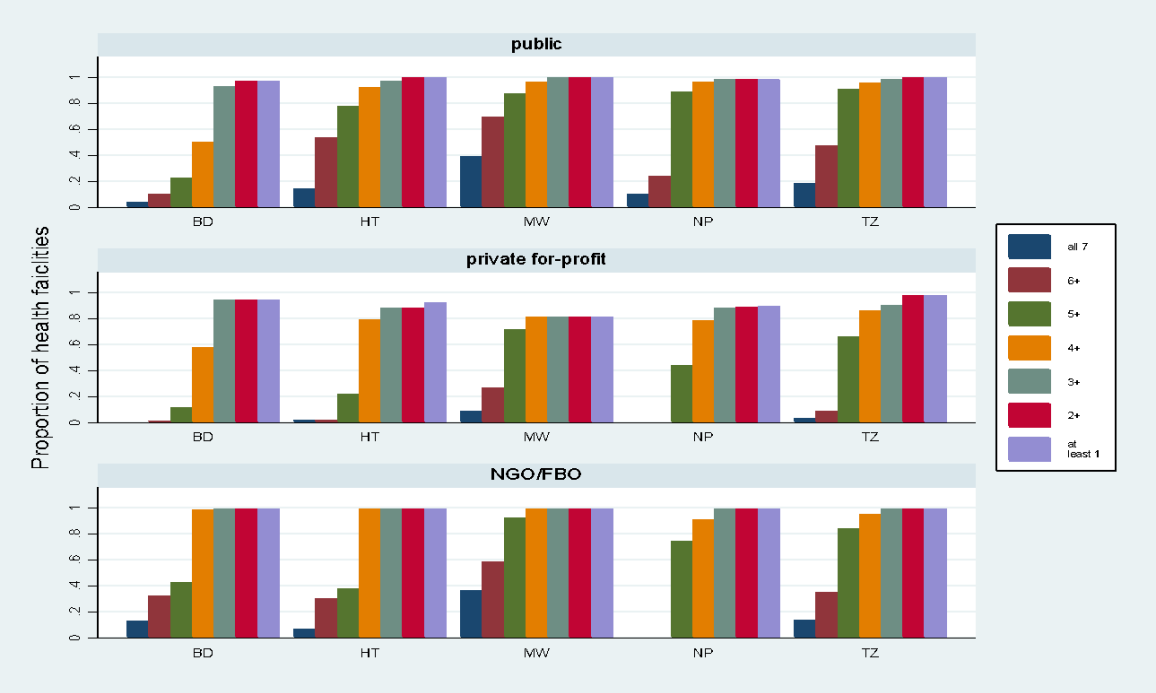
	Public					Private for-profit					NGO/FBO					Mixed
	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	HT
BEmONC guidelines	22%	59%	61%	11%	57%	4%	14%	27%	1%	11%	61%	31%	52%	0%	41%	56%
CEmONC guidelines	23%	56%	52%	24%	30%	3%	11%	18%	1%	4%	38%	31%	44%	0%	16%	44%
Always use partograph	28%	49%	97%	98%	89%	11%	23%	100%	55%	74%	57%	23%	100%	84%	95%	44%
Thermometer	93%	85%	91%	94%	87%	95%	79%	72%	89%	85%	100%	100%	100%	91%	89%	100%
Stethoscope	98%	100%	97%	98%	100%	95%	86%	81%	89%	98%	100%	100%	100%	100%	100%	100%
Blood pressure machine	95%	98%	100%	97%	91%	97%	86%	100%	91%	87%	100%	100%	100%	100%	92%	100%
Fetal stethoscope	19%	90%	97%	97%	99%	53%	79%	73%	81%	98%	32%	92%	93%	91%	97%	100%



Abbreviations: BEmONC = basic emergency obstetric and newborn care; CEmONC = comprehensive emergency obstetric and newborn care.

Figure 10 illustrates the item set readiness cascades for the evidence-based practices for CS decision-making. In general, public and NBO/FBO facilities had more evidence-based practice decision-making for CS items compared to the private sector. Notably in Nepal, no public or NGO/FBO sector facilities had all seven of the evidence-based CS decision-making item set.

FIGURE 10: CS ITEM SET QUALITY READINESS CASCADE FOR WHO QUALITY DOMAIN/STANDARD 1: PRACTICE FOR CS DECISION-MAKING, IN SECONDARY ANALYSIS STRATIFIED BY COUNTRY AND HEALTH SECTOR, SPA SECONDARY ANALYSIS (N=5 COUNTRIES)



Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

High-quality readiness based on the CS-QRI for evidence-based CS decision-making was <10% in private sector facilities in all countries. Among NGO/FBO facilities, high-quality readiness by evidence-based CS decision-making CS-QRI ranged from 0% in Nepal to 37% in Malawi. In the public sector, high-quality readiness for CS decision-making ranged from 4% in Bangladesh to 39% in Malawi (Appendix Table A5).

Medium-quality ready by domain-specific CS-QRI for CS decision-making ranged from 7% in Bangladesh to 39% in Haiti in the public sector facilities, followed by 0% in Nepal to 23% in Haiti in the NGO/FBO sector facilities. The lowest proportion of medium-quality readiness facilities in the private for-profit sector (ranging from ≤1% in Bangladesh, Haiti, and Nepal to 18% in Malawi) (Appendix Table A5).

Over 70% of the private for-profit sector facilities were low-quality ready by CS-QRI for CS decision-making (ranging from 73% in Malawi to 99% in Nepal). CS-QRI for CS decision-making identified 31% in Malawi to 89% in Bangladesh low-quality ready facilities in the public sector and 41% in Malawi to 100% in Nepal NGO/FBO low-quality ready facilities (Appendix Table A5).

B) CS INFECTION PREVENTION AND TREATMENT READINESS

We found 12 SPA items related to quality readiness for evidence-based practice for CS infection prevention and treatment readiness (Table 9), including water, sanitation, and hygiene (WASH); equipment and supplies; personal protective equipment; and drugs.

TABLE 9: MAPPING OF SECTIONS RELEVANT QUALITY MEASURES FOR WHO QUALITY STANDARD 1, EVIDENCE-BASED PRACTICE FOR CS INFECTION PREVENTION AND TREATMENT READINESS, WITH SPA CS QUALITY ITEMS (N=12), INCLUDED IN SECONDARY ANALYSIS

	Quality domain related to CS			SPA CS quality criteria	
WHO quality standard	**Relevant for CS**	**Quality statement category**	**WHO quality measure**		
Evidence-based practice for routine care and management (Standard 1)	Infection prevention and treatment	Infection prevention Process 1	The percentage of healthcare staff in the health facility who clean their hands correctly as per the WHO "5 moments for hand hygiene" audit tool. MNH Quality Statement 1.8	Equipment and supplies	Handwashing soap Alcohol Gloves
		Infection prevention Input 1	The health facility has written, up-to-date guidelines for standard infection control and precautions. MNH Quality Statement 1.8	Equipment and supplies	Skin disinfectant Antiseptic Medical mask Medical gowns Eye protection Waste receptacles. Sharps container
		Infection risk Output/process 1	The proportion of all women who underwent CS in the health facility who received prophylactic antibiotics before CS. MNH Quality Statement 1.7a	Drugs	Injectable antibiotics Syringe 10

Abbreviations: CS = cesarean section; MNH = maternal and newborn health; SPA = Service Provision Assessment

CS individual item readiness for evidence-based practice for CS infection and treatment readiness is shown in Figure 11. WASH-related supplies such as handwashing soap, alcohol, gloves, skin disinfectant, and antiseptic was common in all health facilities (55%–100%), although lower in private for-profit sector facilities. In comparison, personal protective equipment was lower in all sectors (12%–100%), especially eye protection (ranging 12%–62%). Availability of sharps container was notably lower in Bangladesh (54%–100%) and Nepal (53%–100%) compared to the other countries (84%–100%) (Figure 11).

FIGURE 11: FREQUENCY OF CS ITEM READINESS FOR WHO QUALITY DOMAIN/STANDARD 1: EVIDENCE-BASED PRACTICE FOR CS INFECTION PREVENTION AND TREATMENT, STRATIFIED BY COUNTRY AND HEALTH SECTOR SPA SECONDARY ANALYSIS (N=5 COUNTRIES)

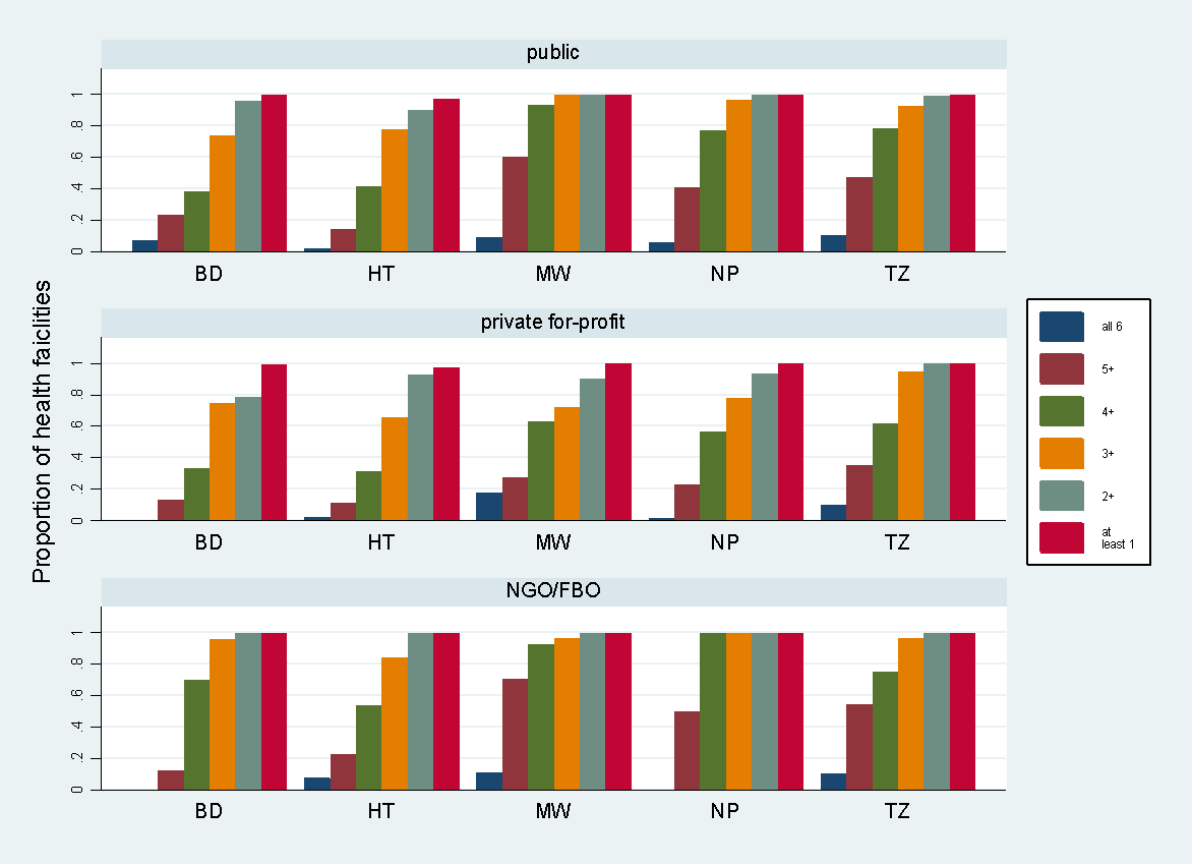
	Public					Private for-profit					NGO/FBO					Mixed
	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	HT
Handwashing soap	83%	78%	76%	95%	93%	91%	74%	77%	91%	92%	99%	77%	93%	100%	98%	100%
Handwashing soap/alcohol	86%	83%	76%	95%	93%	94%	77%	77%	91%	92%	99%	92%	93%	100%	98%	100%
Gloves	74%	98%	100%	100%	97%	69%	95%	100%	90%	96%	100%	92%	100%	100%	99%	89%
Skin disinfectant	70%	85%	67%	95%	80%	69%	86%	55%	77%	82%	87%	100%	85%	100%	84%	78%
Antiseptic	77%	93%	94%	95%	98%	85%	81%	77%	72%	93%	84%	100%	96%	75%	96%	89%
Medical mask	75%	51%	97%	75%	35%	92%	65%	66%	71%	33%	93%	77%	100%	84%	42%	78%
Medical gowns	71%	98%	100%	78%	84%	92%	93%	89%	66%	80%	93%	100%	93%	92%	86%	89%
Eye protection	20%	41%	61%	26%	25%	24%	37%	22%	12%	34%	44%	62%	70%	50%	35%	56%
Injectable antibiotics	69%	59%	82%	88%	49%	68%	61%	55%	57%	46%	93%	92%	82%	75%	68%	78%
Syringe	90%	83%	100%	95%	93%	92%	81%	100%	81%	96%	100%	92%	96%	92%	97%	56%
Waste receptacle	100%	100%	100%	100%	99%	100%	95%	100%	92%	100%	100%	100%	100%	100%	100%	100%
Sharps container	73%	100%	94%	92%	99%	54%	84%	100%	53%	97%	100%	100%	100%	84%	97%	100%

Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

Figure 12 illustrates the item set readiness cascades for evidence-based practice for infection prevention and treatment. Most of the facilities had at least eight items from the item set, except in the private for-profit sector in Malawi and Nepal. Overall, NBO/FBO facilities had the highest number of infection prevention items.

FIGURE 12: CS ITEM SET QUALITY READINESS CASCADE FOR WHO QUALITY DOMAIN/STANDARD 1: PRACTICE FOR CS INFECTION PREVENTION, IN SECONDARY ANALYSIS STRATIFIED BY COUNTRY AND HEALTH SECTOR, SPA SECONDARY ANALYSIS

(N=5 COUNTRIES)



Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

The CS-QRI domain-specific scores for readiness for evidence-based infection prevention and treatment identified that more NBO/FBO facilities compared to private for-profit and public facilities, were high-quality ready: ranging from 8% in Nepal to 46% in Haiti in NBO/FBO; 11% in Bangladesh and Tanzania to 21% in Malawi in the public sector; and 3% in Nepal to 25% in Haiti in the private for-profit sector (Appendix Table A5).

Medium-quality readiness by domain-specific CS-QRI for infection prevention practice ranged from 46% in Haiti to 67% in Nepal in NGO/FBO facilities; and 36% in Bangladesh to 64% in Nepal in public facilities. In the private for-profit sector, 25% of facilities in Tanzania to 45% of facilities in Nepal are medium-quality ready for evidence-based infection prevention practice (Appendix Table A5).

Half or more of the private for-profit facilities were low-quality ready based on the CS-QRI for infection prevention practice (ranging from 50% in Haiti to 64% in Malawi). In the public sector, 18% of facilities in Malawi to 53% of facilities in Bangladesh were low-quality ready, and 7% in Malawi to 30% in Tanzania low-quality ready in the NGO/FBO (Appendix Table A5).

C) MANAGEMENT OF CS COMPLICATIONS READINESS

We found five SPA CS quality items related to readiness for evidence-based management of CS complications readiness that relate to hemorrhage management, including guidelines for safe blood and transfusion practice, stock availability of blood, and necessary drugs (Table 10).

TABLE 10: MAPPING OF SECTIONS RELEVANT QUALITY MEASURES FOR WHO QUALITY STANDARD 1, EVIDENCE-BASED MANAGEMENT OF CS COMPLICATIONS, WITH SPA CS QUALITY ITEMS (N=5), INCLUDED IN SECONDARY ANALYSIS

	Quality domain related to CS			SPA CS quality criteria	
WHO quality standard	Relevant for CS	Quality statement category	WHO quality measure		
Evidence-based practice for routine care and management (Standard 1)	management of complications after CS (hemorrhage)	PPH interventions Input 6	Functional blood transfusion service is always available in the health facility. MNH Quality Statement 1.3	Guidelines	Safe blood and transfusion practice guidelines
				Equipment and supplies	Blood available Blood screened No blood stock-out
		PPH interventions Input 2	The health facility has uterotonic drugs and supplies for intravenous fluid and blood administration (syringes, needles, intravenous cannulas, intravenous fluid solutions, blood) available in sufficient quantities at all times in the childbirth and postnatal care areas. MNH Quality Statement 1.3	Drugs	Injectable uterotonics IV solution with infusion set

Abbreviations: CS = cesarean section; MNH = maternal and newborn health; SPA = Service Provision Assessment

Availability of SPA quality readiness items to provide evidence-based management of CS complications are presented in Figure 13. Blood was not available on site in many facilities (ranging 29%–97%), particularly in the private for-profit sector (ranging from 29% in Bangladesh to 74% in Tanzania). There was a lack of practice guidelines in all countries and sectors (ranging 2%–44%), except in the NGO/FBO and public sectors facilities in Malawi (85% of facilities). There was also a high level of blood stock-outs, particularly in Haiti (67%–77%), Malawi (27%–79%), and Tanzania (50%–59%). In the private for-profit sector, intravenous fluids (46% in Malawi to 89% in Tanzania) and uterotonic (63% in Malawi to 87% in Tanzania) was less common than in public or NGO/FBO.

FIGURE 13: FREQUENCY OF CS ITEM READINESS FOR WHO QUALITY DOMAIN/STANDARD 1: EVIDENCE-BASED PRACTICE FOR CS COMPLICATION MANAGEMENT, STRATIFIED BY COUNTRY AND HEALTH SECTOR SPA SECONDARY ANALYSIS (N=5 COUNTRIES)

	Public					Private for-profit					NGO/FBO					Mixed
	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	BD	HT	MW	NP	TZ	HT
Safe blood and transfusion practice guidelines	23%	27%	85%	15%	39%	9%	23%	36%	2%	20%	26%	23%	85%	9%	36%	44%
Blood available	37%	66%	97%	55%	86%	29%	70%	64%	60%	74%	49%	77%	96%	83%	80%	67%
Blood screened	63%	71%	94%	91%	87%	62%	59%	91%	68%	71%	80%	77%	89%	100%	83%	78%
Blood stock-out*	33%	71%	79%	36%	59%	32%	77%	27%	12%	39%	59%	77%	59%	41%	50%	67%
Injectable uterotonics	81%	73%	97%	98%	93%	70%	77%	63%	72%	87%	93%	100%	96%	100%	98%	78%
IV solution with infusion set	69%	59%	70%	98%	84%	63%	50%	46%	65%	89%	89%	69%	63%	100%	90%	67%

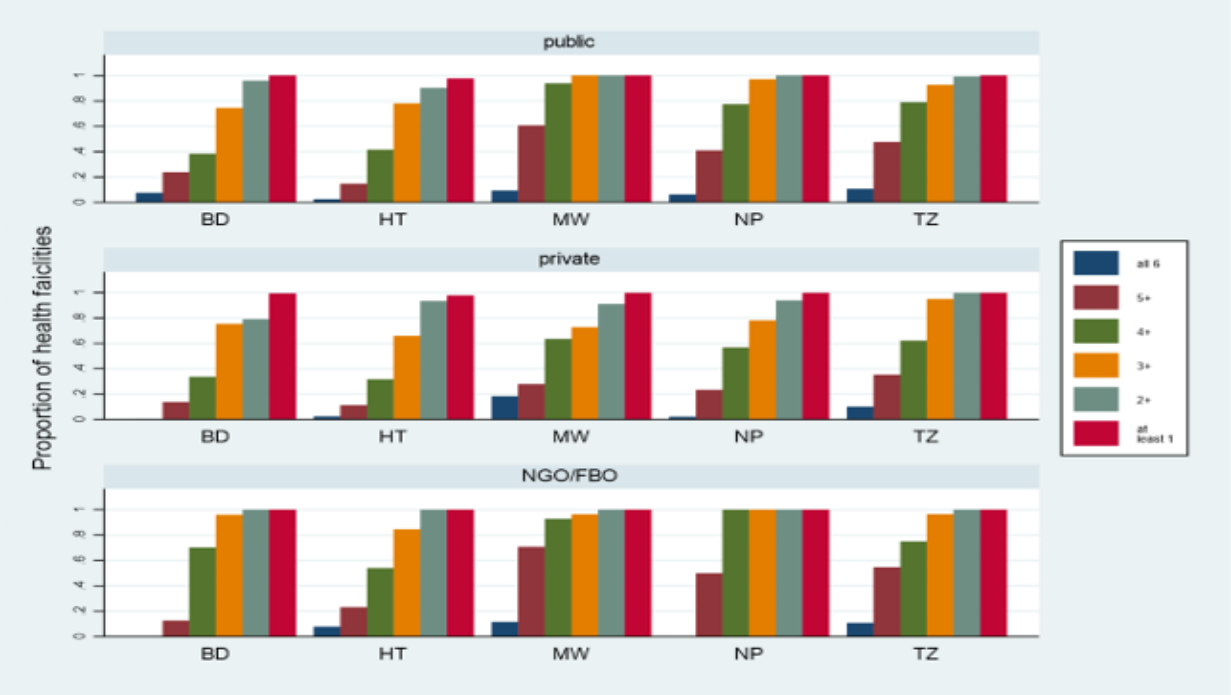
0% 50% 100%

Abbreviations: IV = intravenous; BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal, TZ = Tanzania

*For blood stock-out, heat map progresses from high proportion of stock-outs (100% = red) to low (0% = green)

The item set readiness cascades for evidence-based practices for complication management for CS are shown in Figure 14. Like the infection prevention standard, NGO/FBO health facilities had a larger proportion of the items in set compared to facilities in the other health sectors.

FIGURE 14: CS ITEM SET QUALITY READINESS CASCADE FOR WHO QUALITY DOMAIN/STANDARD 1: PRACTICE FOR COMPLICATION MANAGEMENT FOR CS, IN SECONDARY ANALYSIS STRATIFIED BY COUNTRY AND HEALTH SECTOR, SPA SECONDARY ANALYSIS (N=5 COUNTRIES)



Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal, TZ = Tanzania

The private for-profit sector was less ready for managing CS complication based on the domain-specific CS-QRI for evidence-based complication management for CS. In the private for-profit sector, 3% of facilities in Nepal to 25% of facilities in Haiti were high-quality ready based on the CS-QRI for managing CS complications. In the NGO/FBO sector, 8% of the facilities in Nepal to 46% of facilities in Haiti were high-quality ready. High-quality readiness in the public sector ranged from 11% in Bangladesh and Tanzania to 21% in Malawi.

Many of the facilities are medium-quality ready based on the CS-QRI for managing CS complication: ranging from 25% in Tanzania to 45% in Nepal in private facilities; 46% in Haiti to 67% in Nepal in NGO/FBO facilities, and 36% in Bangladesh to 64% in Nepal public sector facilities.

Low-quality readiness for managing CS complicated based on the CS-QRI ranged from 46% in Haiti to 64% in Malawi in private facilities, 18% in Malawi to 53% in Bangladesh in private facilities, and 7% in Malawi to 31% in Tanzania in NGO/FBO facilities.

OVERALL CS-QRI INDEX ACROSS ALL QUALITY DOMAINS

Combining the quality readiness indices across the five quality standards, the mean and median CS-QRI index, and proportion of health facilities categorizing as high quality and medium quality are shown in Table 11.

There was between-country heterogeneity of the mean CS-QRI for each sector. The median CS-QRI was lowest in private for-profit facilities (0.74, ranging from 0.72–0.81), compared to public (0.81, ranging from 0.72–0.88) and NGO/FBO (0.88, ranging from 0.79–0.93). In mixed public-private facilities in Haiti the mean CS-QRI was 0.86.

Overall, most of the facilities were low CS quality ready based on the CS-QRI (ranging from 45%–100%).

Medium CS quality readiness was higher among public facilities (7%–39%) compared to private for-profit facilities (0%–14%). The NGO/FBO facilities (12%–48%) and mixed public/private (22%) have the highest proportion of medium CS quality readiness as assessed using the CS-QRI, with Malawi being the highest (48%).

A very limited (0%–11%) proportion of facilities were high-quality ready based on CS-QRI index: less than 5% of the private for-profit and public health facilities were high-quality ready CS facilities. The highest proportion of high-quality ready facilities was in the mixed public-private sector in Haiti (11%).

TABLE 11: HEALTH FACILITY MEAN CS-QRI INDEX AND PROPORTION OF HEALTH FACILITIES CATEGORIZING BY LOW-, MEDIUM-, AND HIGH-QUALITY READINESS, BY COUNTRY AND HEALTH SECTOR, SPA SECONDARY ANALYSIS (N=5 COUNTRIES)

Sector	Country	CS – QRI index		Proportion of health facilities by CS-QRI category		
		Mean CS-QRI	Median CS-QRI	Low quality CS-QRI<0.8	Medium quality CS-QRI ≥0.8 to 0.99	High quality CS-QRI= 1.0
Public	Bangladesh	0.66	0.72	93%	7%	0%
	Haiti	0.71	0.79	90%	10%	0%
	Malawi	0.86	0.88	61%	39%	0%
	Nepal	0.73	0.79	80%	15%	5%
	Tanzania	0.78	0.79	78%	20%	2%
Private for-profit	Bangladesh	0.57	0.72	94%	5%	1%
	Haiti	0.64	0.74	91%	9%	0%
	Malawi	0.56	0.81	100%	0%	0%
	Nepal	0.62	0.77	89%	10%	1%
	Tanzania	0.75	0.81	86%	14%	0%
NGO/FBO	Bangladesh	0.76	0.79	82%	12%	6%
	Haiti	0.72	0.86	77%	23%	0%
	Malawi	0.87	0.93	45%	48%	7%
	Nepal	0.77	0.84	75%	25%	0%
	Tanzania	0.81	0.86	65%	33%	2%
Mixed	Haiti	0.79	0.86	67%	22%	11%

Abbreviations: CS-QRI = Cesarean section quality readiness index

OBJECTIVE 4: TO EXAMINE THE ASSOCIATION OF HEALTH FACILITY CHARACTERISTICS WITH HIGH- AND MEDIUM-QUALITY READINESS FOR CESAREAN SECTION SERVICES.

We found associations between health facility characteristics and CS-QRI index as shown in Table 12. By health sector, in the five-country pooled analysis, FBO/NGO health facilities have higher CS-QRI scores compared to the public sector, even after adjustment for other health facility characteristics (Table 9; adjusted odds ratio [aOR]=2.29 95% CI: 1.18, 4.45).

In contrast, private for-profit facilities have nearly 50% less odds of quality readiness compared to the public sector (unadjusted odds ratio [unadjOR]=0.48, 95% CI: 0.25, 0.90); however, this effect was not significantly associated after adjustment for other health facility characteristics (aOR=0.63, 95% CI: 0.28, 1.43). Being a hospital (aOR=2.90 95% CI: 1.05, 8.00) and being a CEmONC-level facility (aOR=2.60 95%CI: 1.40, 4.81) are additional characteristics associated with facilities being medium and high CS quality ready based on the CS-QRI.

TABLE 12: ASSOCIATION OF HEALTH FACILITY CHARACTERISTICS WITH HIGH AND MEDIUM CS-QRI, SECONDARY SPA ANALYSIS (N=5 COUNTRIES)

		Logistic Regression		
Health facility characteristics	**%** **Births in health facilities with high and medium-CS-QRI**	**Bivariable** **OR (95% CI) ***	**Multivariable** **OR (95% CI)****	**p-value**
Health sector				
Public	19.3%	ref	ref	
Private for-profit	7.7%	**0.48 (0.25, 0.90)**	0.63 (0.28, 1.43)	0.266
NGO/FBO	34.7%	**1.89 (1.07, 3.33)**	**2.29 (1.18, 4.45)**	0.015
Location				
Urban	15.5%	ref	ref	
Rural	26.4%	1.4 (0.82, 2.58)	1.12 (0.56, 2.26)	0.747
Not assessed‡	12.4%	2.24 (0.89, 5.60)‡	--‡	
Type of health facility Lower-level Hospital	 7.7% 19.2%	 ref **2.92 (1.13, 7.51)**	 ref **2.90 (1.05, 8.00)**	0.039
Level of health facility Not met CEmONC criteria CEmONC	 11.25% 28.9%	 ref **2.76 (1.64, 4.62)**	 ref **2.60 (1.40, 4.81)**	0.002

*Model adjusted for country only; **Model adjusted for country and all other variables in table

‡Nepal did not assess location of residence; therefore, Nepal not included in multivariable analysis

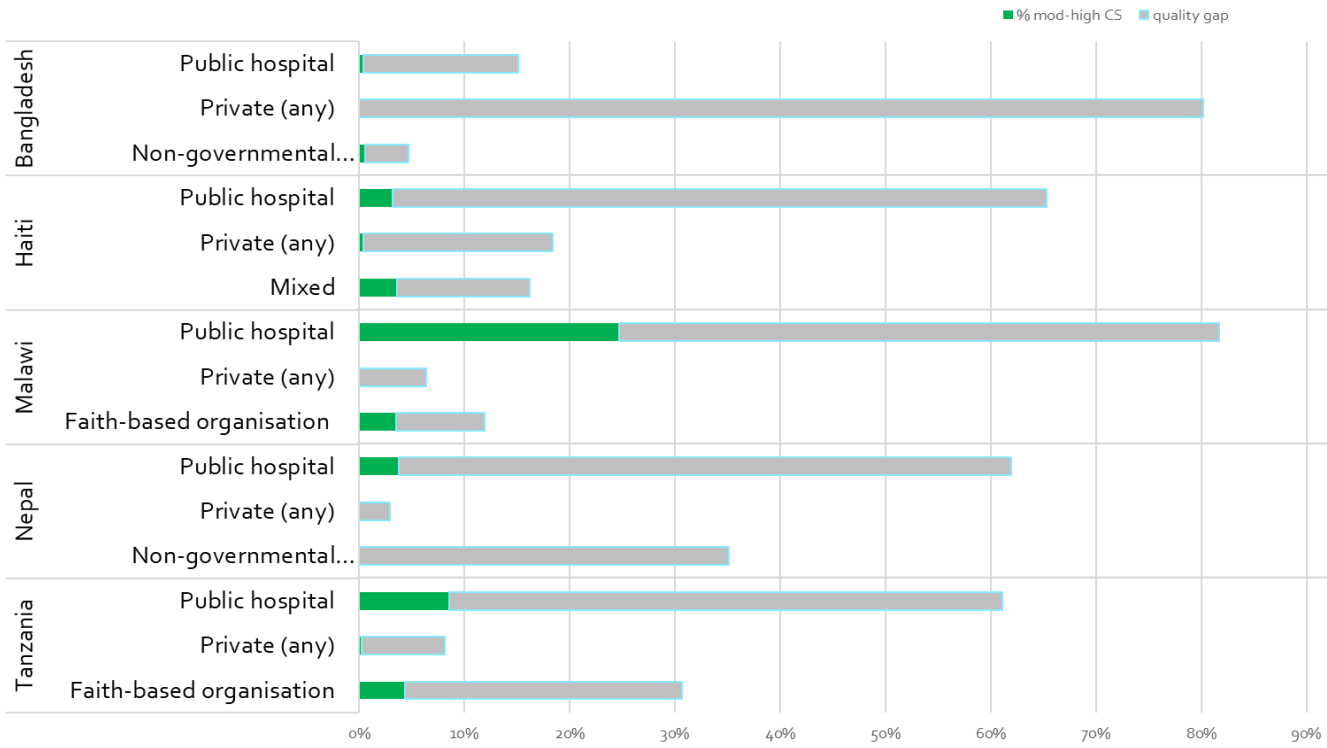
Abbreviations: CEmONC = Comprehensive emergency obstetric and newborn care, CS-QRI = Cesarean section quality readiness index, OR = odds ratio, CI = confidence interval

OBJECTIVE 5. TO ESTIMATE THE AVERAGE PROPORTION OF WOMEN WHOSE CESAREAN SECTION WAS CONDUCTED IN A HEALTH FACILITY WITH HIGH OR MEDIUM QUALITY CS SERVICE-READINESS IN THE PRIVATE AND PUBLIC SECTORS IN DIFFERENT COUNTRIES.

The overall probability that a CS birth was at a health facility with high or medium CS-QRI was 28% Malawi, 13% in Tanzania, 7% in Haiti, 4% in Nepal, and 1% in Bangladesh (Figure 15).

Private for-profit facilities contribute to the largest quality gap (CS-QRI<0.8) in Bangladesh (81%). In the remaining four countries, the public sector contributes to the largest quality readiness gap: 79% in Malawi, 67% in Haiti, 61% in Tanzania, and 60% in Nepal. NGO/FBO sector contributes to the quality gap the least ranging 4%–37% (Figure 15).

FIGURE 15: PROBABILITY POPULATION CESAREAN SECTION WAS IN A HEALTH FACILITY SCORING HIGH OR MEDIUM ON CESAREAN SECTION QUALITY READINESS INDEX (CS-QRI), BY HEALTH SECTOR, SECONDARY ANALYSIS DHS/ SPA (N=5 COUNTRIES)



Sector contribution to CS quality gap (%)			
country	public	private	NGO/FBO
BD	15%	81%	4%
HT	67%	19%	14%
MW	79%	9%	12%
NP	60%	3%	37%
TZ	61%	9%	30%

Green bars indicate proportion of medium or high QRI; grey bars indicate low-quality readiness or quality gap. Abbreviations: BD = Bangladesh; HT = Haiti; MW = Malawi; NP = Nepal; TZ = Tanzania

OBJECTIVE 6: TO ASSESS THE ASSOCIATION BETWEEN CESAREAN BIRTH IN THE PRIVATE/PUBLIC SECTOR WITH MATERNAL AND CHILD OUTCOMES.

Characteristics for CS births in survey population

The results of the pooled DHS datasets comparing the characteristics of the women with CS birth by health sector are shown in Table 13.

Compared to CS birth in the public sector, women who had a CS birth in the private sector were older ($p<0.001$), more educated ($p<0.001$), from a higher wealth index ($p<0.001$) and reported fewer problems accessing healthcare in general ($p<0.001$). Previous CS ($p=0.74$) was similar between the two groups; however, women with CS birth in the private sector had lower birth order ($p<0.001$).

The number of ANC visits was similar between sectors ($p=0.34$), with ANC care in the private sector being more common among women who had CS birth in private health facilities, and ANC in the public sector being more common among women who had CS birth in the public sector (Table 13).

Higher quality content of ANC care (measuring blood pressure, taking blood and urine samples, giving iron supplementation, and being informed about pregnancy complications) was more common among women who had CS birth in the private sector compared to the public sector ($p<0.001$).

There were more multiple births and low birthweight babies in the private sector, compared to public ($p=0.01$), but the male/female ratio was similar between the two groups ($p=0.61$).

TABLE 13: CHARACTERISTICS OF WOMEN WITH CS BIRTH BY HEALTH SECTOR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

Characteristic		Health Sector		Chi-squared
		Private	Public	p-value
Geographic characteristics				
Region	Africa	23.3%	76.7%	<0.001
	Asia	60.2%	39.8%	
	South America	21.0%	78.9%	
Population CS rate	<10%	27.35%	72.6%	<0.001
	10–15%	21.8%	78.2%	
	>15%	58.9%	41.1%	
Sociodemographic characteristics				
Age at CS (in years)	<20	47.6%	52.4%	<0.001
	20–24	50.7%	49.3%	
	25–29	56.4%	43.6%	
	30–34	58.7%	41.3%	
	35–39	59.5%	40.5%	
	≥40	56.4%	43.6%	
Women's highest education level	no education	46.2%	53.8%	<0.001
	primary	42.1%	57.9%	
	secondary	48.9%	51.1%	
	higher	70.1%	29.9%	
Place of residence	urban	57.7%	42.3%	<0.001
	rural	51.4%	48.6%	
Wealth index	poorest	39.8%	60.2%	<0.001
	poorer	42.5%	57.5%	
	middle	44.5%	55.5%	
	richer	54.4%	45.5%	
	richest	69.3%	30.7%	
Problem accessing healthcare (general)		49.6%	50.4%	<0.001
Previous Obstetric history				
Birth order	1	55.9%	44.1%	<0.001
	2	52.5%	47.5%	
	3	52.1%	47.9%	
Previous CS (among birth order >1)	no	41.4%	58.6%	0.736
	yes	45.2%	54.8%	
	don't know/missing	44.3%	55.7%	
Pregnancy				
Mean number of antenatal care (ANC) visits		2.73	2.72	0.869
ANC visits ≥4		53.8%	46.2%	0.327
Location of ANC visits (3,265 missing)	none	53.4%	46.6%	<0.001
	public	27.7%	72.3%	
	private**	85.1%	14.9%	
	other	50.0%	50.0%	

Characteristic		Health Sector		Chi-squared
		Private	Public	p-value
	combination	57.9%	42.0%	
ANC content	took iron supplementation	53.4%	46.6%	<0.001
	blood pressure measured	53.7%	46.3%	0.003
	urine sample taken	53.7%	46.2%	0.127
	blood sample taken	53.8%	46.2%	0.103
	information on potential complications given	52.1%	47.8%	<0.001
	took intestinal parasite drugs†	49.6%	50.4%	<0.001
	received tetanus injection‡	53.9%	46.1%	0.440
Received ANC content*		51.7%	48.3%	<0.001
Intrapartum factors				
Emergency CS (after labor started) ‡‡		55.3%	44.6%	0.514
Newborn characteristics				
Sex of baby	male	54.2%	45.8%	0.613
	female	53.9%	46.1%	
Multiples	singleton	53.9%	46.1%	0.019
	multiple	59.8%	40.2%	
Birthweight <2,500 grams (missing 3,009)		51.9%	48.1%	0.009

Percentages adjusted for country, except for the geographic characteristics. *Received all of the following ANC content: measuring blood pressure, taking sample of blood, taking sample of urine, giving iron tablets/syrup, and informing about pregnancy complications. **Includes for-profit, nongovernmental organizations, and faith-based organizations. †Not measured in Bangladesh and Indonesia. ‡ Not measured in Bangladesh. ‡‡ timing not assessed in Kenya and Ghana

6.1 CS MATERNAL OUTCOMES FOR CS BIRTH BY HEALTH SECTOR

RECOMMENDED BIRTH SPACING

Proportion of women practicing recommended birth spacing overall was 17.6% in the public sector and 17.0% in the private sector (Table 14), with variations by country and sector shown by country in Figure 16.

TABLE 14: ASSOCIATION OF HEALTH SECTOR OF CS BIRTH AND RECOMMENDED BIRTH SPACING FOR MULTIPAROUS WOMEN, PROPORTION AND OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

	%	OR*	Adjusted OR*	P-value
Public	17.6%	ref	ref	

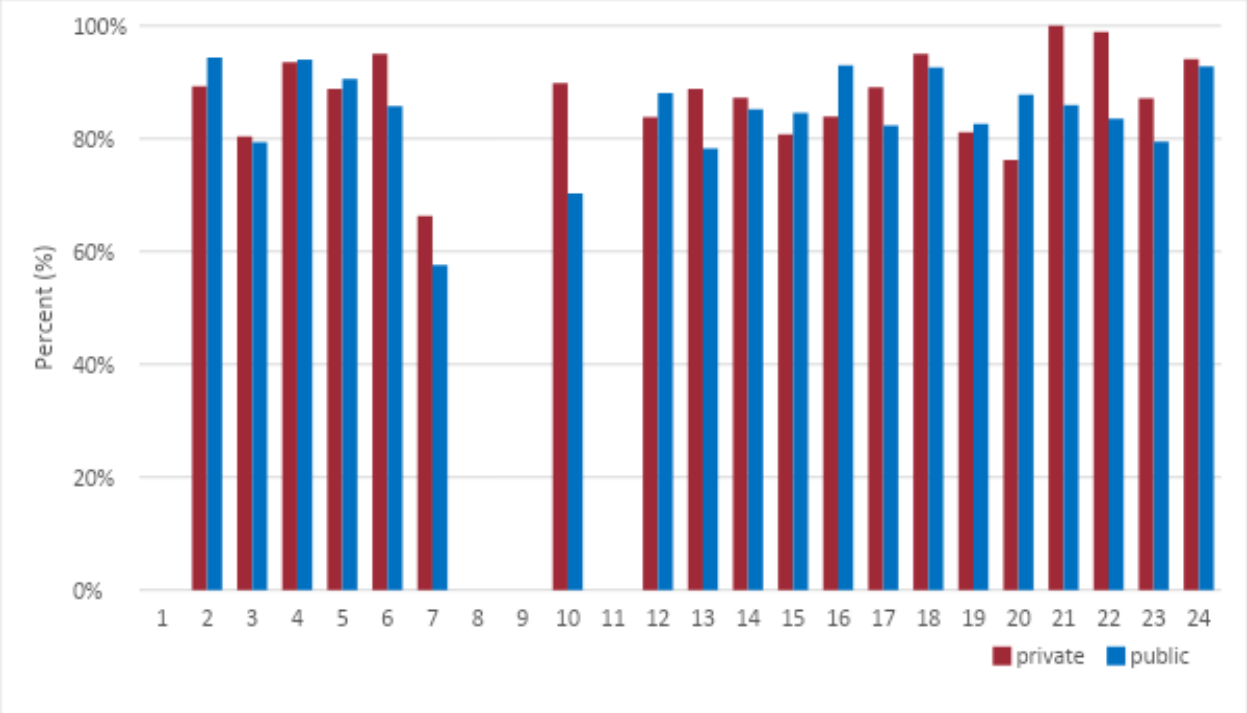
All Private	17.0%	1.03 (0.91, 1.18)	1.07 (0.82, 1.39)	p=0.54

*OR adjusted by country. Adjusted OR adjusted by women's age, education, location, wealth index, healthcare access, birth order, and antenatal care visits. Abbreviation: OR = odds ratio

Practicing recommended birth spacing in the private sector was highest in Sierra Leone and Tanzania (100%) and lowest in Pakistan (66.3%). In the public sector, recommended birth spacing ranged from 57.8% in Pakistan to 94% in Bangladesh (Figure 16).

There was no difference for recommended birth spacing between public and private (p=0.54) in the unadjusted (unadjOR= 1.03, 95% CI: 0.91, 1.18) or adjusted model (aOR=1.07, 95% CI: 0.83, 1.41) (Table 14).

FIGURE 16: PROPORTION OF MULTIPAROUS WOMEN WHO HAD A CS BIRTH THAT PRACTICED RECOMMENDED BIRTH SPACING ≥24 MONTHS, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)



Abbreviations: BD = Bangladesh; BJ = Benin; BU = Burundi; CM = Cameroon; GH = Ghana; IA= India; ID = Indonesia; KE = Kenya; ML = Mali; MW = Malawi; NG = Nigeria; PH = Philippines; PK = Pakistan; RW = Rwanda; SL = Sierra Leone; TZ = Tanzania; UG = Uganda; ZM = Zambia

In the private sector, ANC contact (p=0.01) was associated with birth spacing (Table 15). In the public sector, having three or more children may lower the odds of short spacing (p=0.05).

TABLE 15: FACTORS ASSOCIATED WITH RECOMMENDED BIRTH SPACING FOR MULTIPAROUS WOMEN WITH CS BIRTH IN PRIVATE AND PUBLIC SECTORS, ADJUSTED OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

Characteristic			Health sector	
			Private adjusted OR	Public adjusted OR
Socio-demographic	Woman's age at CS	<20 years 20–24 25–29 30–34 35–39 ≥40 years	0.25 (0.05, 1.17) ref 0.52 (0.10, 2.74) 0.47 (0.44, 1.64) 1.87 (0.07, 3,09) 0.35 (0.04, 3.12)	1.31 (0.78, 2.19) ref 1.38 (0.85, 2.24) 1.55 (0.82, 2.9) 0.74 (0.27, 2.03) --
	Education	None Primary Secondary Higher	0.95 (0.47, 1.95) ref 1.17 (0.63, 2.18) 1.15 (0.58, 2.28)	0.77 (0.42, 1.41) ref 0.66 (0.4, 1.11) 0.53 (0.28, 1.03)
	Place of residence	urban rural	Ref 0.81 (0.54, 1.23)	ref 0.88 (0.56, 1.38)
	Wealth index	poorer poorer middle richer richest	1.08 (0.54, 2.16) 0.92 (0.54, 1.58) ref 0.95 (0.6, 1.51) 0.72 (0.43, 1.2)	0.55 (0.31, 0.99) * 0.83 (0.47, 1.45) ref 1.01 (0.57, 1.78) 1.1 (0.62, 1.98)
Health seeking	No problem accessing. Problem accessing healthcare		Ref 1.02 (0.74, 1.41)	ref 1.10 (0.75, 1.61)
Obstetric history	birth order	1 2 ≥3	-- ref 0.90 (0.37, 2.14)	-- ref 2.21 (1.00, 4.89) *
Pregnancy	ANC visits	0–3 visits ≥4 visits	Ref 0.57 (0.40, 0.81) *	ref 1.18 (0.80, 1.73)

All models adjusted for country and for the other variables in the table. Covariates in the adjusted analysis were selected based on univariable analysis ($p<0.20$). *$p<0.05$. Abbreviations: ANC = antenatal care; OR = odds ratio

POSTPARTUM FAMILY PLANNING

PPFP was not measured in Cameroon, Haiti, and the Philippines. Overall, PPFP was 68.3% in the public sector and 64.9% in the private sector (Table 16). There was large variation in PPFP uptake between countries, ranging from 7.2% in private sector of Sierra Leone to 83.0% in Malawi private sector (Figure 17).

TABLE 16: ASSOCIATION OF HEALTH SECTOR OF CS BIRTH AND POSTPARTUM FAMILY PLANNING FOR WOMEN, PROPORTION AND OR, DHS SECONDARY ANALYSIS (N=17 COUNTRIES)

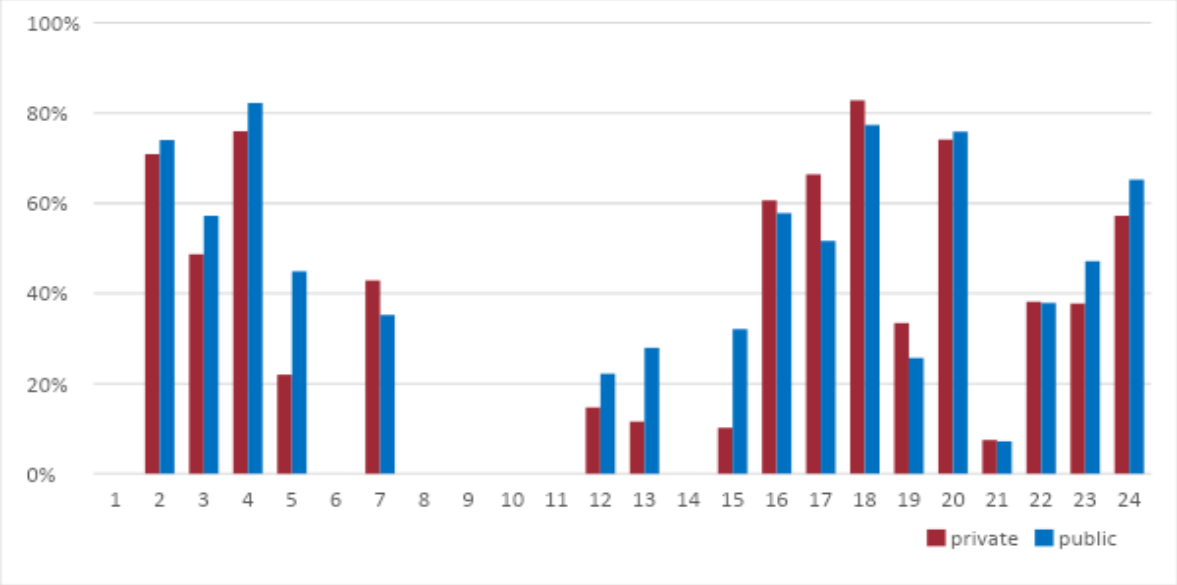
	%	OR*	Adjusted OR*	P-value
Public	68.3%	ref	Ref	
All Private	64.9%	0.97 (0.83, 1.15)	**0.83 (0.73, 0.95)**	**p<0.05**

*OR adjusted for country. Adjusted OR adjusted for women's age, education, location, wealth index, healthcare access, birth order, previous CS, antenatal care, emergency CS. Abbreviation: OR = odds ratio

Women who had a CS birth in the public sector had higher PPFP uptake than the private sector in Asia, except for in Pakistan (Figure 15). In SSA, a similar pattern was seen in Benin, Burundi, Ghana, Uganda, and Zambia. However, the uptake was higher in the private sector in Kenya, Mali, and Nigeria compared to the public. The remaining three countries showed a similar PPFP uptake between the two health sectors.

In the univariate analysis, PPFP was not influenced by health sector of CS birth (p>0.1); however, after adjustment for covariates, odds of PPFP decreased in the private sector compared to the public sector by 17% (aOR=0.83, 95% CI: 0.73, 0.95) (Table 16).

FIGURE 17: PROPORTION OF WOMEN WHO HAD A CS BIRTH WITH POSTPARTUM FAMILY PLANNING UPTAKE, DHS SECONDARY ANALYSIS (N=17 COUNTRIES)



Abbreviations: BD = Bangladesh; BJ = Benin; BU = Burundi; CM = Cameroon; GH = Ghana; IA = India; ID = Indonesia; KE = Kenya; ML = Mali; MW = Malawi; NG = Nigeria; PH = Philippines; PK = Pakistan; RW = Rwanda; SL = Sierra Leone; TZ = Tanzania; UG = Uganda; ZM = Zambia

Increased PPFP uptake was associated with higher education (p-trend <0.10), being poorer and being richest (p-trend-0.04) in both the private and public sectors (Table 17). Among women who had CS in the private sector, higher birth order (p-trend<0.01) and having an emergency CS (p=0.01) was associated with increased PPFP, while having problems accessing healthcare (p=0.01), not going to any ANC visits (p=0.01), or only getting ANC care in the private sector (p=0.02) were all associated with lower PPFP uptake. In the public sector, previous CS (p=0.01) and attending four or more ANC visits (p<0.001) was associated with increased PPFP uptake (Table 17).

TABLE 17: FACTORS ASSOCIATED WITH POSTPARTUM FAMILY PLANNING UPTAKE FOR WOMEN WITH CS BIRTH IN PRIVATE AND PUBLIC SECTORS, ADJUSTED OR, DHS SECONDARY ANALYSIS (N=17 COUNTRIES)

Characteristic			Health sector	
			Private adj OR	Public adj OR
Socio-demographic	Woman's age at CS	<20 years 20–24 25–29 30–34 35–39 ≥40 years	1.01 (0.80, 1.28) ref 1.06 (0.88, 1.29) 0.73 (0.55, 0.96) * 0.72 (0.41, 1.27) 0.46 (0.15, 1.43)	1.07 (0.85, 1.36) ref 0.89 (0.72, 1.1) 0.9 (0.62, 1.32) 0.47 (0.25, 0.9)* 0.22 (0.04, 1.17)
	Education	none primary secondary higher	1.12 (0.73, 1.71) ref 1.39 (1.00, 1.93) * 1.50 (1.06, 2.12) *	1 (0.69, 1.45) ref 1.52 (1.15, 2.02) * 1.61 (1.14, 2.27) *
	Place of residence	urban rural	ref 0.82 (0.69, 0.98) *	ref 0.92 (0.75, 1.14)
	Wealth index	poorest poorer middle richer richest	1.26 (0.91, 1.77) 1.48 (1.12, 1.94) * ref 1.18 (0.94, 1.48) 1.36 (1.06, 1.74) *	1.36 (1.00, 1.85) * 1.32 (1.02, 1.71)* ref 1.19 (0.96, 1.49) * 1.39 (1.08, 1.77) *
Health seeking	No problem accessing. Problem accessing healthcare		ref 0.82 (0.69, 0.96) *	ref 0.98 (0.82, 1.17)
Obstetric history	Birth order	1 2 ≥3	ref 2.59 (1.36, 4.93) * 2.51 (1.16, 5.42) *	ref 0.81 (0.39, 1.70) 1.45 (0.57. 3.80)
	No previous CS Previous CS		ref 1.08 (0.53, 2.22)	ref 3.05 (1.30, 7.10) *
Pregnancy	ANC visits	0–3 visits ≥4 visits	ref 1.09 (0.91, 1.30)	ref 1.50 (1.23, 1.83) *
	ANC location	no ANC visits public private other combination	0.54 (0.34, 0.86) * ref 0.74 (0.61, 0.9) * 1.18 (0.8, 1.72) 1.35 (1.09, 1.68)	0.68 (0.4, 1.16) ref 0.89 (0.66, 1.21) 1.05 (0.68, 1.61) 1.18 (0.93, 1.49)
Intrapartum	Elective CS Emergency CS		ref 1.22 (1.04, 1.43) **	ref 1.12 (0.94, 1.34)

All models adjusted for country and for the other variables in the table. Covariates in the adjusted analysis were selected based on univariable analysis ($p<0.20$). *$p<0.05$. Abbreviations: ANC = antenatal care; CS = cesarean section; OR = odds ratio

6.2 CS CHILD OUTCOMES

NEWBORN SURVIVAL

Neonatal mortality was low after CS. Overall neonatal mortality rate was 18 per 1,000 live births in the public sector and 13 per 1,000 live births in the private sector (Table 18).

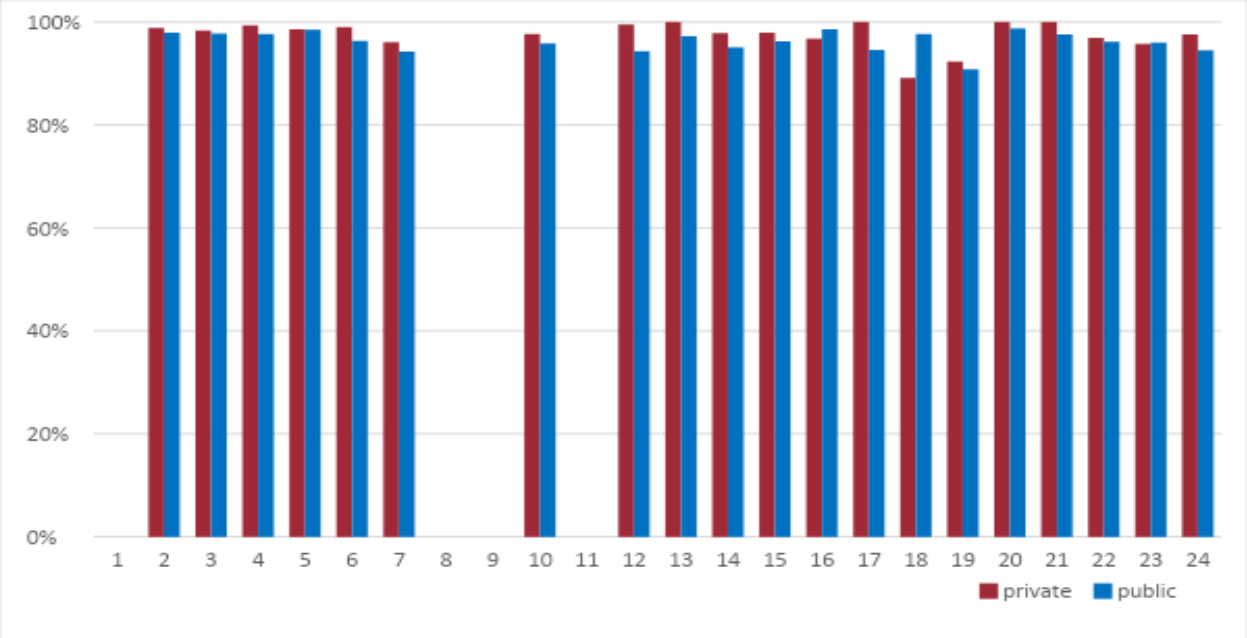
TABLE 18: ASSOCIATION OF HEALTH SECTOR OF CS BIRTH AND NEONATAL MORTALITY, RATE AND OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

	Per 1,000 livebirths	OR*	Adjusted OR*	P-value
Public	18	ref	Ref	
All Private	13	0.74 (0.41, 1.32)	1.43 (0.93, 2.19)	P=0.10

*OR adjusted for country. Adjusted OR adjusted for women's age, wealth index, birth order, previous CS, ANC, birthweight.
Abbreviation: OR = odds ratio

Figure 18 illustrates proportion of children who survived the neonatal period, by country and health sector, ranging from 89%–100%. Women with CS birth in private facilities have higher newborn survival than CS birth in public sector in Benin, India, Indonesia, Philippines, Zambia. Conversely, CS births in public sector have higher neonatal survival compared to private CS birth in Kenya and Malawi. Overall, the private sector had slightly better survival than the public sector, but it was not statistically significant (aOR=1.43, 95% CI: 0.93, 2.19, p=0.101).

FIGURE 18: PROPORTION OF NEWBORN SURVIVAL AFTER CS BIRTH, BY COUNTRY AND HEALTH SECTOR, SECONDARY DHS ANALYSIS (N=20 COUNTRIES)



Abbreviations: BD = Bangladesh; BJ = Benin; BU = Burundi; CM = Cameroon; GH = Ghana; IA = India; ID = Indonesia; KE = Kenya; ML = Mali; MW = Malawi; NG = Nigeria; PH = Philippines; PK = Pakistan; RW = Rwanda; SL = Sierra Leone; TZ = Tanzania; UG = Uganda; ZM = Zambia

In the private and public sectors, higher birth order and low birthweight <2,500 grams were associated with increased neonatal mortality. Having a previous CS was associated with improved newborn survival among private sector CS births. Women older than 40 years with a CS birth in a private facility had 80%

lower odds of newborn survival compared to women aged 20–24 years; however, the confidence interval is wide (aOR=0.18, 95% CI: 0.03, 0.96, Table 19).

TABLE 19: FACTORS ASSOCIATED WITH NEWBORN SURVIVAL FOR WOMEN WHO HAD CS BIRTH IN PRIVATE AND PUBLIC SECTORS, ADJUSTED OR, DHS SECONDARY ANALYSIS (20 COUNTRIES)

Characteristic			Health sector	
			Private adj OR	Public adj OR
Socio-demographic	Women's age at CS	<20 years 20–24 25–29 30–34 35–39 ≥ 40	0.93 (0.45, 1.94) ref 1.56 (0.9, 2.7) 1.22 (0.62, 2.4) 1.96 (0.45, 8.5) 0.18 (0.03, 0.96) *	0.65 (0.36, 1.2) ref 1.19 (0.64, 2.22) 0.96 (0.46, 1.99) 0.59 (0.2, 1.7) 0.27 (0.07, 1.04)
	Wealth index	poorest poorer middle richer richest	0.67 (0.31, 1.45) 0.59 (0.31, 1.12) ref 0.8 (0.41, 1.54) 1.21 (0.64, 2.28)	0.8 (0.41, 1.56) 1.09 (0.62, 1.95) ref 0.94 (0.45, 1.96) 1.53 (0.82, 2.84)
Obstetric history	Birth order	1 2 ≥3	Ref 0.51 (0.23, 1.15) 0.15 (0.07, 0.34)*	ref 0.65 (0.25, 1.67) 0.22 (0.10, 0.48)*
	No previous CS Previous CS		Ref 2.44 (1.01, 5.89)*	ref 1.39 (0.56, 3.46)
Pregnancy	ANC visits	0–3 visits ≥4 visits	Ref 1.39 (0.83, 2.30)	ref 1.56 (0.98. 2.48)
Newborn characteristics	Birthweight ≥2,500 g Low birthweight (<2,500 g)		Ref 0.40 (0.25, 0.63)*	ref 0.36 (0.23, 0.57)*

All models adjusted for country and for the other variables in the table. Covariates in the adjusted analysis were selected based on univariable analysis (p<0.20). *p<0.05. Abbreviations: ANC = antenatal care; CS = cesarean section; OR = odds ratio

INFANT SURVIVAL

Infant mortality after CS birth patterns were similar to neonatal mortality. Overall, the infant mortality rate (child deaths within 12 months after CS) was 23 per 1,000 live births in the public sector and 18 per 1,000 live births in the private sector (Table 20).

TABLE 20: ASSOCIATION OF HEALTH SECTOR OF CS BIRTH AND INFANT MORTALITY, RATE AND OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

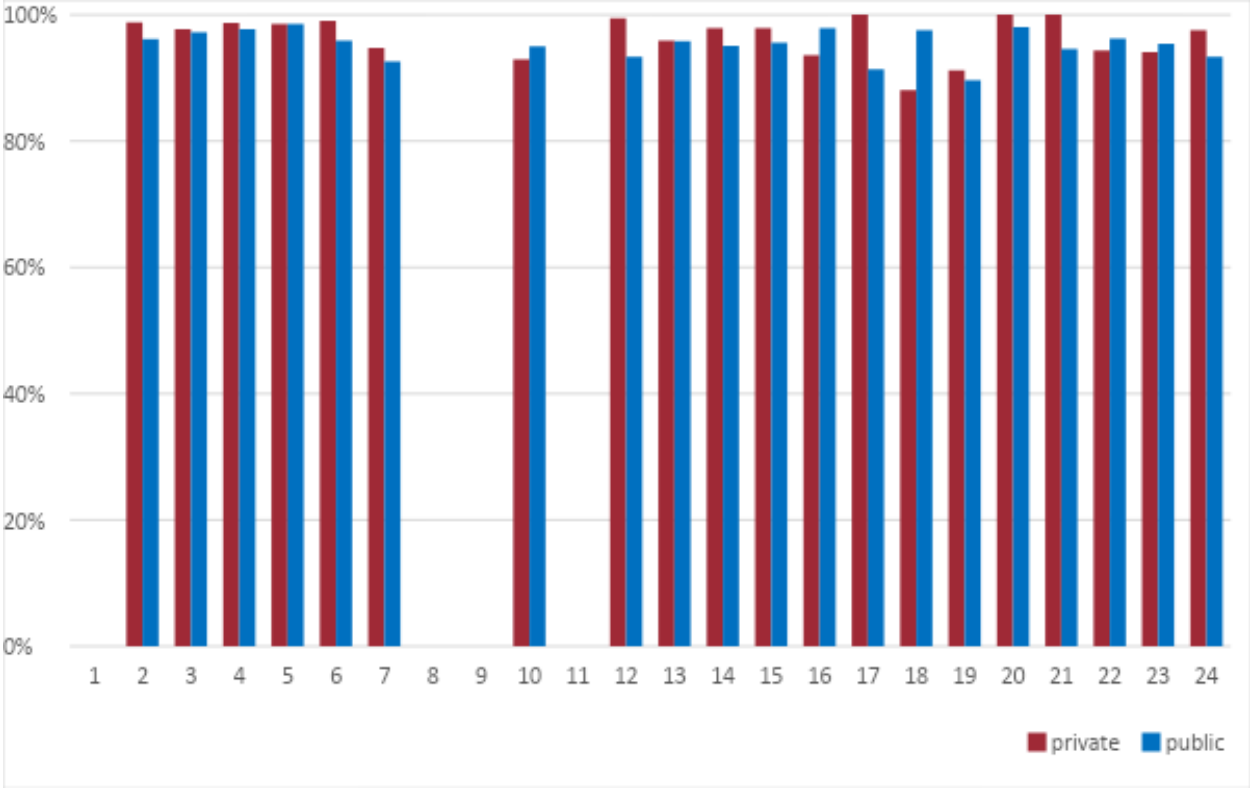
	Per 1,000 live births	OR*	Adjusted OR*	P-value
Public	23	ref	Ref	
All Private	18	0.8 (0.49, 1.3)	1.18 (0.81, 1.71)	P=0.10

*OR adjusted for country. Adjusted OR adjusted for women's age, wealth index, birth order, ANC, birthweight. Abbreviation: OR = odds ratio

Eighty-eight percent to 100% of children survived at least 12 months after CS birth, irrespective of country or health sector (Figure 19). Private CS births had similar or better infant survival compared to public CS births, except in Haiti, Kenya, and Malawi.

There was no difference in infant survival between public and private CS birth sector after adjustment of other covariates (aOR=1.18, 95% CI: 0.81, 1.71).

FIGURE 19: PROPORTION OF INFANT SURVIVAL AFTER CS BIRTH, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)



Abbreviations: BD = Bangladesh; BJ = Benin; BU = Burundi; CM = Cameroon; GH = Ghana; IA = India; ID = Indonesia; KE = Kenya; ML = Mali; MW = Malawi; NG = Nigeria; PH = Philippines; PK = Pakistan; RW = Rwanda; SL = Sierra Leone; TZ = Tanzania; UG = Uganda; ZM = Zambia

We found that among women who had a CS birth (irrespective of where they went to deliver), if they had three or more children, four or more ANC visits, and/or low birth weight newborns, they had higher rates of infant mortality, even after adjusting for maternal age and wealth. (Table 21). In the private sector, lower wealth quintiles were also associated with infant mortality.

TABLE 21: FACTORS ASSOCIATED WITH INFANT SURVIVAL FOR WOMEN WHO HAD CS BIRTH IN PRIVATE AND PUBLIC SECTORS, ADJUSTED OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

Characteristic			Health sector	
			Private adj OR	Public adj OR
Socio-demographic	Woman's Age at CS birth	<20 years 20–24 25–29 30–34 35–39 ≥40 years	0.67 (0.39, 1.16) ref 1.15 (0.8, 1.64) 1.01 (0.68, 1.49) 1.07 (0.58, 1.96) 0.64 (0.27, 1.53)	0.83 (0.52, 1.31) ref 1.00 (0.71, 1.39) 0.85 (0.58, 1.26) 0.69 (0.41, 1.16) 0.74 (0.38, 1.46)
	Wealth index	poorest poorer middle richer richest	0.50 (0.30, 0.85)* 0.62 (0.39, 0.98)* ref 0.82 (0.53, 1.26) 1.15 (0.75, 1.77)	0.72 (0.49, 1.06) 0.78 (0.55, 1.11) ref 0.89 (0.60, 1.33) 1.54 (1.06, 2.23)
Obstetric history	Birth order	1 2 ≥3	Ref 1.36 (0.98, 1.89) 0.56 (0.39, 0.82)*	ref 1.03 (0.76, 1.41) 0.57 (0.40, 0.82)*
Pregnancy	ANC visits	0–3 visits ≥4 visits	Ref 1.42 (1.04, 1.92)*	ref 1.42 (1.09, 1.85)*
Newborn characteristics	Birthweight ≥2,500 g Low birthweight (<2,500 g)		Ref 0.39 (0.29, 0.54)*	ref 0.36 (0.27, 0.47)*

All models adjusted for country and for the other variables in the table. Covariates in the adjusted analysis were selected based on univariable analysis (p<0.20). *p<0.05. Abbreviations: ANC = antenatal care; OR = odds ratio

TABLE 22: ASSOCIATION OF HEALTH SECTOR OF CS BIRTH AND EARLY INITIATION OF BREASTFEEDING, PROPORTION AND OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

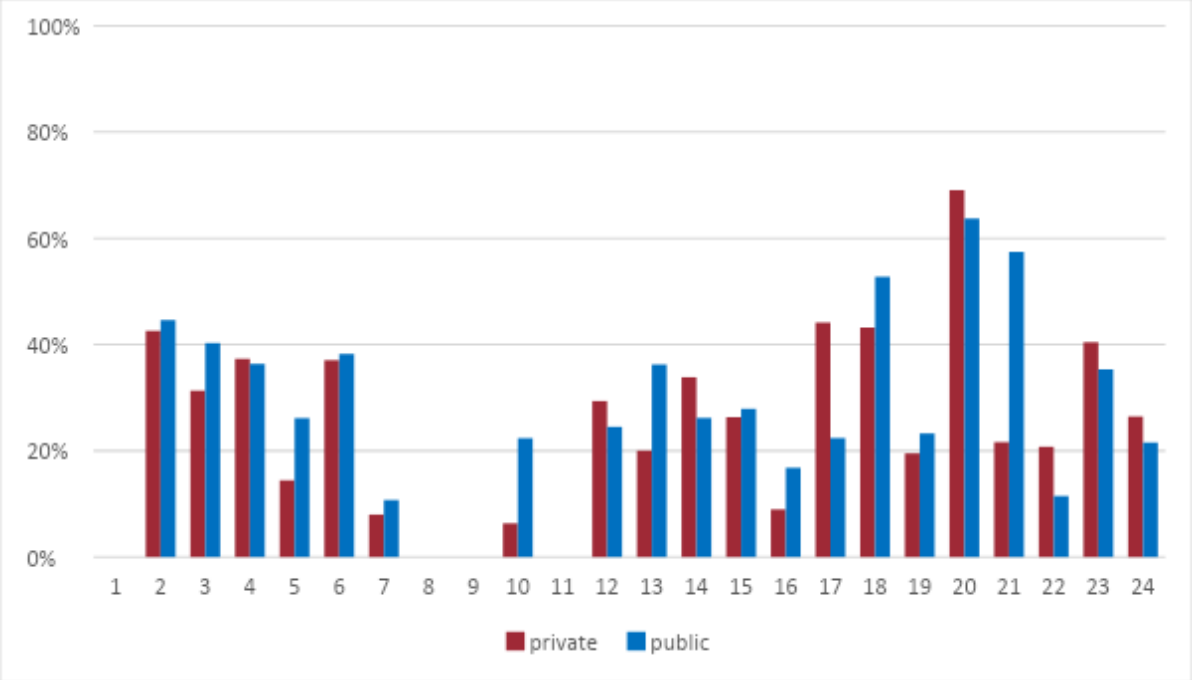
	%	OR*	Adjusted OR*	P-value
Public	41.9%	ref	Ref	
All Private	34.2%	**0.72 (0.62, 0.84)**	**0.78 (0.71, 0.87)**	**p<0.001**

*OR adjusted for country. Adjusted OR adjusted for women's age, education, wealth index, birth order, ANC, emergency, sex of child, birthweight. Abbreviation: OR = odds ratio

Early initiation of breastfeeding ranged from 6% in Pakistan private sector to 69% in Rwanda private sector (Figure 10). Public sector CS birth had higher initiation of early breastfeeding compared to private CS birth in seven countries: Burundi, Haiti, India, Kenya, Malawi, Nepal, and Sierra Leone. Early initiation of breastfeeding was higher in the public sector compared to the private sector in the remaining 13 countries.

Early initiation of breastfeeding was practiced less after CS birth in the private sector and this difference remained after adjusting for confounders (p<0.001) (aOR=0.78, 95% CI: 0.71, 0.87) (Table 18).

FIGURE 20: PROPORTION OF EARLY INITIATION OF BREASTFEEDING AMONG WOMEN WHO HAD A CS BIRTH SECONDARY DHS ANALYSIS (N=20 COUNTRIES)



Abbreviations: BD = Bangladesh; BJ = Benin; BU = Burundi; CM = Cameroon; GH = Ghana; IA = India; ID = Indonesia; KE = Kenya; ML = Mali; MW = Malawi; NG = Nigeria; PH = Philippines; PK = Pakistan; RW = Rwanda; SL = Sierra Leone; TZ = Tanzania; UG = Uganda; ZM = Zambia

Early initiation of breastfeeding was associated with attending four or more ANC visits, receiving essential ANC content, and birthweight ≥2,500 grams in both the private and public sectors (p<0.001). There was a 10% lower odds of early initiating of breastfeeding after emergency CS birth in the private sector (p=0.02)but was not the public sector (Table 23).

TABLE 23: FACTORS ASSOCIATED WITH EARLY INITIATION OF BREASTFEEDING FOR WOMEN WITH CS BIRTH IN PRIVATE AND PUBLIC SECTORS, ADJUSTED OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

Characteristic			Health Sector	
			Private adj OR	Public adj OR
Socio-demographic	Age at birth	<20 20–24 25–29 30–34 35–39 ≥40	1.17 (0.99, 1.4) ref 1.11 (0.99, 1.25) 1.25 (1.07, 1.45) * 1.38 (1.12, 1.74) * 1.38 (0.94, 2.04)	1.12 (0.94, 1.32) ref 0.94 (0.84, 1.05) 1.09 (0.94, 1.27) 1.20 (0.98, 1.49) 1.12 (0.77, 1.65)
	Education	none primary secondary higher	0.77 (0.59, 1.01) ref 1.15 (0.95, 1.37) 1.14 (0.94, 1.39)	0.86 (0.71, 1.04) ref 0.96 (0.83, 1.11) 0.93 (0.77, 1.11)
	Wealth index	poorest poorer	0.91 (0.73, 1.14) 0.92 (0.77, 1.09)	0.92 (0.78, 1.08) 0.82 (0.71, 0.94)*

Characteristic			Health Sector	
			Private adj OR	Public adj OR
		middle richer richest	ref 1.07 (0.93, 1.23) 1.00 (0.86, 1.15)	ref 1.03 (0.91, 1.17) 0.86 (0.74, 1.00)*
Obstetric history	Birth order	1 2 ≥3	ref 1.21 (1.07, 1.35)* 0.95 (0.81, 1.11)	ref 1.19 (1.07, 1.32) 1.11 (0.97, 1.29)
Pregnancy	ANC contact	0–3 visits ≥4 visits	ref 1.42 (1.24, 1.62)*	ref 1.47 (1.32, 1.64)*
	ANC location	no ANC visits public private other combination	1.11 (0.8, 1.53) ref 0.92 (0.81, 1.04) 1.28 (0.99, 1.65) 0.92 (0.80, 1.05)	1.04 (0.75, 1.44) ref 0.8 (0.68, 0.95) 0.98 (0.77, 1.25) 0.81 (0.71, 0.93)*
	ANC content	Content not received Content received*	ref 1.25 (1.12, 1.4)*	ref 1.25 (1.11, 1.41)*
intrapartum	Elective CS Emergency CS		ref 0.89 (0.81, 0.98)*	ref 0.99 (0.90, 1.09)
Newborn characteristics	Male Female		ref 1.09 (0.99, 1.19)	ref 1.02 (0.94, 1.12)
	Birthweight ≥2,500 g Low birthweight (<2,500 g)		ref 0.77 (0.68, 0.88)*	ref 0.82 (0.72, 0.94)*

[+]Received all of the following ANC content: measuring blood pressure, taking sample of blood, taking sample of urine, giving iron tablets/syrup, and informing about pregnancy complications. All models adjusted for country and for the other variables in the table. Covariates in the adjusted analysis were selected based on univariable analysis (p<0.20). *p<0.05. Abbreviations: ANC = antenatal care; CS = cesarean section; OR = odds ratio.

EXCLUSIVE BREASTFEEDING

EBF at six months overall was 46.8% after CS birth in the public sector compared to 50.9% in the private sector (Table 24).

TABLE 24: ASSOCIATION OF HEALTH SECTOR OF CS BIRTH AND EXCLUSIVE BREASTFEEDING AT SIX MONTHS, PROPORTION AND OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

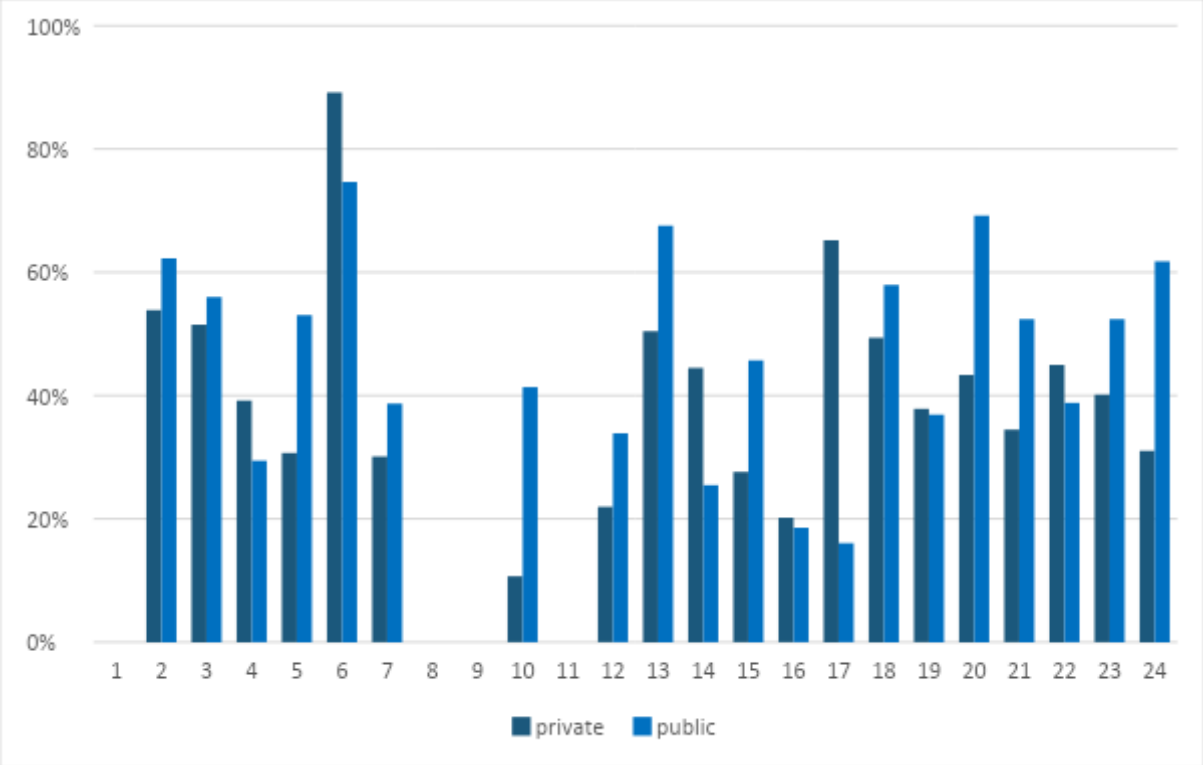
	%	OR*	Adjusted OR*	P-value
Public	46.8%	ref	ref	
All Private	50.9%	0.80 (0.70, 0.92)	0.84 (0.84, 0.97)	p<0.05

*OR adjusted for country. Adjusted OR adjusted for women's age, education, wealth index, birth order, ANC, emergency, sex of child, birthweight. Abbreviation: OR = odds ratio.

Country rates of EBF at six months of age ranged from 10%–89% (Figure 21). The private sector had better EBF after CS birth in the public sector in Cameroon, Kenya, Indonesia, Mali, Nigeria, Philippines, and Tanzania. In the remaining 13 countries, EBF at six months was better in the private sector.

EBF was associated with CS birth by health sector after country adjustment; the association was attenuated after further adjustment of other covariates. EBF was lower among women who gave birth by CS in the private sector compared to the public sector (aOR=0.84, 95% CI: 0.84, 0.97) (Table 24).

FIGURE 21: PROPORTION OF EXCLUSIVE BREASTFEEDING AT 6 MONTHS AFTER CS BIRTH, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)



Abbreviations: BD = Bangladesh; BJ = Benin; BU = Burundi; CM = Cameroon; GH = Ghana; IA = India; ID = Indonesia; KE = Kenya; ML = Mali; MW = Malawi; NG = Nigeria; PH = Philippines; PK = Pakistan; RW = Rwanda; SL = Sierra Leone; TZ = Tanzania; UG = Uganda; ZM = Zambia

Having at least four ANC visits (aOR=1.38, 95% CI: 1.11, 1.72) and being female (aOR-1.24, 95%:CI: 1.03, 1.51) improves the odds of EBF at six months among private sector CS birth, while having higher birth order lowers the odds of EBF (p-trend <0.05). In the public sector, birth order has a similar association with EBF after CS birth (p-trend <0.01). Low birthweight (<2,500 grams) was associated with 40% lower odds of EBF compared to ≥2,500 grams in public facilities (aOR=0.83, 95% CI: 0.73, 0.95), but not in private facilities (Table 25).

TABLE 25: FACTORS ASSOCIATED WITH EXCLUSIVE BREASTFEEDING FOR WOMEN WHO HAD CS BIRTH IN PRIVATE AND PUBLIC SECTORS, ADJUSTED OR, DHS SECONDARY ANALYSIS (N=20 COUNTRIES)

Characteristics			Health sector	
			Private adj OR	Public adj OR
Socio-demographic	Woman's age at birth	<20 years 20–24 25–29 30–34 35–39 ≥40 years	0.73 (0.49, 1.07) ref 1.09 (0.85, 1.39) 1.11 (0.80, 1.55) 1.03 (0.59, 1.79) 0.89 (0.40, 1.98)	0.80 (0.55, 1.17) ref 1.10 (0.84, 1.43) 1.25 (0.87, 1.80) 1.19 (0.73, 1.94) 0.54 (0.27, 1.11)
	Education	none primary secondary higher	0.99 (0.56, 1.45) ref 1.14 (0.78, 1.66) 1.13 (0.76, 1.67)	1.27 (0.81, 1.95) ref 1.22 (0.89, 1.67) 1.20 (0.81, 1.77)
	Wealth index	poorest poorer middle richer richest	1.15 (0.77, 1.07) 1.19 (0.89, 1.67) ref 1.06 (0.79, 1.41) 1.04 (0.78, 1.40)	1.21 (0.23, 1.78) 0.90 (0.66, 1.23) ref 0.77 (0.58, 1.03) 0.74 (0.53, 1.01)
Obstetric history	Birth order	1 2 ≥3	ref 0.79 (0.62, 1.01) 0.70 (0.51, 0.96)*	ref 0.64 (0.50, 0.82)* 0.59 (0.42, 0.84)*
Pregnancy	ANC contact	0–3 visits ≥4 visits	ref 1.38 (1.11, 1.72)*	ref 1.15 (0.90, 1.46)
	ANC location	no ANC visits public private other combination	0.64 (0.32, 1.26) ref 0.87 (0.67, 1.12) 1.01 (0.68, 1.09) 0.96 (0.72, 1.28)	0.64 (0.32, 1.25) ref 0.88 (0.62, 1.27) 1.60 (0.90, 2.84) 0.78 (0.58, 1.06)
	ANC content	Content not received Content received*	ref 1.01 (0.80, 1.26)	ref 0.97 (0.88, 1.07)
Newborn characteristics	Male Female		ref 1.24 (1.03, 1.51)*	ref 1.07 (0.87, 1.30)
	Birthweight ≥2,500 g Low birthweight (<2,500 g)		ref 0.94 (0.73, 1.21)	ref 0.62 (0.47, 0.82)*

[+]Received all of the following ANC content: measuring blood pressure, taking sample of blood, taking sample of urine, giving iron tablets/syrup, and informing about pregnancy complications. All models adjusted for country and for the other variables in the table. Covariates in the adjusted analysis were selected based on univariable analysis ($p<0.20$). *$p<0.05$. Abbreviations: ANC = antenatal care; OR = odds ratio

DISCUSSION

This multi-country assessment report contributes to understanding the dynamics behind CS conducted in private and public sector health facilities, across multiple LMICs. We explored the quality and birth outcomes for women and children after CS birth using secondary analysis of nationally representative publicly available data from DHS surveys in 20 countries and linked them to SPA surveys in five of these countries.

REGIONAL PRIVATE SECTOR CONTRIBUTION TO CESAREAN DYNAMICS

Although global CS rates are rapidly increasing [8], maternal and newborn mortality and stillbirth rate of reduction has stagnated [34]. We found very large regional differences in CS rates across geographies: Nearly half of the countries from SSA had population CS rates <5%. In contrast, almost all the countries in Asia had CS rates >20%. These inequities reflect both underuse and overuse of CS—both of which are associated with increased risk of mortality and morbidity [9,10]. WHO does not currently recommend a specific population CS rate for countries to achieve but emphasizes availability of CS when needed.

Private sector contribution to population CS rates varies widely by region in our analyses. The relative private sector contribution among included countries in SSA ranged from 5.3% (Burundi) to 55.3% (Nigeria), compared to a range in Asia of 37.2% (Nepal) to 79.7% (Bangladesh), and 21.9% in LAC (Haiti). Other studies have shown differences in CS rate between the private and public sectors [15,16,47–50], but to our knowledge this is the first study to estimate the contribution of the private sector to the population CS rate. As other studies have suggested, these differences are likely attributed to differences in organizational structures and financing of private health facilities, health professionals' attitudes and incentives toward birth management and use of CS, and/or women's characteristics and socio-cultural norms that influence their choice [18–20,47]. However, we were unable to identify proxy measures in either SPA or DHS for health professional factors (e.g., belief structure, financial rewards) or the women and community level factors (e.g., choices available, social norms, fear and anxiety) [9] to look at this directly, which is a limitation of this study.

OUTCOMES AFTER CESAREAN BIRTH FOR THE MATERNAL-FETAL DYAD

Our analyses also demonstrate how linking secondary data can contribute to multiple points along effective coverage cascades: service contact coverage, input-adjusted coverage, intervention coverage, and quality-adjusted coverage [51]. Newborn and infant mortality rates across these 20 country DHS analyses showed no significant association between CS birth in the public sector (18 and 23/1,000 live births) and the private sector (13 and 18/1,000 live births). Further post-CS outcome analyses could not be analyzed due to limited outcome data collected in the available DHS datasets. While conducting this study, DHS released Phase 8 data, which now captures the important outcome of stillbirth which was not available in previous rounds of the DHS surveys. Further analyses with these Phase 8 datasets will be important to explore stillbirths after CS, as recommended [21,52,53].

Furthermore, an optional maternal mental health module has now also been included in DHS Phase 8. Our methodology could be repeated on DHS Phase 8 survey data to include these important outcomes of stillbirth and mental health.

However, we found that recommended maternal and newborn care practices were significantly lower among private sector CS births compared to public sector. We found a lower uptake of PPFP after CS birth,

which has not previously been reported. The lower rates of early initiation and exclusive breastfeeding in our analyses align with previous research [54]. CS birth is likely a major contributor to stagnating breastfeeding rates globally, and implementation of strategies to support breastfeeding after CS birth remains a global priority [55–57]. Previous research regarding neonatal outcomes after CS is limited to higher income settings [58–62]. Introducing and ensuring early essential newborn care for babies born by CS birth is crucial [63].

CESAREAN BIRTHS: HIGH-QUALITY PROVISION AND EXPERIENCE OF CARE

Poor-quality care is a major contributor to preventable maternal and newborn mortality and stillbirth [64]. Providing CS safely requires health facilities to be ready across all dimensions of quality. Typically, health facility service readiness analyses focus on equipment, supplies, and human resources needed for care. The strength of our study is the use of the WHO quality-of-care framework to include criteria that include processes of care for CS decision-making, the surgical procedure, management of complications, and routine postnatal practices for woman and baby.

We designed a multi-domain novel CS-QRI that can be used flexibly to explore differences in quality between sectors and demonstrated the use of publicly available data to explore gaps in quality, by domain and overall, for health facilities providing CS. Previous research focused on a more limited number (11) of SPA quality items for the mother alone (e.g., consistent electricity, running water, 24 hours schedule for both cesarean and anesthesia providers; and availability of all general anesthesia equipment) in one geography of Tanzania [32]. Our CS-QRI focuses on a maternal-fetal-newborn dyad approach, identifying 45 quality items in the SPA that mapped to WHO quality measures recommended to improve quality of care in health facilities [28]. These included quality readiness items for: (1) **clinical decision-making for CS** (e.g., availability of clinical guidelines, regular monitoring the progress of labor, and fetal monitoring devices); (2) **surgical procedure of CS** (e.g., infection prevention and control measures, personal protective equipment); and **3) readiness to manage complications of CS** (e.g., blood transfusion for the woman and resuscitation for the newborn).

Quality readiness is only the beginning of ensuring high-quality care for women and newborns which requires a strong health systems approach, effective interprofessional teamwork, and continuous quality improvement cycles. The WHO surgical safety checklist aim to decrease errors and adverse events and increase teamwork and communication in surgery [65], has shown significant reduction in both morbidity and mortality [66,67], and is recommended before every surgical procedure including CS. Although we expanded the items used in previous CS service readiness research definition, we were limited by the content of the SPA questionnaires, which are mostly structure/input components and not process/outcome. Notably, the SPA does not formally assess the operation room, and the CS-specific inventory only includes staffing and availability of anesthetic equipment. With rising CS rates, we recommend that for CEmONC facilities, the operation room be formally assessed during health facility assessments (e.g. SPA and the recently launched WHO Harmonized Health Facility Assessment (HHFA) for CS readiness across quality domains for both the woman and the neonate.

We also gave equal weighting to different staff and equipment since there is no evidence on relative importance of various staff or equipment. Some countries (e.g., Bangladesh) have adapted their SPA to include a more comprehensive inventory list [68] as well as information on CS volume (e.g., Tanzania) [69]; however, this approach has not been adopted widely in other countries. As a result, we used the labor and delivery ward assessment to infer the availability of items for CS (e.g., antibiotics, protective

equipment). This is a reasonable approach as wards often borrow from one another when stock-outs occur.

Furthermore, our analyses used the available DHS and SPA Phase 7 data. During our study, SPA was extensively revised, especially to capture experience of care. Future analyses will need to update the quality items included in the CS-QRI for SPA Phase 8. This newly launched SPA includes exit interviews with postpartum women to capture information about experience of care (respectful treatment, client-provider communication, privacy, and perceived discrimination and verbal/physical abuse) in health facilities [70], which were missing quality domains in our CS-QRI. However, other quality items have been removed from the inventory. Given that we observed differences in availability of these items (e.g., physical resources) between the health sectors and countries, this will limit publicly available data to comprehensively assess all dimensions of quality in the future.

Our linked analysis of five countries (Bangladesh, Haiti, Nepal, Malawi, Tanzania) with both health facility (SPA) and population-based (DHS) data that are nationally representative, enabled us to connect health facility quality readiness to population CS rates and maternal and child outcomes. To the best of our knowledge, similar linked analyses for CS births have not previously been done. We found that CS births in these countries are being conducted in health facilities that are not ready to conduct high-quality CS and both public and private sector are contributing to quality gaps. Lowest scoring were health facilities in the private for-profit sector, with only 0%–14% scoring high or medium CS-QRI compared to 0%–48% among NGO/FBO. The public sector findings were similar to FBOs/NGOs, with high or medium CS-QRI among 0%–39% of facilities. The mixed health facilities (public and private) in Haiti were only 11–22%. However, our linkage of DHS and SPA was ecological and by health sector; our inability to link SPA health facility-level variables (e.g., CS-QRI) to the DHS at the women level was due to lack of a census in most of the countries, which limited our scope to look at how CS quality readiness influenced maternal and newborn outcomes from that same facility [71]. Other research has designed elegant linking methods, but this was beyond the scope of our study [71].

Domain-specific CS-QRI highlighted specific differences between sectors across four domains of quality that require health system strengthening. Action is needed across both sectors for several items to provide high-quality care. For example, consistent electricity was identified in maximum 55% private for-profit (Bangladesh), 69% of NGO/FBO (Haiti), and 58% of public sector facilities (Bangladesh). The mixed health sector in Haiti performed substantially higher, with 89% of facilities reporting consistent electricity. These results align with other studies that highlight the need to invest in generators and other power sources to ensure consistent electricity when providing major surgical procedures such as CS [72].

Health professionals in CS facilities had low rates of in-service training within the last two years across all sectors and especially in the private for-profit sector (11%–58%) compared to NGO/FBO (44%–67%) and public sector (30%–81%). Use of personal protective equipment is recommended for CS, yet eye protection had limited availability across all sectors: private for-profit (12%–37%), NGO/FBO (35%–70%), public (20%–61%) and missed (56%).

As a final example of low-quality readiness in all health sectors, blood transfusion services ranged from 2%–36% at private for-profit, 9%–85% at NGO/FBO, 23%–85% at public, and 44% at mixed facilities. Hemorrhage is still the leading cause of maternal mortality and a common complication of CS and often unpredictable. Our analysis emphasizes that urgent action is needed to ensure all CS facilities have safe blood transfusion practices including guidelines and no stock-outs of screened blood products.

Domain-specific CS-QRI also showed patterns across all sectors, but only in certain geographies, for instance, high HMIS use in CS facilities across all sectors in Tanzania (96%–97%), and low availability of oxygen especially in Nepal 33%–36% and fetal stethoscope especially in Bangladesh (19%–32%). Previous research has shown how care and measurement of that care varies by mode of birth and the importance of stratifying indicators by mode of birth [73].

Use of partograph across all sectors was high in Malawi (97%–100%) and low in Bangladesh (11%–57%). The partograph has previously been shown to reduce CS rates [74]. The WHO has recently published the WHO Labor Care Guide as a new generation partograph and has identified several priority research questions [74], including linking implementation of the guide with perinatal outcomes. Our analysis shows the potential of using secondary SPA data linked to DHS outcome data, and with DHS Phase 8 now including stillbirth, perinatal outcomes will be more complete.

Our analyses also showed health sectors that were high or low performing by quality domain. For example, some specialized anesthetic equipment (e.g. smaller sizes of equipment for emergency intubation) was more available in the private sector. The public and FBO/NGO sector outperformed the private for-profit sector for standard equipment such as stethoscope (98%–100% compared to 81%–98%) and drugs and supplies to manage hemorrhage including injectable uterotonics (73%–100% compared to 63%–87%).

Improving maternal and newborn data is a longstanding priority [34], yet we found low use of HMIS reported for CS facilities, especially the private for-profit sector: 9% in Malawi, 26% in Bangladesh, 61% in Haiti, and 63% in Nepal, compared to 97% in Tanzania. Action is needed to ensure all CS births and outcomes are reported into HMIS, to enable national and sub-national monitoring of rising CS rates, ideally linked to domains of quality.

CONTINUUM OF CARE SEEKING AND CESAREAN SECTION

In our study, the women attending the private sector for CS were more educated, had higher socioeconomic status, and were from Asia. Previous research indicated private-sector childbirth care-seeking might be due to a belief of more choices and more autonomy in health decisions and better quality of care [18]. However, our study has shown readiness for CS as measured by the CS-QRI is low across all sectors. Notably, in Bangladesh with the highest population CS rate and the highest relative contribution from the private sector, the quality gap for population CS is largely driven by the private sector (81%). By comparison, the public sector predominates for quality gaps in Haiti, Malawi, Nepal, and Tanzania. Our secondary analyses spanned antepartum, intrapartum, and postnatal periods to explore the continuum of care. We found a heterogeneity between the sectors, where women receive ANC and where their CS birth occurs. Our analysis showed women who had ANC and CS birth in the private sector (for-profit or not-for-profit) had lower uptake of PPFP and lower rates of early initiation of breastfeeding. In contrast, women with CS birth in the private sector, but ANC in a combination of private and public facilities, had higher rates of these practices. Previous research has indicated how poor experience of private ANC may lead to “shopping” across other sectors for quality ANC [18].

TEN GROUP CLASSIFICATION TO TRACK CESAREAN SECTION RATES

The 10-group Robson classification is recommended by WHO to track use of CS [75]. Previous DHS analyses have used modified Robson classification in DHS analyses [49]. Although the proxy “small size at birth” could be used as a proxy of preterm birth, without the critical variables of spontaneous or induced labor, as well as lie/presentation of the baby, all 10 groups cannot be assigned, thus the interpretation is

of limited use. Robson classification was designed for use with routine data from obstetric clinical data regularly collected in health facilities, so strengthening routine data sources to track should be prioritized over changing DHS survey questions.

LIMITATIONS OF SECONDARY DATA TO UNDERSTAND CESAREAN SECTION DYNAMICS, READINESS, AND QUALITY

Our study explored in-depth patterns and quality readiness for CS across health sectors. But we also call attention to the limitations of publicly available data to understanding the process and outcomes related to CS birth which continues to rapidly increase in many geographies.

First, there is the limited public availability of datasets. We considered possible other data sources, such as service availability and readiness assessments (SARA) and EmONC assessments, as well as customized national health facility data (e.g., in Indonesia where Workstream 2 is being conducted), but were unable to secure data access within the timeline of this research. Therefore, we limited our analyses to SPA and DHS data.

Second, country adaptation of the DHS (e.g., Cameroon, Haiti, Philippines) meant critical variables (e.g., PPFP) were not available, necessitating reducing DHS datasets from 22 to 20. Country leadership of nationally representative datasets such as DHS including context adaptation is vital yet this has implications for multi-country analyses.

Third, the timing between DHS and SPA surveys created limitations for estimating the proportion of women with CS conducted in high or medium quality CS readiness that requires linking DHS and SPA datasets from similar time periods for comparability. We identified twenty DHS datasets and nine SPA datasets, but only five countries had conducted SPA and DHS surveys within two years of each other, Our study shows the added value of being able to merge datasets for in-depth analyses if they are conducted within a similar period which could be used to advocate for population-based and health facility assessments done within similar timeframes.

Finally, data collected specific to CS section was somewhat limited across both DHS and SPA. For household survey data, it is understandable why limited intrapartum care data are collected, due to low validity of women's report after hospital childbirth [73]. However, as CS birth increases, for health facility assessments, the operation room as a place of birth should be added to allow the calculation of the CS quality readiness indices, we describe in this report in addition to using the labor and delivery ward data, as a proxy.

CONCLUSIONS

This study shows the importance of using data to highlight safe CS readiness as well as maternal and newborn health practices and outcomes after CS birth. Secondary analysis of publicly available DHS and SPA datasets can provide detailed insights into the dynamics behind CS conducted in private and public sector health facilities across multiple LMICs. This includes CS rates, relative contribution by sectors, and analysis of domains of quality.

Our CS-Quality readiness Index (CS-QRI) can be applied in other geographies with SPA phase 7 data even without linkage to DHS data sets. The CS-QRI can also be adapted for SPA phase 8 and other health facility

assessments (e.g., HHFA) as well as be adapted to measure quality at different points along the continuum of maternal and newborn health and beyond.

This study showed the vast majority of CS in the five countries of Bangladesh, Haiti, Nepal, Malawi, Tanzania and are being conducted in health facilities unprepared for providing high-quality care. These quality gaps are across both private and public health sectors, highlighting the importance of an all-sector approach.

Our study showed the importance of including multiple domains of quality linked to maternal and newborn health outcomes. Notably, readiness varied by domain and by health sector. However, health practices of PPFP and early initiation and exclusive breastfeeding were substantially worse in the private sector, necessitating additional programmatic focus. With rising CS rates worldwide, improving quality of care for maternal and newborn health must include strategies to improve the quality and safety of CS. Investments in improving quality of care at birth must link to high-quality antenatal care, postnatal care, and emergency referral systems to prevent poor outcomes for women, children, and families.

We illustrate the scope and usefulness of publicly available data analyses to understand dynamics of CS across diverse geographies, while also demonstrating probable saturation of analyses from currently available data.

We have identified opportunities to invest in future potential learning and data-driven improvements for women and newborns experiencing CS birth, by additional focused data collected from the operation room within health facility assessments and experience of care surveys stratified by mode of birth.

We recommend linking such secondary analyses with special studies to explore the process, outcomes, and experience of CS birth. MOMENTUM Private Healthcare delivery will undertake this approach in Indonesia, as the second part of this project, to understand the dynamics behind CS procedures in private and public sector health facilities.

REFERENCES

[1] United States Agency for International Development. MOMENTUM Private Healthcare Delivery n.d. https://usaidmomentum.org/about/projects/private-healthcare-delivery/ (accessed September 5, 2023).

[2] Jeremy A Lauer, Ana P Betran, Mario Merialdi, et al. Determinants of caesarean section rates in developed countries: supply, demand, and opportunities for control. 2017.

[3] Chu K, Cortier H, Maldonado F, et al. Cesarean Section Rates and Indications in Sub-Saharan Africa: A Multi-Country Study from Medecins sans Frontieres. PLoS ONE 2012;7:e44484. https://doi.org/10.1371/journal.pone.0044484.

[4] Cavallaro FL, Cresswell JA, Ronsmans C. Obstetricians' Opinions of the Optimal Caesarean Rate: A Global Survey. PLoS ONE 2016;11:e0152779. https://doi.org/10.1371/journal.pone.0152779.

[5] Betran AP, Torloni MR, Zhang J, et al. What is the optimal rate of caesarean section at population level? A systematic review of ecologic studies. Reprod Health 2015;12:57. https://doi.org/10.1186/s12978-015-0043-6.

[6] Betran A, Torloni M, Zhang J, et al. WHO Statement on Caesarean Section Rates. BJOG: Int J Obstet Gy 2016;123:667–70. https://doi.org/10.1111/1471-0528.13526.

[7] World Health Organization, United Nations Population Fund, Mailman School of Public Health, et al. Monitoring emergency obstetric care : a handbook. World Health Organization; 2009.

[8] Betran AP, Ye J, Moller A-B, et al. Trends and projections of caesarean section rates: global and regional estimates. BMJ Glob Health 2021;6:e005671. https://doi.org/10.1136/bmjgh-2021-005671.

[9] Betrán AP, Temmerman M, Kingdon C, et al. Interventions to reduce unnecessary caesarean sections in healthy women and babies. The Lancet 2018;392:1358–68. https://doi.org/10.1016/S0140-6736(18)31927-5.

[10] Boerma T, Ronsmans C, Melesse DY, et al. Global epidemiology of use of and disparities in caesarean sections. The Lancet 2018;392:1341–8. https://doi.org/10.1016/S0140-6736(18)31928-7.

[11] Kruk ME, Gage AD, Arsenault C, et al. High-quality health systems in the Sustainable Development Goals era: time for a revolution. The Lancet Global Health 2018;6:e1196–252. https://doi.org/10.1016/S2214-109X(18)30386-3.

[12] Alonso BD, Silva FMBD, Latorre MDRDDO, et al. Caesarean birth rates in public and privately funded hospitals: a cross-sectional study. Rev Saúde Pública 2017;51:101. https://doi.org/10.11606/S1518-8787.2017051007054.

[13] McCall SJ, Semaan A, Altijani N, et al. Trends, wealth inequalities and the role of the private sector in caesarean section in the Middle East and North Africa: A repeat cross-sectional analysis of population-based surveys. PLoS ONE 2021;16:e0259791. https://doi.org/10.1371/journal.pone.0259791.

[14] Kibe PM, Mbuthia GW, Shikuku DN, et al. Prevalence and factors associated with caesarean section in Rwanda: a trend analysis of Rwanda demographic and health survey 2000 to 2019–20. BMC Pregnancy Childbirth 2022;22:410. https://doi.org/10.1186/s12884-022-04679-y.

[15] Singh P, Hashmi G, Swain PK. High prevalence of cesarean section births in private sector health facilities- analysis of district level household survey-4 (DLHS-4) of India. BMC Public Health 2018;18:613. https://doi.org/10.1186/s12889-018-5533-3.

[16] Neuman M, Alcock G, Azad K, et al. Prevalence and determinants of caesarean section in private and public health facilities in underserved South Asian communities: cross-sectional analysis of

data from Bangladesh, India and Nepal. BMJ Open 2014;4:e005982. https://doi.org/10.1136/bmjopen-2014-005982.
[17] Chi C, Pang D, Aris IM, et al. Trends and predictors of cesarean birth in Singapore, 2005-2014: A population-based cohort study. Birth 2018;45:399–408. https://doi.org/10.1111/birt.12341.
[18] Strong J, Lattof SR, Maliqi B, et al. Experiences of private sector quality care amongst mothers, newborns, and children in low- and middle-income countries: a systematic review. BMC Health Serv Res 2021;21:1311. https://doi.org/10.1186/s12913-021-06905-3.
[19] Luz Gibbons, Jose M Bellzan, Jeremy A Lauer, et al. The global numbers and costs of additionally needed and unnecessary caesarean sections performed per year: Overuse as a barrier to universal coverage. 2010.
[20] Khan MN, Islam MM, Akter S. Spatial distribution of caesarean deliveries and their determinants in Bangladesh: evidence from linked data of population and health facility survey. The Lancet Regional Health - Southeast Asia 2023;14:100153. https://doi.org/10.1016/j.lansea.2023.100153.
[21] Sobhy S, Arroyo-Manzano D, Murugesu N, et al. Maternal and perinatal mortality and complications associated with caesarean section in low-income and middle-income countries: a systematic review and meta-analysis. The Lancet 2019;393:1973–82. https://doi.org/10.1016/S0140-6736(18)32386-9.
[22] Ologunde R, Vogel JP, Cherian MN, et al. Assessment of cesarean delivery availability in 26 low- and middle-income countries: a cross-sectional study. American Journal of Obstetrics and Gynecology 2014;211:504.e1-504.e12. https://doi.org/10.1016/j.ajog.2014.05.022.
[23] Esteves-Pereira AP, Deneux-Tharaux C, Nakamura-Pereira M, et al. Caesarean Delivery and Postpartum Maternal Mortality: A Population-Based Case Control Study in Brazil. PLoS ONE 2016;11:e0153396. https://doi.org/10.1371/journal.pone.0153396.
[24] Miller S, Abalos E, Chamillard M, et al. Beyond too little, too late and too much, too soon: a pathway towards evidence-based, respectful maternity care worldwide. The Lancet 2016;388:2176–92. https://doi.org/10.1016/S0140-6736(16)31472-6.
[25] Institute of Medicine (US) Commitee on Quality of Healthcare in America. Crossing the Quality Chasm: A New Health System for the 21st Century. Washington, D.C.: National Academies Press; 2001. https://doi.org/10.17226/10027.
[26] WHO Patient Safety & World Health Organization. WHO guidelines for safe surgery 2009: safe surgery saves lives. World Health Organization; 2009.
[27] Tunçalp Ö., Were W, MacLennan C, et al. Quality of care for pregnant women and newborns-the WHO vision. BJOG: Int J Obstet Gy 2015;122:1045–9. https://doi.org/10.1111/1471-0528.13451.
[28] World Health Organization. Standards for improving quality of maternal and newborn care in health facilities. Geneva: World Health Organization; 2016.
[29] Donabedian A. The Quality of Care: How Can It Be Assessed? JAMA 1988;260:1743. https://doi.org/10.1001/jama.1988.03410120089033.
[30] Donabedian A. Evaluating the Quality of Medical Care. Milbank Quarterly 2005;83:691–729. https://doi.org/10.1111/j.1468-0009.2005.00397.x.
[31] Beyene MG, Zemedu TG, Gebregiorgis AH, et al. Cesarean delivery rates, hospital readiness and quality of clinical management in Ethiopia: national results from two cross-sectional emergency obstetric and newborn care assessments. BMC Pregnancy Childbirth 2021;21:571. https://doi.org/10.1186/s12884-021-04008-9.
[32] Cavallaro FL, Pembe AB, Campbell O, et al. Caesarean section provision and readiness in Tanzania: analysis of cross-sectional surveys of women and health facilities over time. BMJ Open 2018;8:e024216. https://doi.org/10.1136/bmjopen-2018-024216.

[33] Compaoré GD, Sombié I, Ganaba R, et al. Readiness of district and regional hospitals in Burkina Faso to provide caesarean section and blood transfusion services: a cross-sectional study. BMC Pregnancy Childbirth 2014;14:158. https://doi.org/10.1186/1471-2393-14-158.
[34] World Health Organization. Improving maternal and newborn health and survival and reducing stillbirth: progress report 2023. Geneva: World Health Organisation; 2023.
[35] DHS Program. Survey Types n.d. https://dhsprogram.com/Methodology/Survey-Types/index.cfm. (accessed March 1, 2023).
[36] DHS Program. DHS Overview n.d. https://dhsprogram.com/Methodology/Survey-Types/DHS.cfm. (accessed March 1, 2023).
[37] DHS Program. SPA Overview n.d. https://dhsprogram.com/methodology/Survey-Types/SPA.cfm (accessed March 1, 2023).
[38] Mallick L, Temsah G, Wang W. Comparing summary measures of quality of care for family planning in Haiti, Malawi, and Tanzania. PLoS ONE 2019;14:e0217547. https://doi.org/10.1371/journal.pone.0217547.
[39] Murphy GAV, Gathara D, et al. Effective coverage of essential inpatient care for small and sick newborns in a high mortality urban setting: a cross-sectional study in Nairobi City County, Kenya. BMC Med 2018;16:72. https://doi.org/10.1186/s12916-018-1056-0.
[40] Wang W, Mallick L, Allen C, et al. Effective coverage of facility delivery in Bangladesh, Haiti, Malawi, Nepal, Senegal, and Tanzania. PLoS ONE 2019;14:e0217853. https://doi.org/10.1371/journal.pone.0217853.
[41] World Health Organization. Report of a WHO technical consultation on birth spacing: Geneva, Switzerland 13-15 June 2005 2007.
[42] Pimentel J, Ansari U, Omer K, et al. Factors associated with short birth interval in low- and middle-income countries: a systematic review. BMC Pregnancy Childbirth 2020;20:156. https://doi.org/10.1186/s12884-020-2852-z.
[43] Gaffield ME, Egan S, Temmerman M. It's about time: WHO and partners release programming strategies for postpartum family planning. Glob Health Sci Pract 2014;2:4–9. https://doi.org/10.9745/GHSP-D-13-00156.
[44] Rutstein SO, Johnson K. The DHS wealth index. Calverton, Maryland, USA: ORC Macro; 2004.
[45] Sharma A, Minh Duc NT, Luu Lam Thang T, et al. A Consensus-Based Checklist for Reporting of Survey Studies (CROSS). J GEN INTERN MED 2021;36:3179–87. https://doi.org/10.1007/s11606-021-06737-1.
[46] DHS Program. Protecting the Privacy of DHS Survey Respondents n.d. https://dhsprogram.com/Methodology/Protecting-the-Privacy-of-DHS-Survey-Respondents.cfm. (accessed September 5, 2023)
[47] Hernández-Vásquez A, Chacón-Torrico H, Bendezu-Quispe G. Differences in the prevalence of cesarean section and associated factors in private and public healthcare systems in Peru. Sexual & Reproductive Healthcare 2020;26:100570. https://doi.org/10.1016/j.srhc.2020.100570.
[48] Solanki GC, Cornell JE, Daviaud E, et al. Caesarean section rates in South Africa: A case study of the health systems challenges for the proposed National Health Insurance. S Afr Med J 2020;110:747. https://doi.org/10.7196/SAMJ.2020.v110i8.14699.
[49] Berglundh S, Benova L, Olisaekee G, et al. Caesarean section rate in Nigeria between 2013 and 2018 by obstetric risk and socio-economic status. Tropical Med Int Health 2021;26:775–88. https://doi.org/10.1111/tmi.13579.
[50] Lazzerini M, Valente EP, Covi B, et al. Rates of instrumental vaginal birth and cesarean and quality of maternal and newborn health care in private versus public facilities: Results of the IMAGINE EURO study in 16 countries. Intl J Gynecology & Obste 2022;159:22–38. https://doi.org/10.1002/ijgo.14458.

[51] Marsh AD, Muzigaba M, Diaz T, et al. Effective coverage measurement in maternal, newborn, child, and adolescent health and nutrition: progress, future prospects, and implications for quality health systems. The Lancet Global Health 2020;8:e730–6. https://doi.org/10.1016/S2214-109X(20)30104-2.
[52] McClure EM, Saleem S, Goudar SS, et al. Stillbirth rates in low-middle income countries 2010 - 2013: a population-based, multi-country study from the Global Network. Reprod Health 2015;12:S7. https://doi.org/10.1186/1742-4755-12-S2-S7.
[53] Harrison MS, Pasha O, Saleem S, et al. A prospective study of maternal, fetal and neonatal outcomes in the setting of cesarean section in low- and middle-income countries. Acta Obstet Gynecol Scand 2017;96:410–20. https://doi.org/10.1111/aogs.13098.
[54] Li L, Wan W, Zhu C. Breastfeeding after a cesarean section: A literature review. Midwifery 2021;103:103117. https://doi.org/10.1016/j.midw.2021.103117.
[55] Huang C, Hu L, Wang Y, et al. Effectiveness of early essential newborn care on breastfeeding and maternal outcomes: a nonrandomized controlled study. BMC Pregnancy Childbirth 2022;22:707. https://doi.org/10.1186/s12884-022-05037-8.
[56] Tran HT, Murray JCS, Sobel HL, et al. Early essential newborn care is associated with improved newborn outcomes following caesarean section births in a tertiary hospital in Da Nang, Vietnam: a pre/post-intervention study. BMJ Open Qual 2021;10:e001089. https://doi.org/10.1136/bmjoq-2020-001089.
[57] Kuyper E, Vitta BS, Dewey KG. Implications of cesarean delivery for breastfeeding outcomes and strategies to support breastfeeding., 2014.
[58] Kirkeby Hansen A, Wisborg K, Uldbjerg N, et al. Elective caesarean section and respiratory morbidity in the term and near-term neonate. Acta Obstet Gynecol Scand 2007;86:389–94. https://doi.org/10.1080/00016340601159256.
[59] Karlström A, Lindgren H, Hildingsson I. Maternal and infant outcome after caesarean section without recorded medical indication: findings from a Swedish case-control study. BJOG 2013;120:479–86. https://doi.org/10.1111/1471-0528.12129.
[60] Sotiriadis A, Makrydimas G, Papatheodorou S, et al. Corticosteroids for preventing neonatal respiratory morbidity after elective caesarean section at term. Cochrane Database of Systematic Reviews 2018;2018. https://doi.org/10.1002/14651858.CD006614.pub3.
[61] Thanh BYL, Lumbiganon P, Pattanittum P, et al. Mode of delivery and pregnancy outcomes in preterm birth: a secondary analysis of the WHO Global and Multi-country Surveys. Sci Rep 2019;9:15556. https://doi.org/10.1038/s41598-019-52015-w.
[62] Kamath BD, Todd JK, Glazner JE, et al. Neonatal Outcomes After Elective Cesarean Delivery. Obstetrics & Gynecology 2009;113:1231–8. https://doi.org/10.1097/AOG.0b013e3181a66d57.
[63] World Health Organization. Early essential newborn care: clinical practice pocket guide, 2nd edition. 2nd ed. 2022.
[64] Kruk ME, Gage AD, Joseph NT, et al. Mortality due to low-quality health systems in the universal health coverage era: a systematic analysis of amenable deaths in 137 countries. The Lancet 2018;392:2203–12. https://doi.org/10.1016/S0140-6736(18)31668-4.
[65] World Health Organization. WHO Surgical Safety Checklist n.d. https://www.who.int/teams/integrated-health-services/patient-safety/research/safe-surgery/tool-and-resources (accessed September 15, 2023).
[66] Chaudhary N, Varma V, Kapoor S, et al. Implementation of a Surgical Safety Checklist and Postoperative Outcomes: a Prospective Randomized Controlled Study. J Gastrointest Surg 2015;19:935–42. https://doi.org/10.1007/s11605-015-2772-9.

[67] Bergs J, Hellings J, Cleemput I, et al. Systematic review and meta-analysis of the effect of the World Health Organization surgical safety checklist on postoperative complications. British Journal of Surgery 2014;101:150–8. https://doi.org/10.1002/bjs.9381.
[68] National Institute of Population Research and Training (NIPORT), ICF. Bangladesh health facility survey, 2017. Dhaka, Bangladesh: NIPORT, ACPR, and ICF; 2019.
[69] Ministry of Health and Social Welfare (MoHSW), Ministry of Health (MoH) [Zanzibar], National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), et al. Tanzania Service Provision Survey Report, 2014-2015. Dar Es Salaam, Tanzania and Rockville, MD, USA: MoHSW, MoH, NBS, OCGS, and ICF International; 2015.
[70] DHS Program. Introducing the revised Service Provision Assessment. USAID; 2022.
[71] Burgert CR, Prosnitz D. Linking DHS household and SPA facility surveys: Data considerations and geospatial methods. Rockville, Maryland, USA: ICF International; 2014.
[72] Chawla S, Kurani S, Wren SM, et al. Electricity and generator availability in LMIC hospitals: improving access to safe surgery. Journal of Surgical Research 2018;223:136–41. https://doi.org/10.1016/j.jss.2017.10.016.
[73] Day LT, Sadeq-ur Rahman Q, Ehsanur Rahman A, et al. Assessment of the validity of the measurement of newborn and maternal health-care coverage in hospitals (EN-BIRTH): an observational study. The Lancet Global Health 2021;9:e267–79. https://doi.org/10.1016/S2214-109X(20)30504-0.
[74] World Health Organization partograph in management of labour. World Health Organization Maternal Health and Safe Motherhood Programme. Lancet 1994;343:1399–404.
[75] World Health Organization. Robson classification: implementation manual. Geneva: World Health Organisation; 2017.

APPENDICES

TABLE A1. DESCRIPTION OF SPA READINESS MEASURE

Quality standard	Quality domain	SPA service readiness measures		SPA item / definition (Item number)
Availability of essential physical resources (Standard 8)	Essential physical resources need for mother and baby related to CS	Infrastructure	Consistent electricity	During past 7 days, electricity (excluding back-up generator) was always available during the times when the facility was open for services or was not interrupted for more than 2 hours at a time (I – 341)
			Piped running water	Observed running water (piped bucket with tap or pour pitcher) in delivery/labor ward (I – 1651)
		Equipment and supplies	Anesthesia equipment and supplies	In the location where CS deliveries are done, ***observed the following equipment is available and functioning:*** **(i)** tubings and connectors, **(ii)** oropharyngeal airways (adult), **(iii)** oropharyngeal airways (pediatric), **(iv)** Magill's forceps (adult), **(v)** Magill's forceps (pediatric), **(vi)** endotracheal tube (cuffed size 3.0 – 5.0), **(vii)** endotracheal tube (cuffed size 5.5 – 9.0), **(viii)** incubating stylet, **(ix)** spinal needle (I – 2510)
			Newborn bag and mask	In delivery/labor ward, ***observed the following equipment is available and functioning:*** newborn bag and mask (I – 1622)
			Suction	In delivery/labor ward, ***observed the following equipment is available and functioning:*** suction apparatus with catheter (I – 1622_04 or suction bulb/penguin sucker (I – 1622)
			Infant scale	In delivery/labor ward, ***observed the following equipment is available and functioning:*** infant scale (I – 1622)
			Thermometer	In delivery/labor ward, ***observed the following equipment is available and functioning:*** thermometer or thermometer for low-body temperature (I – 1622)
		Drugs	Oxygen	In location where CS deliveries are done, ***observed the following equipment is available and functioning:*** oxygen cylinder with and without flowmeter or concentrator (Bangladesh/Tanzania I – 2510) In delivery/labor ward, ***observed the following equipment is available and functioning:*** oxygen concentrator or tanks (Haiti/Malawi I – 1622) In general client exam room, ***observed the following equipment is available and functioning:*** oxygen concentrators or filled oxygen cylinders, or oxygen distribution system (Nepal I – 700)

Quality standard	Quality domain	SPA service readiness measures		SPA item / definition (Item number)
Competent human resources (Standard 7)	Competent motivated human resources – conduct CS operation	Human resources	24-hour CS provider work schedule	In location where CS deliveries are done, ***observed*** the 24-hour duty schedule or call list for health work who can perform CS at facility (I – 2503)
			24-hour anesthetist work schedule	In location where CS deliveries are done, ***observed*** the 24-hour duty schedule or call list for anesthetist (I – 2506)
		Training	Health workers involved in labor and delivery were trained in last 24 months	Has any labor and delivery health worker received any in-service training, training updates or refresher training in the last 24 months: **(i)** Integrated management of pregnancy and childbirth, **(ii)** CEmONC, **(iii)** routine care of labor and normal vaginal delivery, **(iv)** active management of the third stage of labor, **(v)** emergency obstetric care/lifesaving skills in general (HW – 510)
Evidence-based practice for routine care and management (Standard 1)	Evidence-based CS decision	Guidelines	BEmONC guidelines	In delivery/labor ward, ***have and observed*** guideline/protocol/manual for BEmONC (I – 1605/1606)
			CEmONC guidelines	In delivery/labor ward, ***have and observed*** guideline/protocol/manual for CEmONC (I – 1607/1608)
		Routine practice	Always use partograph	Partographs used routinely (for all cases) to monitor labor and delivery in this facility (I – 1614)
		Equipment and supplies	thermometer	In delivery/labor ward, ***observed the following equipment is available and functioning:*** thermometer or thermometer for low-body temperature (I – 1622)
			stethoscope	In delivery/labor ward, ***observed the following equipment is available and functioning:*** stethoscope (I – 1622)
			blood pressure machine	In delivery/labor ward, ***observed the following equipment is available and functioning:*** digital or manual blood pressure machine (I – 1622)
			fetal stethoscope	In delivery/labor ward, ***observed the following equipment is available and functioning:*** fetal stethoscope (I – 1622)
	Evidence-based infection prevention and treatment	Equipment and supplies	handwashing soap	In delivery/labor ward, ***observed the following:*** handwashing soap (I – 1651)
			alcohol	In delivery/labor ward, ***observed the following:*** alcohol-based hand rub (I – 1651)
			gloves	In delivery/labor ward, ***observed the following:*** disposable latex/other gloves (I – 1651)
			skin disinfectant	In delivery/labor ward, ***observed and at least valid the following:*** skin disinfectant (I – 1625)

Quality standard	Quality domain	SPA service readiness measures		SPA item / definition (Item number)
			antiseptic	In delivery/labor ward, ***observed the following:*** disinfectant/antiseptics (I – 1651)
			medical mask	In delivery/labor ward, ***observed the following:*** medical masks (I – 1651)
			medical gowns	In delivery/labor ward, ***observed the following:*** gowns (I – 1651)
			eye protection	In delivery/labor ward, ***observed the following:*** eye protection [goggles or face protection] (I – 1651)
			waste receptacles	In delivery/labor ward, ***observed the following:*** waste receptacles (pedal bin) with lid and plastic bin liner (I – 1651)
			sharps container	In delivery/labor ward, ***observed the following:*** sharps container ("safety box") (I – 1651)
		Drugs	injectable antibiotics	In delivery/labor ward, ***observed and at least valid the following:*** injectable antibiotics (e.g., ceftriaxone) (I – 1625)
			syringe	In delivery/labor ward, ***observed the following:*** single-use standard disposable syringes with needles or auto-disable syringes with needles (I – 1651)
	Evidence-based management of complications (hemorrhage)	Guidelines	Safe blood and transfusion practice guidelines	In facility where blood is collected/stored/process/handled prior to transfusion, ***have and observed*** guideline/protocol/manual on appropriate use of blood and safe blood transfusion (I – 2724/2724)
		Equipment and supplies	blood available	In facility blood transfusion services available (I – 2700)
			blood screened	Is blood that is transfused in this facility screened, either in this facility or externally, for any infectious diseases prior to transfusion (I – 2710)
			blood stock-out	Has the facility run out of blood for more than one day anytime during the past 3 months (I – 2720)
		Drugs	injectable uterotonics	In delivery/labor ward, ***observed and at least valid the following:*** injectable uterotonics (e.g., oxytocin) (I – 1625)
			IV solution with infusion set	In delivery/labor ward, ***observed and at least valid the following:*** IV solution (ringer lactate) with infusion set (I – 1625)
Actionable information systems	Actionable information systems that record actionable information on CS	Infrastructure	HMIS reporting	Does this facility have a system in place to regularly collect health/family planning service, and if yes are maternal and newborn report completed monthly (***observed report***) (I-460/461)

Abbreviations: I Inventory questionnaire; HW Health worker interview

TABLE A2. HARMONIZING SPA AND DHS FACILITIES

Harmonized facility category	SPA facility category	DHS facility category
	Bangladesh	
Government hospital	Government district hospital	Government hospital
		Government district hospital
Government upazila facilities[1]	Upazila health complex	Upazila health complex
	Maternal and child welfare center	Upazila health and family welfare center
		Maternal and child welfare center
Non-CS facilities	Union health and family welfare center	Other Government sector
	Union health and family welfare center	Community clinic
	Union subcenter/rural dispensary	
	Community clinic	
NGO	NGO clinic	NGO clinic
	NGO hospital	Other NGO sector
Private hospital, clinic	Private hospital	Private hospital/clinic
	Haiti	
Government hospital	Government university hospital	Government hospital
	Government departmental hospital	Government maternity
	Government community hospital	
	Other government hospital	
Government health center	Government health center with bed	Government health center
	Government health center without bed	
Private hospital	Private university hospital	Private hospital/clinic
	Private departmental hospital	
	Private community hospital	
	Private hospital	
Private health center	Private health center with bed	Private health center
	Private health center without bed	
Mix hospital, health center[3]	Mix hospital	Mix hospital

Harmonized facility category	SPA facility category	DHS facility category
	Mix health center	Mix health center
		Mix maternity center
Dispensary	Dispensary	
	Malawi	
Government hospital	Central hospital	Government hospital
	District hospital	
	Rural/community hospital	
	Other hospital	
Government health center	Government health center	Government health center
	Government maternity health	Government health post
		Other Government sector
Private for-profit hospital, health center, clinic	Private hospital	Private for-profit hospital/clinic
	Private health center	
	Private clinic	
	Private maternity center	
Faith-based/NGO	Private not-for-profit hospital	Christian Health Association of Malawi (CHAM)/mission hospital
Faith-based/NGO, maternity	Private not-for-profit health center	CHAM/mission health center
	Private not-for-profit maternity	Banja La Mtsogolo (BLM)
	Private not-for-profit clinic	
	Nepal	
Government Hospital	Central government hospital	Government hospital
	Regional government hospital	
	Sub-regional government hospital	
	Zonal government hospital	
	District government hospital	
Government primary healthcare center	Government primary healthcare center	Government primary healthcare center
	Government health post	Government health center
Government health post, sub-post, other	Government sub-health post	Other government sector

Harmonized facility category	SPA facility category	DHS facility category
Private hospital	Private hospital	Private hospital
	Tanzania	
Government hospital	Government national referral hospital	Government national referral hospital
	Government regional hospital	Governmental regional referral hospital
	District hospital	Government regional hospital
	Government district-designated hospital	Government district hospital
	Other government hospital	
Government health center	Government health center	Government health center
Government dispensary	Government dispensary	Government dispensary
Private hospital, other	Private hospital	Private hospital
	Private health center	Private health center
	Private dispensary	Private dispensary
	Private clinic	Private clinic
Faith-based hospital	Religious national referral hospital	Religious national referral hospital
	Religious regional hospital	Religious district hospital
	Religious district hospital	Other religious hospital
	Religious district-designated hospital	
	Other religious hospital	
Faith-based center, other	Religious health center	Religious health center
	Religious other	Religious other

TABLE A3. DESCRIPTION OF DHS EXPOSURE MEASURES

	Exposure measure	Description
Country-level characteristics	Region	UN geographic regions
	Population-level CS	Calculated from DHS survey – percentage of live births in the 2 years preceding the survey delivered by CS
Health-facility level	Managing authority of place of delivery	Where did delivery occur of most recent (last) birth
Socio-demographic characteristics (women-level)	Age at birth	Calculated from child's date of birth and women's date of birth
	Highest education	Education attainment (years of education completed) for women 15–49 years old
	Self-reported problems accessing healthcare	Women who reported any of the following serious problems accessing healthcare for themselves when sick: ***(i)*** permission, ***(ii)*** getting money for treatment, ***(iii)*** distance to health facility, (***iv)*** not wanting to go alone
Socio-demographic characteristics (household-level)	Place of residence	Urban or rural (as defined by country)
	Wealth index	Composite measure of household assets, services, and amenities [45]
Obstetric history	Birth order	Number of births from first to last
	Previous CS	Calculated for the last reported birth based on answer to the question "was [NAME] delivered by cesarean that is, did they cut your belly open to take the baby out?" for next-to-last birth
Pregnancy	Number ANC	Women report the number of ANC visits attended
	Location of ANC visits	Women who reported that any of the ANC visits were at private, public, NGO, FBO, other facilities
Intrapartum	Emergency CS	Response for "when was the decision to have the cesarean section taken? Was it before or after labor pains started?" was "after"
Newborn characteristics	sex of baby	Male or female
	children of multiple birth	Asked if the birth of most recent child was a twin/triplet/multiple
	birthweight <2,500 grams	Weight of birth recorded from health card or recall

TABLE A4. CHECKLIST FOR REPORTING OF SURVEY STUDIES (CROSS)

Section/topic	Item	Item description	Reported on page #
Title and abstract			
Title and abstract	1a	State the word "survey" along with a commonly used term in title or abstract to introduce the study's design.	1
	1b	Provide an informative summary in the abstract, covering background, objectives, methods, findings/results, interpretation/discussion, and conclusions.	4–5 key findings`
Introduction			
Background	2	Provide a background about the rationale of study, what has been previously done, and why this survey is needed.	7–9
Purpose/aim	3	Identify specific purposes, aims, goals, or objectives of the study.	9
Methods			
Study design	4	Specify the study design in the methods section with a commonly used term (e.g., cross-sectional or longitudinal).	10
	5a	Describe the questionnaire (e.g., number of sections, number of questions, and number and names of instruments used).	10
Data collection methods	5b	Describe all questionnaire instruments that were used in the survey to measure particular concepts. Report target population, reported validity and reliability information, scoring/classification procedure, and reference links (if any).	10 (detailed reference provided)
	5c	Provide information on pretesting of the questionnaire, if performed (in the article or in an online supplement). Report the method of pretesting, number of times questionnaire was pre-tested, number and demographics of participants used for pretesting, and the level of similarity of demographics between pretesting participants and sample population.	not reported for secondary analysis of publicly available data (reference provided on 10)
	5d	Questionnaire, if possible, should be fully provided (in the article, or as appendices or as an online supplement).	question items in Appendix A1 and A3
Sample characteristics	6a	Describe the study population (i.e., background, locations, eligibility criteria for participant inclusion in survey, exclusion criteria).	10–13
	6b	Describe the sampling techniques used (e.g., single stage or multistage sampling, simple random sampling, stratified sampling, cluster sampling, convenience sampling). Specify the locations of sample participants whenever clustered sampling was applied.	10
	6c	Provide information on sample size, along with details of sample size calculation.	10
	6d	Describe how representative the sample is of the study population (or target population if possible), particularly for population-based surveys.	10

Section/topic	Item	Item description	Reported on page #
Survey administration	7a	Provide information on modes of questionnaire administration, including the type and number of contacts, the location where the survey was conducted (e.g., outpatient room or by use of online tools, such as SurveyMonkey).	10 (detailed reference provided)
	7b	Provide information of survey's time frame, such as periods of recruitment, exposure, and follow-up days.	10 (detailed reference provided)
	7c	Provide information on the entry process: –>For non-web-based surveys, provide approaches to minimize human error in data entry. –>For web-based surveys, provide approaches to prevent "multiple participation" of participants.	n/a
Study preparation	8	Describe any preparation process before conducting the survey (e.g., interviewers' training process, advertising the survey).	10 (detailed reference provided)
Ethical considerations	9a	Provide information on ethical approval for the survey if obtained, including informed consent, institutional review board (IRB) approval, Helsinki declaration, and good clinical practice (GCP) declaration (as appropriate).	16
	9b	Provide information about survey anonymity and confidentiality and describe what mechanisms were used to protect unauthorized access.	16
Statistical analysis	10a	Describe statistical methods and analytical approach. Report the statistical software that was used for data analysis.	15
	10b	Report any modification of variables used in the analysis, along with reference (if available).	10–16
	10c	Report details about how missing data was handled. Include rate of missing items, missing data mechanism (i.e., missing completely at random [MCAR], missing at random [MAR] or missing not at random [MNAR]) and methods used to deal with missing data (e.g., multiple imputation).	10–16
	10d	State how non-response error was addressed.	10–16
	10e	For longitudinal surveys, state how loss to follow-up was addressed.	n/a
	10f	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for non-representativeness of the sample.	10–16
	10g	Describe any sensitivity analysis conducted.	n/a
Results			
Respondent characteristics	11a	Report numbers of individuals at each stage of the study. Consider using a flow diagram, if possible.	16
	11b	Provide reasons for non-participation at each stage, if possible.	n/a

Section/topic	Item	Item description	Reported on page #
	11c	Report response rate, present the definition of response rate or the formula used to calculate response rate.	16–17
	11d	Provide information to define how unique visitors are determined. Report number of unique visitors along with relevant proportions (e.g., view proportion, participation proportion, completion proportion).	16–17
Descriptive results	12	Provide characteristics of study participants, as well as information on potential confounders and assessed outcomes.	16–54
Main findings	13a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates along with 95% confidence intervals and p-values.	38, 43–54
	13b	For multivariable analysis, provide information on the model building process, model fit statistics, and model assumptions (as appropriate).	38, 43–54
	13c	Provide details about any sensitivity analysis performed. If there are considerable amount of missing data, report sensitivity analyses comparing the results of complete cases with that of the imputed dataset (if possible).	n/a
Discussion			
Limitations	14	Discuss the limitations of the study, considering sources of potential biases and imprecisions, such as non-representativeness of sample, study design, important uncontrolled confounders.	56–57
Interpretations	15	Give a cautious overall interpretation of results, based on potential biases and imprecisions and suggest areas for future research.	55–57
Generalizability	16	Discuss the external validity of the results.	55–57
Other sections			
Role of funding source	17	State whether any funding organization has had any roles in the survey's design, implementation, and analysis.	57
Conflict of interest	18	Declare any potential conflict of interest.	n/a
Acknowledgements	19	Provide names of organizations/persons that are acknowledged along with their contribution to the research.	57

TABLE A5. DOMAIN-SPECIFIC CS-QRI CATEGORIZING BY LOW-, MEDIUM-, AND HIGH-QUALITY READINESS, BY COUNTRY AND HEALTH SECTOR, SPA SECONDARY ANALYSIS (N=5 COUNTRIES)

		Proportion of health facilities by domain-specific CS-QRI category						
Sector	Country	Physical resources			Human resources*		Information systems*	
		Low quality CS-QRI<0.8	Medium quality CS-QRI ≥0.8 to 0.99	High quality CS-QRI= 1.0	Low quality CS-QRI<0.8	High quality CS-QRI= 1.0	Low quality CS-QRI<0.8	High quality CS-QRI= 1.0
Public	Bangladesh	39%	45%	16%	87%	12%	13%	87%
	Haiti	42%	41%	17%	51%	49%	29%	71%
	Malawi	12%	52%	36%	67%	33%	9%	91%
	Nepal	38%	52%	10%	79%	21%	30%	70%
	Tanzania	47%	37%	16%	63%	37%	3%	97%
Private for-profit	Bangladesh	15%	54%	31%	92%	8%	74%	26%
	Haiti	21%	50%	29%	30%	70%	39%	61%
	Malawi	28%	26%	46%	100%	0%	91%	9%
	Nepal	25%	48%	27%	91%	9%	37%	63%
	Tanzania	17%	39%	44%	76%	23%	3%	97%
NGO/FBO	Bangladesh	43%	32%	25%	69%	31%	8%	92%
	Haiti	23%	23%	54%	54%	46%	46%	54%
	Malawi	4%	33%	63%	48%	52%	11%	89%
	Nepal	8%	76%	16%	75%	25%	26%	74%
	Tanzania	24%	39%	37%	66%	34%	4%	96%

*Given the number of items, CS-QRI for human resources and information systems can only be categorized by low and high quality.

Sector	Country	Proportion of health facilities by domain-specific CS-QRI category								
		CS decision-making			CS Infection prevention			CS complication management		
		Low quality CS-QRI<0.8	Medium quality CS-QRI ≥0.8 to 0.99	High quality CS-QRI= 1.0	Low quality CS-QRI<0.8	Medium quality CS-QRI ≥0.8 to 0.99	High quality CS-QRI= 1.0	Low quality CS-QRI<0.8	Medium quality CS-QRI ≥0.8 to 0.99	High quality CS-QRI= 1.0
Public	Bangladesh	89%	7%	4%	53%	36%	11%	53%	36%	11%
	Haiti	46%	39%	15%	39%	44%	17%	39%	44%	17%
	Malawi	31%	30%	39%	18%	61%	21%	18%	61%	21%
	Nepal	76%	13%	11%	19%	64%	17%	19%	64%	17%
	Tanzania	52%	29%	19%	51%	38%	11%	51%	38%	11%
Private for-profit	Bangladesh	98%	1%	1%	51%	35%	14%	51%	35%	14%
	Haiti	98%	0%	2%	46%	29%	25%	46%	29%	25%
	Malawi	73%	18%	9%	64%	27%	9%	64%	27%	9%
	Nepal	99%	1%	0%	52%	45%	3%	52%	45%	3%
	Tanzania	90%	6%	4%	57%	25%	18%	57%	25%	18%
NGO/FBO	Bangladesh	67%	19%	14%	15%	53%	32%	15%	53%	32%
	Haiti	69%	23%	8%	8%	46%	46%	8%	46%	46%
	Malawi	41%	22%	37%	7%	52%	41%	7%	52%	41%
	Nepal	100%	0%	0%	25%	67%	8%	25%	67%	8%
	Tanzania	65%	21%	14%	31%	50%	19%	31%	50%	19%
Mixed	Haiti	89%	7%	4%	53%	36%	11%	53%	36%	11%