Series:
Who cares for women? Towards a greater understanding of maternal and reproductive healthcare markets

Journal: Tropical Medicine & International Health

Title:
Role of the private sector in childbirth care: cross-sectional survey evidence from 57 low- and middle-income countries using Demographic and Health Surveys

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Abstract

Objective
Maternal mortality rates have decreased globally but remain off-track for Millennium Development Goals. Good-quality delivery care is one recognised strategy to address this gap. This study examines the role of the private (non-public) sector in providing delivery care and compares the equity and quality of the sectors.

Methods
The most recent Demographic and Health Survey (2000-2013) for 57 countries was used to analyse delivery care for most recent birth among >330,000 women. Wealth quintiles were used for equity analysis; skilled birth attendant (SBA) and caesarean-section rates served as proxies for quality of care in cross-sectoral comparisons.

Results
The proportion of women who used appropriate delivery care (non-facility with SBA or facility-based births) varied across regions (49%-84%), but wealth-related inequalities were seen in both sectors in all regions. One-fifth of all deliveries occurred in the private sector. Overall, 36% of deliveries with appropriate care occurred in the private sector, ranging from 9%-46% across regions. Presence of a SBA was comparable between sectors (≥92%) in all regions. In every region, caesarean-section rate was higher in the private compared to public sector. The private sector provided between 13% (Latin America) and 66% (Asia) of caesarean-section deliveries.

Conclusion
This study is the most comprehensive assessment to date of coverage, equity and quality indicators of delivery care by sector. The private sector provided a substantial proportion of delivery care in low- and middle-income countries. Further research is necessary to better understand this heterogeneous group of providers and their potential to equitably increase the coverage of good-quality intrapartum care.

Introduction

Recent estimates suggest that despite an acceleration in the reduction of maternal mortality since 2000, more than a quarter of a million lives were lost to maternal mortality in 2011 [1]. Over 98% of these deaths occurred in low- and middle-income countries (LMICs), and maternal mortality is an off-track Millennium Development Goal (MDG). One of the strategies posited to improve women's survival is ensuring that deliveries are attended by skilled birth attendants, which usually happens in health facilities [2,3]. Providing effective intrapartum care, based on a strategy of having these skilled birth attendants conduct deliveries in primary-level institutions (health centres) with access to referral-level facilities, could be an efficient approach to reducing maternal mortality and morbidity [4]. It will also make a critical contribution to reducing the 2.9 million neonatal deaths that occur each year [5]. In practice however, the proportion of deliveries attended by skilled personnel in LMIC regions is reported to have increased only moderately from 55% in 1990 to 66% in 2011 [6]. Moreover, skilled birth attendant coverage was the most inequitably distributed indicator among twelve key maternal, newborn and child health interventions outlined in an analysis of 54 countries [7]. Strategies aiming to effectively and sustainably reduce maternal mortality and morbidity will need to address inequalities in women's access to quality reproductive and maternal care as well as ensure good quality of such care [8].

The role of private-sector providers in delivering reproductive and maternal services has recently received increased attention [9]. The private sector includes a group of providers whose diverse organisational character (formal, informal, facility-based, home-care providers), ownership and management structures, commercial nature (for-profit, not-for-profit), affiliations (faith-based [FBO], non-governmental [NGO], humanitarian), and interface with the public sector are not well understood [10,11]. Specifically, it is important to establish whether and how the private sector contributes to coverage of good-quality delivery care and reduction in inequalities in this coverage [12].

We identified 23 studies which assessed the private-sector provision of delivery services across more than two LMICs (Web Material 1) [13]. These studies included between 3 and 56 countries; the most comprehensive was a report by Gwatkin et al [14] which only looked at broad sector categories and consisted of tabulations without discussion. Most studies examined levels of use by sector with some effort to differentiate between private for-profit, FBOs and NGOs. Some assessed inequalities in private delivery care utilisation and its content (caesarean-section rates and birth attendance); however none considered these dimensions together. Looking at both of these dimensions and adopting a more nuanced approach to defining and disaggregating private providers of delivery care would allow for a more comprehensive assessment of the role of the private sector in providing delivery care and a greater understanding of inequalities in coverage and quality of private sector care relative to the public sector.

The main objective of this study is to use the most recent population-level data from a wide variety of LMICs to examine the role of private-sector providers in the provision of appropriate delivery care services among women who had a birth in the recall period, as described previously [13]. Second, we examined the typology of private-sector delivery providers and analysed the characteristics of private-sector delivery care. In contrast to antenatal care [15], the DHS surveys contain few questions with which to assess delivery care quality. In our third objective, we used the type of birth attendant and caesarean-section rates as proxies for judging quality of care. Within all three objectives, equity analysis based on quintiles of the DHS wealth score was conducted, comparing between public- and private-sector delivery care.

Methods

Data

We used the most recent available Demographic and Health Surveys (DHS) dataset for each country which conducted a DHS survey between 2000 and mid-2013. The DHS are cross-sectional nationally-representative household surveys and use model questionnaires which are adapted to each country's circumstances. Their sampling design is based on a multi-stage cluster strategy, which must be accounted for in statistical analyses. The resulting dataset contained 57 countries (Supplementary Material 1) from four geographic regions: Sub-Saharan Africa, North Africa/West Asia/Europe, South/Southeast Asia and Latin America & the Caribbean. For simplicity, in the remainder of this paper we refer to these as Sub-Saharan Africa, Middle East/Europe, Asia, and Latin America. These regions were constructed based on a classification of countries by MeasureDHS, following other analyses of DHS data [16]. Data are generally based on the self-reports of women in reproductive age (15-49 years)

Population

All women aged 15-49 with a live birth in the survey recall period were included in the analysis; delivery care for the most recent birth in the recall period was examined. In previous work, we describe these as women in need of delivery care services [13]. The recall period was five years in all countries except in Vietnam (three years), and Colombia and Peru (one year). We decided to analyse circumstances for the most recent birth to provide comparable data to our antenatal care analysis in this Series [15] and to characterise most recent levels of delivery care.

Indicators and Definitions

Service use

We considered women to have received an appropriate service type (i.e., met need for appropriate services) if their care complied broadly with what is understood to be an effective service. According to our definition, appropriate delivery care service was received if women delivered at home or in another non-facility location with a skilled birth attendant, or if they delivered in a health facility. However, we do not wish to imply that the actual care was necessarily appropriate in terms of quantity or content. Women delivering in a non-facility environment without a skilled birth attendant were considered to have used a suboptimal service type and therefore had unmet need for delivery care (Table 1).

Delivery attendant

Women listed all people who assisted with the delivery. If multiple cadres of delivery attendants were present at delivery, we considered the person with the highest level of qualification. To retain as much detail about the qualification of the delivery attendant as possible, we constructed eleven categories (Table 2). We used published literature to place medical professionals from each country in the relevant category, given the lack of comparability in job titles across countries. Three of these categories (doctor, nurse/midwife and auxiliary midwifery staff) were considered to be skilled birth attendants (SBA) in our categorisation, while the remaining categories of attendants were not. This corresponds with the World Health Organisation definition of skilled delivery care as "accredited health professional – such as a midwife, doctor or nurse – who has been educated and trained to proficiency in the skills needed to manage normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns" [17]. Although doctors may not have received obstetrics/midwifery training, they are likely to be able to handle complicated deliveries and caesarean-sections. Midwives and nurse-midwives usually have certified or accredited midwifery training, which may or may not include medical or nursing training beyond midwifery skills. Our categorisation also included nurses, who may have completed nursing but not midwifery training, and may not have skills in birth attendance. However, as nurses and midwives are often grouped together in DHS datasets despite having different qualifications in various countries, we could not separate them in this analysis. Auxiliary midwifery staff make up the third category of skilled birth attendants, and were only considered as skilled in certain countries, according to WHO definitions [18]. In countries where auxiliary midwifery staff are not considered skilled, they were grouped with the traditional birth attendant category [19]. All other persons attending deliveries were not considered to be skilled birth attendants and were categorised into the following groups, reflecting their qualification in descending order: auxiliary staff, traditional birth attendants (TBA), community health workers (CHW), traditional practitioners, general

facility staff, husband/friend/relative, others, and no-one. Not all eleven categories of delivery attendants existed in all 57 included countries.

Classification of sector of delivery (public or private)
We divided deliveries with an appropriate service type into those delivered at locations for which sector was known (classifiable sector) and those without information on provider sector (unclassifiable sector), Table 1. Women who indicated they had home-based skilled birth attendant delivery care had an unclassifiable sector of provision. Among deliveries with a classifiable sector, we divided providers into the public or the private sector. Public-sector delivery locations were those occurring in public, government or social security health facilities. Private-sector locations were those occurring in facilities outside the public sector, further divided into five provider categories: private facilities, private health professionals, FBO facilities, NGO facilities, and other private facilities (Table 1). Some countries had a category error in the response options whereby women could respond "private doctor", "private nurse", "private midwife", or "private professional" to the question on *where* they delivered, making the actual location of care unknown, while sector was known [20]. Not all five private-sector provider categories existed in all 57 countries.

Mode of delivery
Women were asked whether they delivered by caesarean-section. Caesarean-section births reported by women who delivered in a home environment were recoded as normal deliveries, regardless of who assisted with the delivery. This approach has been used previously [21-23]. Caesarean-sections that were reported in facilities, but where the highest level of delivery attendant was reported as general facility staff (e.g., patient attendant or sanitary), husband/friend/relative, other person or no one, were recoded as missing the mode of delivery.

Equity
Asset ownership grouped into five equally sized groups (wealth quintiles) is a common method used to classify household socio-economic position within countries. We used these DHS wealth quintiles where available and constructed our own based on DHS methodology [24] when needed. Different component variables and cut-offs are applied in each country and therefore wealth quintiles are not comparable between countries on an absolute level.

Missing data
All analyses were conducted on the 99.5% of the sample of women with births in the recall period that had non-missing values in the three main indicator variables (delivery location, delivery attendant, and mode of delivery). The treatment of missing delivery location, suboptimal service type, and locations with unclassifiable sector is detailed in Table 1.

Construction of regional and overall summary measures
Women in each DHS survey have an individual sample weight that is used to calculate country-level representative summary statistics. We also calculated region-level and overall (combining the 57 countries) summary statistics by applying weights that accounted for both country-specific survey design and country population, to ensure that estimates are representative of the population residing in study countries (Supplementary Material 2). To capture the extent of variability, we report ranges and medians across the included countries. Analyses were conducted in Stata/SE v13.

Ethical approval
The DHS received institutional review centrally (ICF International) and approval by every participating country. This study was approved by the Research Ethics Committee of the London School of Hygiene and Tropical Medicine, UK.

Results

We analysed data from 57 countries, which represented a total population of 3 billion people. There were 30 countries in the Sub-Saharan Africa region, nine in the Middle East/Europe region, ten in the Asia region, and eight in the Latin America region. The included countries represented 83%, 29%, 88%, and 20% of the populations of these four regions, respectively. The combined sample consisted of 865,547 women aged 15 to 49 years old, 337,208 of whom had a live birth in the recall period and constituted our analysis sample. The countries, year of survey, recall period and sample

characteristics are in Supplementary Material 1. Across the 57 countries, we identified 50 unique delivery locations and 91 unique types of delivery attendant (including 'no one').

Panel A of Figure 1 shows the regional distribution of all women surveyed in the included countries according to their need for delivery care in the recall period. The proportion of women with a birth in the recall period was higher in the Sub-Saharan Africa region (53%) compared to the remaining three regions (35% in Middle East/Europe, 36% in Asia and 32% in Latin America). Among women in need of delivery care, there were large regional differences in the proportion of women who used an appropriate service type (Figure 1B) – ranging from 49% in Sub-Saharan Africa and Asia, to 79% in Latin America and 84% in Middle East/Europe (Table 3). Among users of appropriate service type, the proportion that delivered in the private sector varied between regions from a low of 9% in Latin America, 20% in Sub-Saharan Africa, 31% in Middle East/Europe, and 46% in Asia (Figure 1C), and 36% overall.

Figure 2 is a scatter plot of each country according to the proportion of all births using appropriate service type and the proportion of births with appropriate service type occurring in the private sector. It shows that countries with high proportions of all deliveries with appropriate service type generally have smaller proportions of these deliveries occurring in the private sector. However, within each of the four regions, the levels and ranges of these two indicators differed markedly by country. The Sub-Saharan Africa region showed the widest range of proportions of births delivered with appropriate service type, from 12% in Ethiopia to 93% in Gabon. The proportion of appropriate service type deliveries occurring in the private sector ranged between <1% in Sao Tome and Principe to 42% in Swaziland. The lowest proportion of deliveries occurring with appropriate service type in the Middle East/Europe region was in Morocco (65%) and several countries approached the 100% mark (Albania, Armenia, Jordan, Moldova, and Ukraine). Most of the countries in this region had a relatively small private sector, except for Jordan and Egypt, where the proportion of appropriate service type deliveries occurring in the private sector was 35% and 57%, respectively. In the Asia region, the proportion of deliveries using appropriate service type ranged from 33% in Timor-Leste to 97% in the Maldives. This region had the largest variability between countries in private sector's share of appropriate service type deliveries, ranging from Timor-Leste (2%) to Pakistan (60%). The Latin America region had a relatively high proportion of deliveries with appropriate service type (79%). Haiti was the only country in this region where less than half of all deliveries used appropriate service type (41%), and it also had the largest private sector in the region (accounting for 27% of appropriate service type deliveries). Colombia had the lowest proportion of appropriate service type deliveries occurring in the private sector (<1%) in this region.

Wealth-based inequalities in appropriate service type were present in all four regions in both the public and the private sectors (Figure 1B). The proportion of women using appropriate service type who delivered in a location with unclassifiable sector (largely home deliveries with SBA) ranged from 4% (Latin America) to 17% (Asia), and this proportion was highest among women in the poorest quintile in each region (Figure 1C). The proportion of women who used appropriate service type who delivered in the private sector was higher among women in the richest quintile compared to the poorest in each region.

Understanding private sector delivery care

We characterised private-sector providers to the extent possible based on the response coding in the DHS (Table 1 and Figure 1D). Private facilities (i.e., private hospital, clinic, health centre) constituted the majority of the private-sector deliveries reported by women in Sub-Saharan Africa (79%), Asia (83%) and Latin America (88%), but not in Middle East/Europe (44%). In Sub-Saharan Africa, FBOs were the second largest provider of private-sector delivery care (19%), although only nine of the 30 countries in this region had response options listing FBO providers. Other than in Sub-Saharan Africa, NGOs and FBOs together provided a very small proportion of private-sector delivery care (accounting for 5% of private-sector delivery care overall).

The category of private health professionals (actual location of delivery unknown) provided the majority of private-sector delivery care in the Middle East/Europe region (53%), although this provider category was reported by women in only two of the nine countries in this region - Egypt and Turkey. Private health professionals were also an important private-sector delivery care category in Asia (14% of private sector), largely driven by Indonesia. The country ranges and medians (Table 3) show a wide variation in the most important private-sector provider category. In each region, the country with

the highest private-sector share of deliveries with appropriate service type had a different category of private provider: Swaziland (FBOs), Egypt (private health professional – doctors), Indonesia (private health professional – nurse/midwives), and Haiti (private facilities).

Characteristics of delivery care provided by the private sector

i. Delivery attendant

To address the third objective of assessing quality of delivery care, we compared the type of care and sector of deliveries in each region (Figure 3). Among deliveries with suboptimal service type, larger proportions of deliveries in Middle East/Europe and Asia occurred with a TBA or CHW than in Sub-Saharan Africa and Latin America. In all regions, the majority of deliveries in unclassifiable locations were assisted by a nurse/midwife. The proportion of women who were assisted by a skilled birth attendant was high (≥92%) among appropriate service type births occurring in both the public and private sectors. The majority of both public and private sector deliveries in Sub-Saharan Africa were assisted by a nurse/midwife (66% and 59%, respectively). The majority of deliveries in both sectors in the remaining three regions were assisted by a doctor.

Figure 4 shows the delivery attendant for births by service type and sector for the aggregate of 57 countries, disaggregated by women's wealth quintile. In the public sector, the percentage point difference in having a skilled birth attendant was 5 between the poorest and richest wealth quintiles (93% in poorest and 98% in richest) compared to a 2 percentage point difference in the private sector (97% in poorest and 99% in richest). The proportion of births to women in the poorest quintile attended by a doctor was higher in the private sector than in the public sector (63% and 45%, respectively).

ii. Caesarean-section deliveries

We compared caesarean-section rates within each region between the public and private sector. Figure 5 displays the caesarean-section rates among all deliveries, all deliveries with appropriate service type, deliveries in providers with classifiable sector, public-sector deliveries, and private-sector deliveries. The proportions of all births delivered by caesarean-section ranged from 4% in Sub-Saharan Africa to 24% in Latin America. In all four regions, the caesarean-section rate was higher in the private than in the public sector. The percentage point difference in caesarean-section rates between the two sectors was smallest in Sub-Saharan Africa (2) and widest in Middle East/Europe (21). We examined the caesarean-section rates within the private sector among provider categories with a sample of >100 births in a given region. Figure 6 shows that in all regions except Sub-Saharan Africa, the highest caesarean-section rates of the private sector occurred in the private facilities category. In Sub-Saharan Africa, rates in FBOs were slightly higher than those in private facilities. In Latin America, caesarean-section rates in FBOs were lower than in private facilities (31% and 49%, respectively). Caesarean-section rates in the category of private health professionals were higher in the Middle East/Europe (37%) compared to Asia region (6%).

Analysis of inequalities in caesarean-section rates showed that in every region, the overall caesarean-section rate increased with rising wealth quintile (Figure 7A). Figure 7B shows that a wealth-based gradient in caesarean-section rates among deliveries with appropriate service type existed in all regions, although it was less steep than the gradient in caesarean-section rate for all deliveries. Sub-Saharan Africa had both the lowest caesarean-section rates and the flattest wealth gradients in these two indicators. Figures 7C and 7D examine the wealth quintile-specific caesarean-section rates by sector. In Sub-Saharan Africa, public and private sectors showed comparable levels and gradients in caesarean-section rates. Among women from the poorest wealth quintile in the Middle East/Europe region, the caesarean-section rate was twice as high in the private (33%) compared to the public sector (17%). Within the poorest quintile of women in the Asia region, the caesarean-section rate was higher in the private compared to the public sector, and the gradient across quintiles was steeper in the private sector. Among women from the poorest wealth quintile in Latin America, the caesarean-section rate was comparable between the sectors, but among the richest wealth quintile, women delivering in the private sector had a substantially higher caesarean-section rate (55%) than in the public sector (38%). Figure 8 shows the caesarean section deliveries, among all women and by wealth quintile, according to which sector provided them. In Middle East/Europe and Asia, the private sector provided approximately half or more of all caesarean sections (49% and 66%, respectively). The percentage of caesarean sections performed in the private sector was 23% in Sub-Saharan

Africa and 13% in Latin America. In all regions, a larger percentage of caesarean sections provided to richest women was obtained in the public sector than caesarean sections to poorest women.

Discussion

In this paper, we used nationally-representative surveys collected since 2000 from 57 LMICs to describe the character and role of the private sector in providing delivery care in four world regions. Overall, we found that one-fifth of all deliveries and two-fifths of deliveries with a classifiable sector occurred in the private sector. The four regions varied in the proportions of all births occurring with appropriate service type, and in those occurring in the private sector. The majority of appropriate service type deliveries in Sub-Saharan Africa, Middle East/Europe and Latin America regions occurred in the public sector. Asia was the only region in which the majority of appropriate service type births occurred outside of the public sector (in either unclassifiable locations or in the private sector). The proportion of deliveries occurring with appropriate service type was higher among the richest than the poorest in all four regions, a pattern which held for both public- and private-sector facility deliveries. Private facilities and private health professionals accounted for the majority of private-sector deliveries, and the contribution of NGOs and FBOs was low. The proportions of deliveries assisted by a skilled birth attendant were similar by sector. In every region, caesarean-section rates increased with women's wealth quintile and were higher in the private sector. The proportion of caesarean-sections provided by the private sector across the four regions ranged from one-tenth to two-thirds.

As with most secondary-data analyses, our study has limitations. First, not all countries in the four regions had a DHS. In Latin America and the Middle East/Europe regions, only about one-third of the regions' populations were included in our analyses. However, in the regions with the highest global maternal mortality ratios – Sub-Saharan Africa and Asia – population coverage was above 80% [25]. Second, the analyses relied on women's recall of their delivery circumstances, information which is rarely validated. Complexities of provider types (such as private doctors practicing in public hospitals or franchised by an NGO) were unlikely to be captured via women's reports, nor did we expect most women to know or recall the exact qualification of their birth attendant [26]. Finally, the DHS did not collect the sector of practice for professionals assisting home births (e.g., doctors or midwives) and in some countries, the provider categories included a type of birth attendant (e.g., a private health professional) rather than a location (e.g., private hospital) as a valid response option [20]. Our estimates may have therefore underestimated private-sector provision, by between 3-8% across the four regions. On the other hand, despite these limitations, this is the most comprehensive study to date (in terms of numbers of LMICs included) to assess various indicators of coverage, equity, and elements of quality comparatively between public- and private-sector delivery care. We also went beyond others in categorising the sector of provision and the delivery attendants (based on several sources of information on qualifications on a country-by-country basis [20]).

Our analysis showed the coverage level of private sector in delivery care for each region as well as overall for the 57 countries. The extent of reliance on the private sector for delivery care is less than suggested by some advocates of private sector provision, but is nonetheless substantial [27]. Assessment of the importance of the private sector depends in part on whether it is expressed as a percentage of all deliveries, in which case the coverage is 19% overall (ranging from 7% in Latin America to 26% in Middle East/Europe), as a percentage of deliveries with appropriate service type, in which case the coverage is more substantial at 36% overall (ranging from 9% in Latin America to 46% in Asia), or as a percentage of classifiable sector deliveries, where the private-sector contribution ranged from 9% in Latin America to 56% in Asia. Three other studies constructed regional averages, two of which present regional estimates of private-sector deliveries [14,28]. The only study which weighted country-level coverage by population presented private-sector use by wealth quintile, but not overall [16]. In geographic regions where we could compare, we found that the proportion of all deliveries occurring in private facilities in Sub-Saharan Africa was 10%, whereas Yoong et al estimated this to be 7.7% (weighting unclear) and Gwatkin et al 2007 at 6.1% (unweighted). Gwatkin et al also estimated this proportion for all included countries (8.2%), compared to our estimate of 19%. Our coverage levels are not expected to match those of others, because we differ in the countries included, the approach to producing regional estimates, the survey dates, and the classification of sector. None of the identified studies estimated coverage of private sector as a proportion of deliveries with appropriate service type, regionally or overall. We were the first multi-country study that

went beyond the categories of home, public and private to define appropriate service type according to location and attendant, and to comprehensively classify all delivery locations, though previously Kagawa and colleagues examined faith-based provision [29]. Our results confirmed that the proportion of private delivery care provided by NGOs and FBOs was surprisingly small (0.9% of all deliveries), and substantial only in Sub-Saharan Africa (1.9% of all deliveries, primarily FBOs). A previous study in 31 countries found FBOs provided 2.5% of delivery care, but did not specify whether this was a proportion of all deliveries or only facility deliveries, had coding errors, and included different countries [29]. We also showed inequalities between wealth quintiles in the proportion of all deliveries occurring with appropriate service type in all four regions. These findings agree with an analysis in 45 countries that found public- and private-sector use was lower among poorer women and that the poor-rich gradients were larger in private facilities [30], as well as with other studies that examined equity [14,16,31-35].

Our proxies for assessing quality of care examined whether deliveries were attended by skilled birth attendants and compare their caesarean-section rates, none of which had previously been examined by sector across regions. The global maternal health strategy aims to ensure all women are assisted by a skilled birth attendant [36]. The proportions delivering with a skilled birth attendant were comparable across public and private sectors. We found a higher proportion of private- compared to public-sector deliveries were assisted by doctors in three regions. A previous analysis in three Sub-Saharan African countries noted more obstetrician/gynaecologist deliveries in NGO/FBO facilities than in government facilities, but showed that comparable proportions delivered by nurse/midwives [37]. Four out of six Asian countries analysed by another study had a higher proportion of births in the private sector attended by a doctor; the proportion attended by a combined doctor/nurse/midwife attendant was lower in the private sector in three countries and comparable to the public sector in the other three [35].

Caesarean-sections save lives of women and newborns, but can be unnecessarily instigated by women or providers in which case they are an indicator of poor quality. While studies report a strong inverse association between caesarean-section rates and maternal, infant and neonatal mortality rates in high-mortality contexts [38-40], optimal caesarean-section rates remain controversial. Betran and colleagues estimated that 15% of births globally occurred by caesarean-section, ranging from a low of 3.5% in Africa to a high of 29.2% in Latin America and the Caribbean [38]. Countries may have reasonable population-level caesarean-rates that mask subpopulations of women who get too many or too few caesarean-sections [41]. We compared rates by sector and found those in the private sector exceeded those in the public in all regions. Previous analyses in Latin American countries [22,42] and in three of five Arab countries reported similar findings [23]. Two studies demonstrated large socio-economic inequalities in caesarean-sections [21,41]. Our analysis by sector showed that both sectors had lower caesarean-section rates among poor compared to rich women and that this inequality was wider in the private sector. This may be due to a different case-mix between the sectors. The private sector provided a substantial proportion of caesarean sections in each region. In their analysis of three sub-Saharan African countries, Vogel et al noted that NGO/FBO facilities had higher caesarean-section rates than government facilities, but that women delivering in these facilities had consistently more ANC complications [37]. It would be important to examine the extent to which women with complications are more or less likely to deliver in private-sector facilities, and how this varies across countries and regions. The general literature indicates that private-sector providers may seek to avoid patients with complications [43].

A debate on “whether private health care is the answer to the health problems of the poor” raises many points salient to the provision of delivery care [44]. Smith and colleagues stated that the private sector is a significant actor in health care and cannot be ignored. We confirm this to be the case for delivery care. Moreover, when characterising the nature of private health services, Hanson and colleagues observed that “[p]rivate health services range from sophisticated inpatient facilities delivering advanced medical care of the highest international standard, through to the individual practices of doctors, nurses, and midwives, sometimes working in parallel with their public practice, and to unqualified peddlers of drugs from market stalls.” They went on to say that “[w]hat evidence there is suggests that poor people are more likely to use the lower-quality, highly dispersed, and fragmented end of this spectrum.” Our findings are also in line with these general observations. In particular, we found that pro-rich inequalities exist and that there was a large variation in the range of private providers. While the level of SBA was comparable across sectors, attendants in the private sector were more likely to be doctors for the rich, and unskilled attendants for the poor. The

caesarean-section rates above 30% observed in Middle East/Europe and Latin America regions likely reflect unnecessary interventions, and there is evidence to suggest that these are being differentially provided to the rich and higher in the private sector. A substantial literature elucidates how private providers are incentivised to overperform caesarean-sections either because they are financially more lucrative, because they can be conveniently scheduled, or because of women's demands for care from the same individual [45-47].

An ecological study of Sub-Saharan African countries correlated the level of private-sector participation with increased use of health care facilities and found a positive association, leading the authors to conclude that greater private sector participation is associated with better access and equity outcomes without harmful effects [28]. The positive correlation seen is unsurprising because private sector participation is a subset of total participation, and we therefore remain unconvinced by their conclusions. When we correlated the proportion of appropriate service type deliveries occurring in the private sector with the overall proportion of deliveries with appropriate service type, we found that counties with higher appropriate service type coverage tended to have fewer of these deliveries occurring in the private sector. However, more sophisticated, context-specific and adjusted analyses are needed to disentangle whether and how the private sector contributes to universal coverage. In order for the private sector to increase overall coverage, it will either need to reach those who are currently receiving suboptimal delivery care or substitute for women currently receiving public services, thereby freeing up public services to serve women not receiving appropriate service type. In either case, there are challenges, because such women are likely to be the most difficult to reach, the most rural and the poorest. Such features do not incentivise the commercial private sector, which has to make a substantial investment in infrastructure and staffing while making a return on investment. In many countries, the public and non-commercial (FBOs, NGOs) private sectors also find it difficult to serve such women.

In conclusion, this is the most comprehensive analysis of the private-sector role in providing delivery care to date. A significant proportion of women in LMICs seek delivery care in the private sector. It is therefore imperative to fully engage with the diverse array of providers in the private sector in order to promote quality intrapartum care, which is inextricably linked with achieving the Sustainable Development Goals and universal health coverage.

Contributors
OC had the initial idea and obtained funding for the study. OC and LB designed the study. LB, DM, KF, CL and OC contributed to constructing the dataset. LB and DM conducted the statistical analysis. All authors contributed to the interpretation of findings and writing of the manuscript. All authors have seen and approved the final version of the paper.

Funding
The research in this publication was supported by funding from Merck Sharp & Dohme Corp. ("MSD"), a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ USA, through its MSD for Mothers program. Funding was used for general financial support, including staff salaries, travel, and overhead. MSD had no role in the design, collection, analysis and interpretation of data, in writing of the manuscript, or in the decision to submit the manuscript for publication. The content of this publication is solely the responsibility of the authors and does not represent the official views of MSD.

Conflict of interest
None declared.

Acknowledgements
We thank our funders for their continued support. We acknowledge the Measure Demographic and Health Surveys Program for making the DHS data from 57 countries accessible, and thank the women who participated in these surveys.

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Figure 3. Highest level of delivery attendant for most recent birth, by sector and region

Figure 4. Highest level of delivery attendant for most recent birth, by sector and wealth quintile

Figure 5. Proportion of births delivered by caesarean-section, by sector and region

Figure 6. Proportion of births delivered by caesarean-section in the private sector, by provider type and region

Figure 7. Proportion of births delivered by caesarean-section, by wealth quintile and region

Figure 8. Deliveries by caesarean section in classifiable providers, by sector and region

Web Material 1. Characteristics of studies which looked at delivery care across multiple low- and middle-income countries

Author, Year	Countries, time period, data source, construction of averages	Population, recall period and analysis sample	Sector definitions	Delivery attendant by sector	Mode of delivery by sector	Equity analysis by sector	Main findings related to delivery care by sector
Berman & Rose, 1996 [48]	4 countries (Bolivia, Indonesia, Morocco, Tunisia), 1987-1991 Data: DHS. Overall averages not constructed.	All live births in 5 years before survey, Ever-married women 15-49.	**Public:** public clinics and hospitals **Private:** private clinics and hospitals, pharmacies(unless otherwise specified in survey) **Other:** traditional providers, others. Relied primarily on classification adopted by each country	None	None	Residence: urban or rural. Mother's education: none, primary, secondary, or higher. Mother's current employment: working or not working.	**Sector within all deliveries:** In 3 countries, home births accounted for >60% of all deliveries. In Tunisia, the reverse was true (68% in facilities). The range of proportions of all deliveries occurring in the private sector was 4.5% (Tunisia) to 11.5% (Indonesia). **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** Urban residence, higher levels of education and current employment were associated with higher levels of private sector use (data not shown).
Belizan et al, 1999[22]	19 countries in Latin America, 1990-1997 Data: several sources including DHS and Ministries of Health. Overall averages not constructed.	Population unclear - several sources of data. Recall for DHS, period not stated; 1 year for facility statistics Birth-based analysis.	**Public/social security**: free of charge. **Private**: charge fees directly or through insurance.	None	Caesarean-section rates compared in private and public hospitals in 6 countries.	None	**Sector within all deliveries:** Not examined. **Sector within facility deliveries:** Not examined. **Mode of delivery by sector:** In the six countries where rates between public and private hospitals could be compared, the caesarean section rate in the private sector was higher.
Bell et al, 2003 [31]	6 countries (Bangladesh, Bolivia, Ghana, Indonesia, Malawi, Philippines). 1987-2000, time trends. Data: DHS. Overall averages not constructed.	Recall <3 years. Birth-based analysis.	**Government**: government hospital, government health centre. **Private**: Private hospital/health centre, other health facility. **Domiciliary**: Outside of health facility.	Not by sector	Not by sector	Residence: urban or rural.	**Sector within all deliveries:** In the most recent surveys, health-facility deliveries were highest in Bolivia (55.9%) and lowest in Bangladesh (8.6%). Largest proportion increase was in Bolivia, but was also significant in Bangladesh and the Philippines. On most recent surveys, the proportion of all deliveries in the private sector ranged between 3.9% in Bangladesh and 19.9% in Bolivia. **Sector within facility deliveries:** On the most recent surveys, the majority of facility deliveries occurred in government facilities, except for Indonesia. **Equity of sector within all deliveries:** Proportion of all deliveries occurring in health facilities was higher in urban compared to rural areas, by a factor of 3 (Indonesia), 5 (Bangladesh) and around 2 in the other countries. The increase in facility delivery in rural areas in all countries over the time period was attributable to increase in the use of government sector facilities, except for in the Philippines.
Brugha & Pritze-Aliassime, 2003[32]	5 LMICs, one from each WHO region (Brazil, Egypt, India, Indonesia, Kenya), 1992-1998. Data: most recent	Not specified. Birth-based analysis	**Public:** public facility **Private**: DHS categories, private is outside the direct control of the state, on a for-profit or	Not by sector	None	Wealth quintiles, poor/rich ratio, urban richest quintile, rural richest quintile.	**Sector within all deliveries:** Between 10-15% of all deliveries took place in private facilities. **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** Wealthier women were more likely to deliver in private facilities in all countries and more likely to deliver in public facilities in four countries.

Author, Year	Countries, time period, data source, construction of averages	Population, recall period and analysis sample	Sector definitions	Delivery attendant by sector	Mode of delivery by sector	Equity analysis by sector	Main findings related to delivery care by sector
	DHS. Overall averages not constructed.		non-profit basis. **Home**: not defined				Poor/rich ratio for private delivery ranged from 0.026 (Indonesia) to 0.146 (Kenya). Public delivery poor/rich ration ranged from 1.238 (Brazil) to 0.161 (Indonesia). In the four countries where estimates were produced, the proportion of urban richest quintile of women that used public delivery facilities was higher that rural richest quintile in three (Kenya, India, Egypt) and comparable in one (Indonesia). In the same four countries, the proportion of women from urban richest quintile delivering in private facilities was higher than in rural richest quintile in India, Egypt and Indonesia, and comparable in Kenya.
Gwatkin et al, 2004 [49]	51-56 countries. Years not stated. Data: DHS. Unweighted average of all countries.	Not stated.	**Public**: not defined **Private**: includes advanced facilities or providers, traditional healers, pharmacies, untrained village midwives, non-governmental not-for-profit.	None	None	Wealth quintiles: Lowest quintile, High-low ratio.	**Sector within all deliveries:** Not examined. **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** Among women in the lowest wealth quintile, approximately 27% of deliveries occurred in public facilities and about 2.5% in private facilities. **Equity of sector within facility deliveries:** The ratio of coverage with facility-based attended delivery between the richest and poorest wealth quintiles was around 2 for public and nearly 8 for private services.
Jurdi & Khawaja, 2004[23]	18 Arab countries, 1993-2001. Data: DHS, Palestine Central Bureau of Statistics, PAPCHILD/ PAPFAM; Gulf Family Health Survey. Overall averages not constructed.	All births in last five years	**Public:** not defined **Private:** not defined	None	Caesarean section	None	**Sector within all deliveries:** Not examined. **Sector within facility deliveries:** Not examined. **Mode of delivery by sector:** Large disparities in caesarean section rates were seen (population-based rates ranged between 16% in Bahrain to 1.7% in Yemen). In the five countries where rates could be compared by sector, they were higher in private facilities compared to public facilities in Egypt, Jordan and Morocco, and lower than public facilities in Yemen and Palestine.
Peters et al, 2004[10]	41 countries in South Asia; East Asia/ Pacific; Sub-Saharan Africa; Latin America/ Caribbean; Middle East/ North Africa, 1990s. Data: DHS. Overall averages constructed (method not described, but based on World Bank, 2003).	Not stated	**Private:** not defined **Public:** not defined **Home:** not defined	None	None	None	**Sector within all deliveries:** In four of the five regions, home births were the largest proportion of all births, followed by the public sector (it was the most important in Latin America & Caribbean). The private sector provided approximately 10% of delivery care in East Asia & Pacific; Latin America & Caribbean; Middle East & North Africa and approximately 5% in South Asia and Sub-Saharan Africa regions. **Sector within facility deliveries:** Not examined.
Zellner et al, 2005[50]	46 countries in Sub-Saharan Africa; North Africa/ West	Women 15-49 with birth in last 5 years (woman-	Any birth in the recall period in: **Private:** for profit	None	None	Wealth quintiles: two bottom wealth quintiles combined compared to	**Sector within all deliveries:** The private sector ranged from 0% (Ethiopia) to 32% (Indonesia), n=31 countries where estimates provided.

Author, Year	Countries, time period, data source, construction of averages	Population, recall period and analysis sample	Sector definitions	Delivery attendant by sector	Mode of delivery by sector	Equity analysis by sector	Main findings related to delivery care by sector
	Asia/ Europe; South Central/ Southeast/ East Asia; Latin America/ Caribbean, 1999-2005. Data: DHS and RHS. Overall averages not constructed.	based analysis).	and not for profit, includes private practitioners, clinics, hospitals, laboratories, diagnostic facilities, NGOs, FBOs, shopkeepers, traditional healers, pharmacies, pharmaceutical wholesalers, distributors & manufacturers.			overall total.	**Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** The use of the private sector in all deliveries among the bottom quintiles (subset of 20 countries) ranged from 2% (Rwanda, Bolivia, Peru) to 17% (Zimbabwe). Minimal interpretation or discussion of findings.
Villar et al, 2006[42]	8 countries in Latin America, 2004-5. Data: WHO global survey on maternal and perinatal health (facility records). Overall averages not constructed.	All women admitted for delivery in the last 2-3 months to 120 sampled institutions. Birth-based analysis, not a population based study. Not representative of all institutions.	**Public:** including state university hospitals. **Social security**: including labour union hospitals. **Private**: not public. **Religious:** classified according to patients' main mechanism of payment (no further information).	Not by sector	Compared caesarean-section rates (emergency, intrapartum and elective) between different sector institutions.	None	**Sector within all deliveries:** Not examined. **Sector within facility deliveries:** Not examined. **Mode of delivery by sector**: Four countries (Argentina, Brazil, Ecuador and Mexico) had both private and/or other provider types and caesarean rates were higher in private than in public facilities in all four countries. However, the type of facility was not a significant predictor of caesarean-section in a multivariable linear regression. Facilities were also characterised by whether they had economic incentives to conduct caesarean-sections (i.e. higher fees for caesarean-sections than vaginal deliveries, or caesarean-section income benefited senior staff). 58% (7/12) of private institutions had such economic incentives compared to 5% of social security and 24% of public institutions.
Gwatkin et al, 2007[14]	56 countries in East Asia/Pacific, Europe/ Central Asia, Latin America/Caribbean, Middle East/North Africa, South Asia, Sub-Saharan Africa, 1991-2004. Data: DHS (multiple surveys per country totalling 95 surveys). Regional averages were constructed as unweighted means of all countries within the region that have adequate data.	Married women or women in consensual unions. Five year recall period. Woman-based analysis.	**Public:** government hospitals, health centres, health posts, dispensaries; or facilities operated by government-affiliated social securing programs. **Private:** private hospitals or clinics, private doctors' offices, facilities operated by other private medical providers (such as NGOs). Excludes treatment obtained in private pharmacies or shops. **Home**: woman's	Not by sector	None	Wealth quintiles: Low-high ratio, Low-high difference, Concentration index.	**Sector within all deliveries:** Proportion of all deliveries occurring in public and private facilities respectively in the various regions were: East Asia/Pacific: 29.1% and 12.4%, Europe/ Central Asia: 89.7% and not applicable, Latin America/Caribbean: 53.0% and 9.3%, Middle East/North Africa: 36.5% and 17.9%, South Asia: 9.1% and 7.0%, Sub-Saharan Africa: 38.7% and 6.1%. **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** Public facility (low/high ratio, low-high difference, concentration index): East Asia/Pacific: 0.326, 29.855, 0.30266; Europe/ Central Asia: 0.863, 12.900, 0.04333; Latin America/ Caribbean: 0.599, 24.430, 0.19700; Middle East/North Africa: 0.804, 7.308, 0.17398; South Asia: 0.134, 19.465, 0.49731; Sub-Saharan Africa: 0.345, 42.009, 0.32037. Private facility (low/high ratio, low-high difference, Concentration Index): East Asia/Pacific: 0.104, 28.440, 0.37438; Europe/ Central Asia: n/a, n/a, n/a; Latin America/Caribbean: 0.055, 27.482, 0.46556; Middle East/North Africa: 0.139, 34.404, 0.41732; South Asia: 0.045, 22.248, 0.67362; Sub-Saharan Africa: 0.201, 11.584, 0.43214.

Author, Year	Countries, time period, data source, construction of averages	Population, recall period and analysis sample	Sector definitions	Delivery attendant by sector	Mode of delivery by sector	Equity analysis by sector	Main findings related to delivery care by sector
			own or any other home				Minimal interpretation or discussion of findings.
Houweling et al, 2007[30]	45 countries, stratified into five wealth groups, 1990-1998. Data: World Bank country reports of DHS data. Overall averages not constructed for place of delivery. Total median – unweighted.	Women aged 15-49. All births in 3 or 5 year recall period. Woman-based analysis.	**Public:** government hospital, government health centre, government maternity centre, other country-specific public sector facilities. **Private:** mission hospital/clinic, other private hospital or clinic.	Not by sector	None	Wealth quintiles: Absolute gap (rate difference in percentage points between poorest and richest quintiles)	**Sector within all deliveries:** Not examined. **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** Use of both public and private facilities was lower among poorest women, except for the Dominican Republic and Brazil where the poor had higher use of public-sector facilities. The absolute poor-rich gap was larger in the public sector because private facility use is low in all groups. This suggests the public sector does not provide a safety net for the poor. Relative poor-rich differences were larger in private facilities (results not shown).
Stupp et al, 2007[51]	4 countries in Central America (El Salvador, Guatemala, Honduras, Nicaragua). Data: 3 RHS surveys for each country, time trends 1987-1993, 1995-1998, 2001-2002. Overall averages not constructed.	Five year recall period, women 15-49 years, birth-based analysis.	**Ministry of Health facility (MOH), Social Security (SS) facility, Private facility**, **Home with TBA Home alone**: nobody assisted **Home with others**: family, friends, medical personnel	Not by sector	None	Wealth quintiles	**Sector within all deliveries:** The proportion of all births in private facilities was 6%-7% in Guatemala, Nicaragua and Honduras; 3% in El Salvador. **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** The proportion of births in MOH facilities increased with wealth quintile, up to quintile 4 and declined for quintile 5 (richest) in all countries. In all four countries, births in private facilities occurred almost exclusively in quintiles 3, 4 and 5, and only the fifth quintile had more than 12% of births in private facilities. For all four countries traditional birth attendants are used primarily in quintiles 1, 2 and 3.
Limwattananon, 2008[52]	25 countries in Sub-Saharan Africa; South/Southeast Asia, two most recent surveys from 1995-2000 & 2001-2006 Data: DHS. Overall averages not constructed	Recall <5 years. Woman-based analysis All women's births in recall period classified - multiple births as "public" (at least one delivery at public facility), "private" (a combination of private and informal) or "all informal".	**Public**: Government hospital, government health centre/ post, government maternity home, community health centre, primary health centre, government dispensary, other public facility **Formal private**: Private hospital/ clinic, private maternity home, non-governmental organisation hospital/clinic, mission hospital/ clinic, other private facility	None	None	Urban/rural, poorest/richest wealth quintiles	**Sector within all deliveries:** Private (formal and informal – including home) sector was >50% in 17 countries. Informal private sector prevailed in delivery care in Ethiopia and Bangladesh, formal private sector in Indonesia, public sector in Vietnam. Nearly all informal private care took place in mother's homes. Time trends in formal private sector share of all deliveries not obvious. Only three countries saw formal private sector increase by >5% (Indonesia, Mali and India). **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** graphs shown for selected countries with urban/rural and poorest/richest gap >20% by sector.

Author, Year	Countries, time period, data source, construction of averages	Population, recall period and analysis sample	Sector definitions	Delivery attendant by sector	Mode of delivery by sector	Equity analysis by sector	Main findings related to delivery care by sector
			Informal private: traditional birth attendant's home, midwife's home, relative's home, respondent's home, other				
Perkins et al, 2009[53]	3 sub-Saharan African countries (Tanzania, Kenya and Burkina Faso), 2003 and 2006. Data: Representative population-based surveys conducted in two predominantly rural districts in each country. Overall averages not constructed.	All women age 15-49 in sampled households asked about most recent pregnancy in 24 months preceding survey. Woman-based analysis.	**Government:** hospital, health centre, dispensary **Private or mission facilities:** private hospital, private health centre, private dispensary, private/mission health centre, private maternity/ nursing home and other private (not all types of providers exist in all three countries). **Home**	None	None	None	**Sector within all deliveries:** Proportion of all births in health facilities in 2006 was 56% (Tanzania), 45% (Burkina Faso) and 33% (Kenya). **Sector within facility deliveries:** Proportion of facility births in private or mission facilities was 11% (Tanzania), 16% (Burkina Faso) and 28% (Kenya).
Pomeroy et al, 2010[54]	16 countries in Africa, Asia & Latin America. 2 surveys per country, time-trends 1997-2003 & 2003-2008. Data: DHS. Overall averages not constructed.	Recall ≤3 years in India and ≤5 years in others. Birth-based analysis.	**Government facility:** not defined **Private facility:** not defined **NGO facility:** not defined **Home:** not defined **Excluded:** NGO facilities in multivariate analysis	None	None	For subset of eight countries: Wealth quintiles: bottom; middle three grouped, highest; Residence: urban or rural; Mothers' Education: primary, secondary, tertiary; Husband's education primary, secondary, tertiary.	**Sector within all deliveries:** Across the 32 surveys, the proportion of all deliveries in government facilities ranged from 4.7% to 56.8%, in private facilities from 0.1% to 36.5%, and NGO facilities from 0.0% to 13.7%. **Sector within facility deliveries:** Not examined. **Equity of sector within facility deliveries:** Examined by country in multivariable probit model.
Yoong et al, 2010[28]	34 countries in Sub-Saharan Africa, 1995-2009. Data: DHS. Regional average constructed, method of weighting not stated.	Recall period <3 years. Birth-based analysis.	**Public:** public health facilities. **Medical private sector:** private, non-profit/NGO and mission/religious hospitals, clinics, health centres, dispensaries and pharmacies but excluding shops and traditional healers. **Home**: not defined	None	None	Urban/rural ratio. Richest/poorest wealth quintile ratio. Mother's education in years. Excluded six countries without wealth quintile in the DHS datasets.	**Sector within all deliveries:** 50.3% of all deliveries took place in a facility, and 7.7% of all deliveries took place in the private sector. **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** Examined in multivariable analysis.

Author, Year	Countries, time period, data source, construction of averages	Population, recall period and analysis sample	Sector definitions	Delivery attendant by sector	Mode of delivery by sector	Equity analysis by sector	Main findings related to delivery care by sector
Montagu et al, 2011[16]	48 countries in Sub-Saharan Africa, South Asia, South East Asia, Latin America/ Caribbean and Europe/North Africa/Middle East. 2003-2008. Data: DHS. Regional averages constructed by weighting by country size (population in 2008).	Recall period of five years. Birth-based analysis.	**Public**: government hospital, government health center, government health post, other public sector **Private**: private hospital/clinic and other private sector **Religious providers:** mentioned in results but not defined in methods. **Home**: woman's home or other home.	Not by sector	None	Wealth quintiles	**Sector within all deliveries:** Not examined. **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** Home delivery was most common among the poorest women. Private hospitals were very rarely used by poor women, while wealthy women in all regions commonly gave birth in private facilities (51% and 57% of richest women in South Asia and Southeast Asia, respectively, gave birth in a private facility). In Latin America/Caribbean, Europe, North Africa and the Middle East, over half of women in every quintile gave birth in public facilities, while in sub-Saharan Africa, South Asia and South East Asia it was much more common for the richest women to deliver in public facilities than the poorest women.
Limwatt-ananon, 2011[33]	25 countries in Sub-Saharan Africa, South Asia, and South East Asia. Time trends between 1995-2001 and 2001-2006. Data: DHS. Overall averages not constructed.	Recall period <5 years. Woman-based analysis. Women's all births in recall period characterised as "public" (at least one delivery at public facilities), "private" (or a combination of private and non-institutional) or all "non-institutional".	**Public:** facilities under jurisdiction of national or local government. **Private:** well-defined commercial, for-profit entities and non-governmental organisations, foundations or missions, other private facility. **Non-institutional:** traditional birth attendant's home, midwife's home, pregnant woman's home, relative's home, other non-facility; in another section says non-institutional births were with an unqualified provider (contradicting midwife's home inclusion in this category).	None	None	Urban/rural and poorest/richest wealth quintile absolute difference.	**Sector within all deliveries:** In most countries, the majority of women's births were non-institutional. Between 1995 and 2006, all five Asian countries (except for Bangladesh) had a 10-20% increase in institutional coverage. India and Indonesia saw rapid growth in private facility deliveries. None of the Sub-Saharan African countries had an increase of more than 10% in institutional deliveries. **Sector within facility deliveries:** Not examined. **Equity of sector within all deliveries:** All 25 countries had a rich-poor gap in institutional delivery greater that 20%. Women in wealthiest quintile tended to have most deliveries in public facilities whereas the poorest quintile of women had non-institutional deliveries. 20 of the 25 countries had more than a 20% urban-rural gap in institutional delivery. Most urban women delivered in public facilities, while the urban rich tended to deliver in private facilities. The wealth quintile difference in India and Indonesia was driven by the private sector, whereas in Ghana, Zambia and Mali by the public sector.
Wang, 2011 [55]	38 countries in Sub-Saharan Africa, North Africa/West Asia/Europe,	Women aged 15-49. Recall period of five years. Woman-	**Public**: based on DHS categories **Private:** based on DHS categories	Not by sector	Caesarean-section rates were compared	None	**Sector within all deliveries:** Proportion of all deliveries occurring in facilities ranged between 6.4% and 82.3% in Sub-Saharan Africa, between 63.6% and 98.9% in North Africa/West Asia/Europe, between 16.1% and 79.4% in

Author, Year	Countries, time period, data source, construction of averages	Population, recall period and analysis sample	Sector definitions	Delivery attendant by sector	Mode of delivery by sector	Equity analysis by sector	Main findings related to delivery care by sector
	South/Southeast Asia, Latin America/Caribbean. Time trends for countries with two or more surveys between 1990-2009. Data: DHS. Overall averages not constructed.	based analysis.	**Other, Home**		across countries and over time.		South/Southeast Asia, and between 27.4% and 97.9% in Latin America & the Caribbean. Proportion of all deliveries occurring in the private sector ranged between 0.3% and 27.3% in Sub-Saharan Africa, between 0.7% and 45.6% in North Africa/West Asia/Europe, between 3.6% and 37.5% in South/Southeast Asia, and between 4.0% and 21.9% in Latin America & the Caribbean. **Sector within facility deliveries:** The majority of facility births were in the public sector, though in some countries (Egypt, Jordan, Indonesia, Pakistan and India), the private sector constituted an important part (23-46%) of delivery care. **Mode of delivery by sector**: The caesarean-section rate was higher in private facilities compared to public in several countries (data not shown).
Kagawa et al, 2012[29]	31 countries in Sub-Saharan Africa, Latin America, South East Asia, South Asia and Asia/North Africa/Europe, 2003-2008. Data: DHS. Regional averages constructed by weighting by 2010 population estimates from World Bank.	Does not specify sample of women, recall period or type of analysis.	**Faith-based organisations (FBOs):** not clearly defined.	None	None	None	**Sector within all deliveries:** The proportion of delivery care provided by FBOs was 6.1% overall, ranging from 0% in Honduras to 45.6% in Egypt (the latter is a coding error). Taking into account an additional 16 countries where there was no reported FBO use, the overall proportion of delivery care provided by FBOs was 2.5%. Among regions where FBOs were used, the highest level of use was in South Asia (25.3%) and the lowest was in Latin America (1.3%). **Sector within facility deliveries:** Not examined.
Vogel et al, 2012[37]	3 countries in sub-Saharan Africa (Uganda, Kenya and DRC), 2004-2005. Data: Survey of delivery institutions –WHO Global Survey on Maternal and Perinatal Health. Overall averages not constructed.	3 NGO and 19 FBO institutions (11594 deliveries) and 20 government institutions (25,825 deliveries). Delivery-based analysis, not a population based study. Not representative of all institutions.	**Government:** administered by national, regional or local governments or ministries of health. **NGO**: independent societal organisations that are private and not-for-profit. **Faith-based organisations (FBOs):** independent not-for-profit religious organisations.	Compared type of delivery attendant between governmental and NGO/FBO institutions.	Caesarean-section rates were compared between governmental and NGO/FBO institutions.	Maternal education level	**Sector within all deliveries:** Not examined. **Sector within facility deliveries:** Not examined. **Equity of sector within facility deliveries:** 57.3% of women delivering in NGO/FBO institutions had 10 or more years of education compared to 30.5% of women delivering in government institutions. **Delivery attendant by sector:** NGO/FBO institutions had higher rates of delivery performed by obstetrician/gynaecologist (12.0%) than governmental institutions (1.6%). The majority of births in both types of institutions were delivered by nurse/midwife cadres (73.4% in NGO/FBO and 75.6% in governmental). **Mode of delivery by sector:** NGO/FBO institutions had higher caesarean-section and instrumental delivery rates (18.5% and 1.6%) compared to governmental institutions (13.6% and 0.3%). Women in NGO/FBO institutions had consistently more antenatal complications, which may explain this result.
Tey et al, 2013[34]	6 countries in South Asia; sub-Saharan Africa (Bangladesh, India, Pakistan,	Women 15-49 with births in five year recall period; most	**Public:** not defined **Private:** not defined **Non-institutional:** not defined.	Not by sector	None	None	**Sector within all deliveries:** The majority of births occurred in non-institutional environments in all countries. The proportion of all births in private facilities ranged from 1.4% in Tanzania to 24.9% in Pakistan.

Author, Year	Countries, time period, data source, construction of averages	Population, recall period and analysis sample	Sector definitions	Delivery attendant by sector	Mode of delivery by sector	Equity analysis by sector	Main findings related to delivery care by sector
	Kenya, Nigeria, Tanzania), 2006-2010. Data: DHS. Overall averages not constructed.	recent birth. Woman-based analysis.					**Sector within facility deliveries:** Not examined.
Pomeroy et al, 2014[35]	6 countries in Asia (Bangladesh, Cambodia, India, Indonesia, Nepal and the Philippines). Two surveys per country, time trends: Period 1: 1997-2003, Period 2: 2003-2008. Data: DHS. Overall averages not constructed.	Women with births in recall period (3 years in India, 5 years in other countries). Birth-based analysis.	**Home** versus **facility** births. Among facility births: **Public**, **private** or **NGO** facility (no further definitions). NGO facilities excluded from multivariate analysis.	Delivery attendant: Doctor, nurse/midwife or TBA/other (no further definition).	Caesarean sections	Wealth quintiles (poorest quintile, middle 3 quintiles, richest quintile), urban/rural residence, woman's education level, husband's education level.	**Sector within all deliveries:** The proportion of births occurring in health facilities increased between the two periods. On the more recent surveys, the proportion of all deliveries occurring in health facilities ranged from around 15% (Bangladesh) to around 48% (Indonesia); the private sector delivered more than 10% of all births in the Philippines, India and Indonesia and around 7% in Bangladesh. **Sector within facility deliveries:** Not examined. **Equity of sector within facility deliveries:** Wealthier and more educated women were more likely to deliver in health facilities in all six countries in multivariable analysis. Greater wealth predicted choice of private facility in Cambodia, India, Indonesia and the Philippines. Secondary or tertiary education was positively associated with private delivery in Cambodia, India, Indonesia and Nepal. Husband's tertiary education level was positively associated with private delivery in Cambodia and India. Urban residence was positively associated with private-sector delivery in the Philippines and negatively in Bangladesh. **Delivery attendant by sector**: The proportion of deliveries with a doctor was higher in private- compared to public-sector facilities on the more recent survey in Bangladesh, Cambodia, India and Nepal. The proportion of deliveries with doctor or nurse/midwife (SBA) was lower in private- than in public-sector facilities in Cambodia, Indonesia and Nepal, and very similar between the sectors in the other countries. **Mode of delivery by sector:** Caesarean section rates were higher in the private sector than in the public sector in Bangladesh, India and the Philippines, and negligible or lower in the private sector compared to public sector in Indonesia, Cambodia and Nepal.

DHS – Demographic and Health Survey. MICS – Multiple Indicator Cluster Survey. RHS – Reproductive Health Survey. LMICs – low- and middle-income countries. CDC – Centers for Disease Control and Prevention.

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Table 1. Classification of women according to need for delivery care, appropriateness of service type, and sector, with examples of DHS response options

Need for care	Type of care	Location Category	Birth attendant	Examples of DHS response options	Sector of care
No	-	Did not have birth in recall period			-
Yes	Unknown	Delivery location missing (Women who had a birth but had any of the location, attendant or caesarean section responses missing)			-
	Suboptimal	Non-facility location, non-SBA level professional, or delivery location not captured by response	Non-SBA	Delivered at home, in a traditional birth attendant's home, in other location (including abroad, with public or private non-SBA professionals (public health professional, public ambulatory health professional, private health professional), or in public or private providers that were not explicitly designated as health facilities (public other, private other) and without a skilled birth attendant	Suboptimal: not classified
	Appropriate	Non-facility location or delivery location not captured by response, without information on sector	SBA	Delivered at home, in other location, or abroad and with a skilled birth attendant	Unclassifiable
		Public facility	Any	All government, public or social security facilities at all levels (e.g., public provincial/ district/ referral/ rural hospital, public health center, public polyclinic/ woman's consultation, public health unit, public health post/ clinic, dispensary, maternal clinic, maternity home), regardless of delivery attendant	Classifiable: **Public**
		Public non-facility or public non-SBA level professional	SBA	Public sector locations not explicitly designated as health facilities (e.g., public other, public ambulatory health professional, public health professional), with a skilled birth attendant	
		Private facility	Any	Private facilities (e.g., hospital/clinic, maternity clinic/hospital, health center), regardless of delivery attendant	Classifiable: **Private**
		Private health professional - SBA-level - Non-SBA level	 Any SBA	Private providers not explicitly designated as facilities: - Service run by SBA (e.g., private midwife, private doctor, private nurse), regardless of delivery attendant - Service run by non-SBA (e.g., private health professional) and with a skilled birth attendant	
		FBO facility	Any	Faith-based organization or missionary facility (e.g., hospital, health center, health post/dispensary), regardless of delivery attendant	
		NGO facility	Any	NGO facility (e.g., non-governmental organization clinic/hospital), regardless of delivery attendant	
		Private other	SBA	Private sector locations not explicitly designated as health facilities and with a skilled birth attendant	

Table 2. Categorisation of delivery attendants

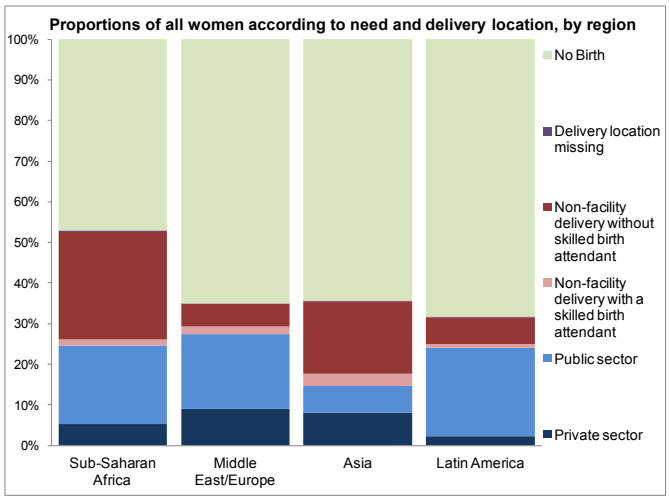
Category	Examples of DHS response options for delivery attendants	Level of skill	Skilled birth attendant
Doctor	Doctor, obstetrician/gynaecologist, doctor/clinical officer, gynaecologist, paediatrician	Highest – able to attend normal and complicated deliveries/caesarean-sections	Yes
Nurse/midwife	Nurse, midwife, nurse/midwife	High – trained and able to attend normal delivery	
Auxiliary midwifery staff	Auxiliary midwife, auxiliary nurse, professional auxiliary birth attendant	Medium – trained and able to attend normal delivery	
Auxiliary staff	Doctor's assistant, physician assistant nurse/medical assistant other health personnel, feldsher	Low - medically trained, but not specifically trained in delivery care	No
Traditional birth attendant (TBA)	Matrone/professional birth attendant, trained traditional birth attendant, traditional birth attendant	Low - no formal qualification but may have received some training in basic delivery care	
Community health worker (CHW)	Family welfare visitor, maternal and child health worker, community health mother and child, health extension worker	Low – no formal qualification, less likely to have training in basic delivery care	
Traditional practitioner	Traditional healer, traditional practitioner, hakim	None	
General facility staff	Patient attendant, sanitary		
Husband/friend/relative	Relative/friend, husband/partner		
Other person	Other		
No one	No one		

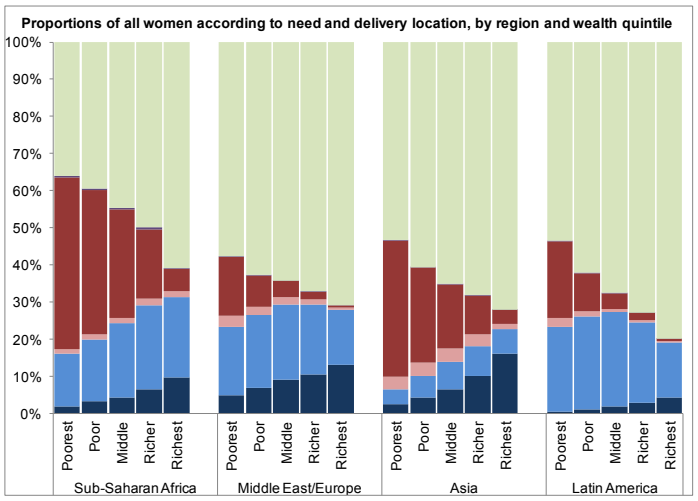
Table 3. Summary of need, use, and sector of use for delivery-care services across regions (including overall weighted mean of regions) and countries (median and range)

Coverage indicators (%)	Sub-Saharan Africa	Middle East/ Europe	Asia	Latin America	Overall weighted mean of regions	Median (Range) across countries
All women						
Not in need for delivery care	47	65	64	68	61	54 (32-84)
Missing delivery location	<1	<1	<1	<1	<1	0 (0-3)
Used suboptimal delivery care	27	6	18	7	18	13 (0-55)
Used appropriate delivery care	26	29	18	25	21	26 (6-59)
TOTAL	100	100	100	100	100	
Selected sub-categories						
Use of public-sector service	19	18	7	22	11	19 (4-43)
Use of private-sector service	5	9	8	2	7	4 (0-22)
Use of unclassifiable sector service	2	2	3	1	3	1 (0-10)
Use among women in need for delivery care						
Missing delivery location	1	<1	1	<1	<1	0 (0-5)
Used suboptimal delivery care	50	16	50	21	47	32 (0-88)
Used appropriate delivery care	49	84	49	79	53	68 (12-100)
TOTAL	100	100	100	100	100	
Selected sub-categories						
Use of public-sector service	36	53	18	69	28	51 (10-98)
Use of private-sector service	10	26	23	7	19	9 (0-46)
Use of unclassifiable sector service	3	5	8	3	6	2 (0-19)
Sector among women with appropriate service type						
Use of public-sector service	74	63	37	87	52	80 (17-99)
Use of private-sector service	20	31	46	9	36	13 (0-60)
Use of unclassifiable sector service	6	6	17	4	12	4 (0-42)
TOTAL	100	100	100	100	100	
Sector among women using appropriate services with a classifiable sector						
Use of public-sector service	78	67	44	91	60	87 (23-100)
Use of private-sector service	22	33	56	9	40	13 (0-77)
TOTAL	100	100	100	100	100	
Provider categories among women using appropriate, classifiable, private sector services						
Private facility	79	44	83	88	79	95 (0-100)
Private health professional	<1	53	14	8	16	0 (0-100)
FBO facility	19	<1	<1	3	3	0 (0-90)
NGO facility	<1	<1	2	<1	2	0 (0-100)
Private other	2	3	1	1	1	1 (0-40)
TOTAL	100	100	100	100	100	

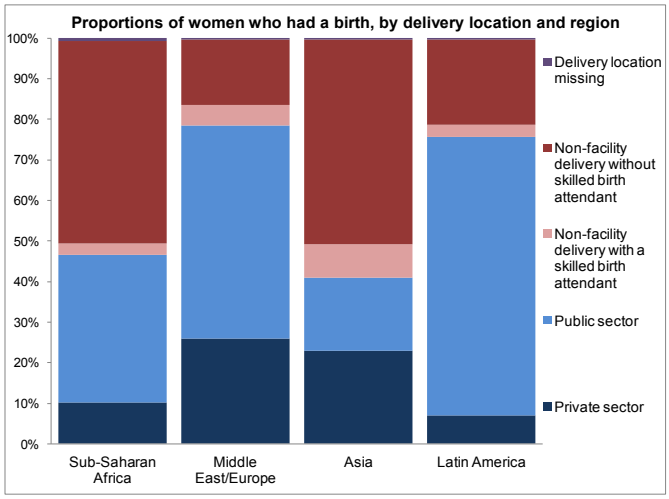
Figure 1.

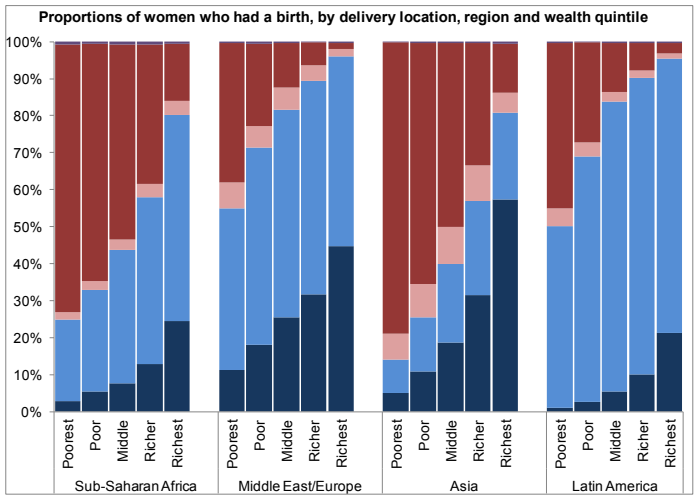
A. All women



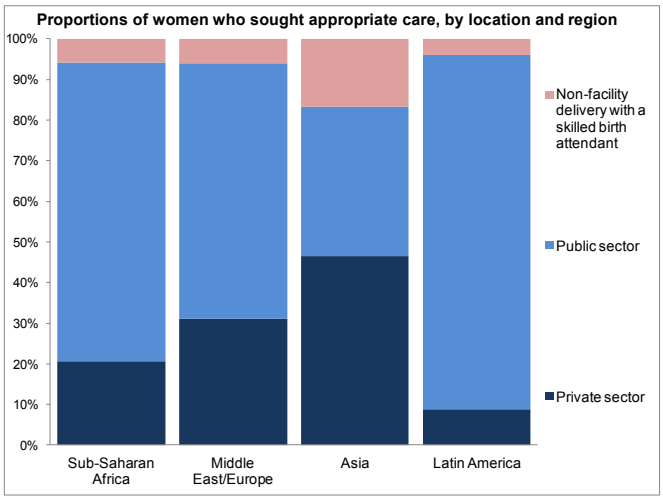


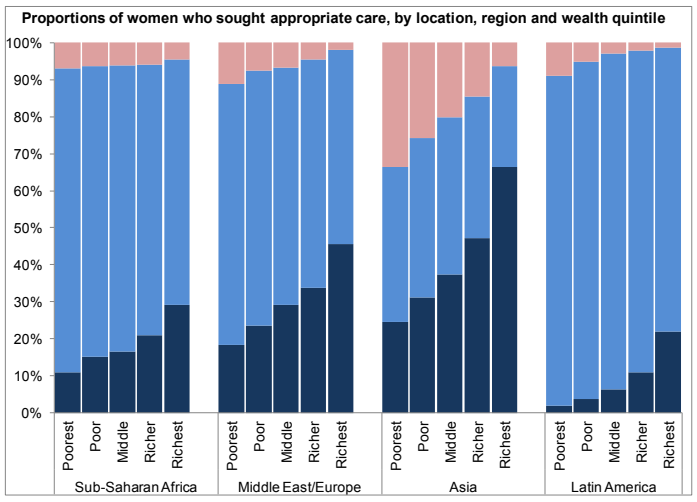
B. Women with birth in recall period



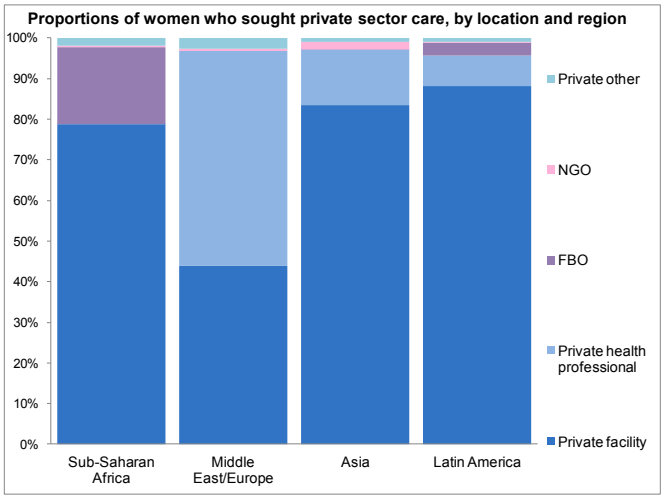


C. Women who received appropriate care





D. Women who used private sector care



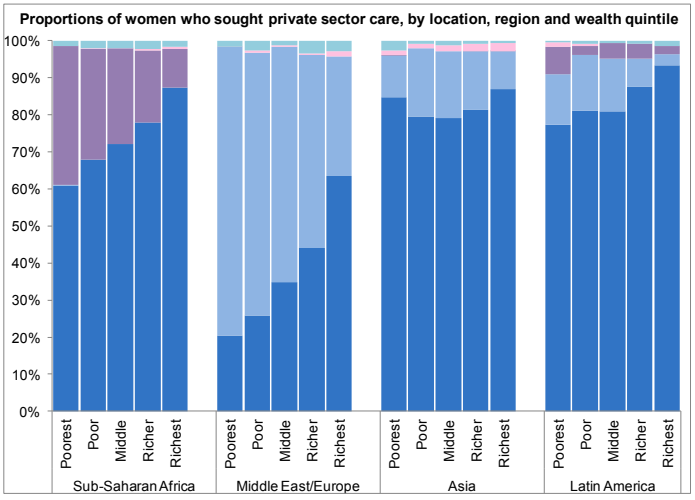


Figure 2.

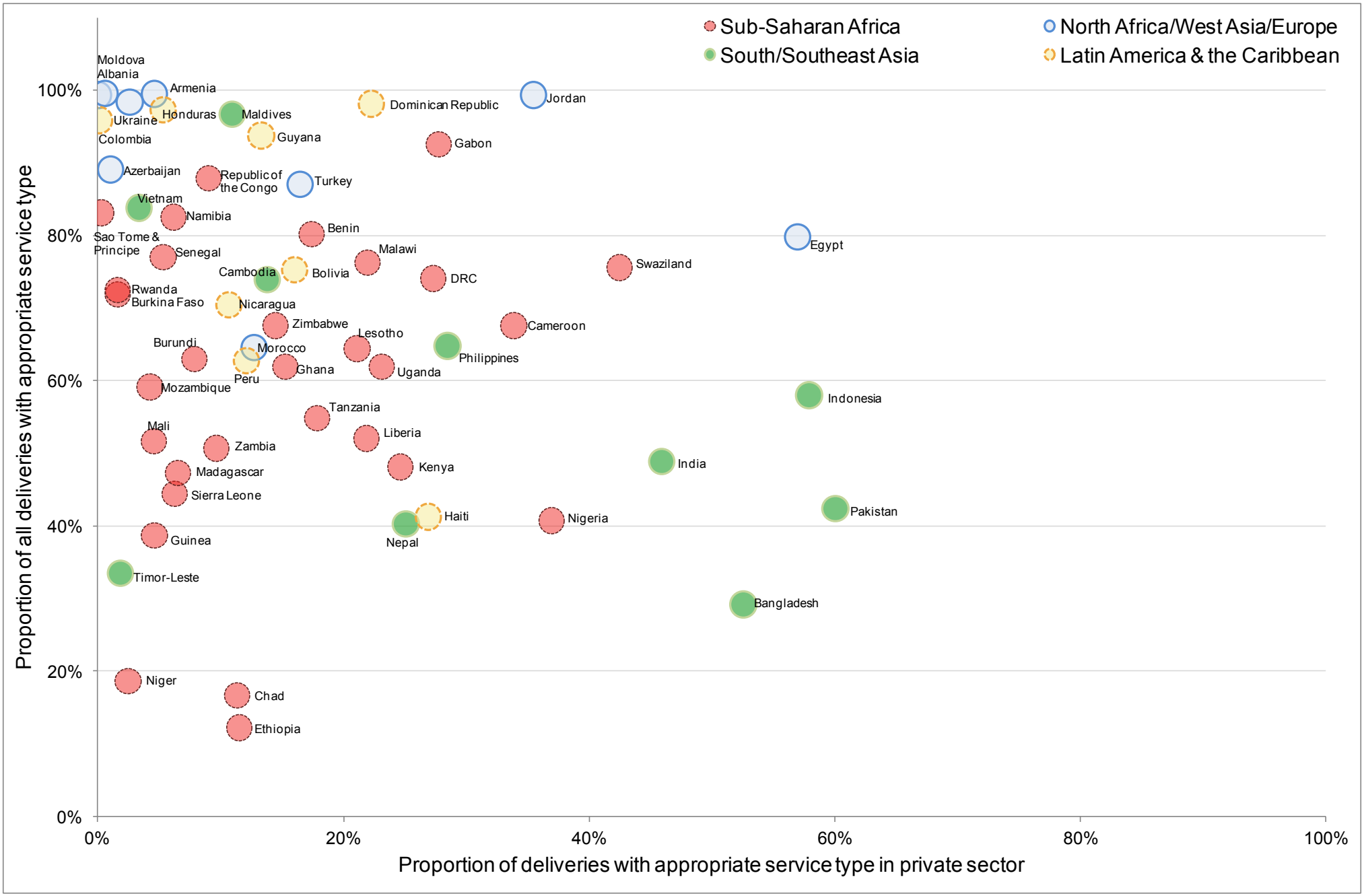
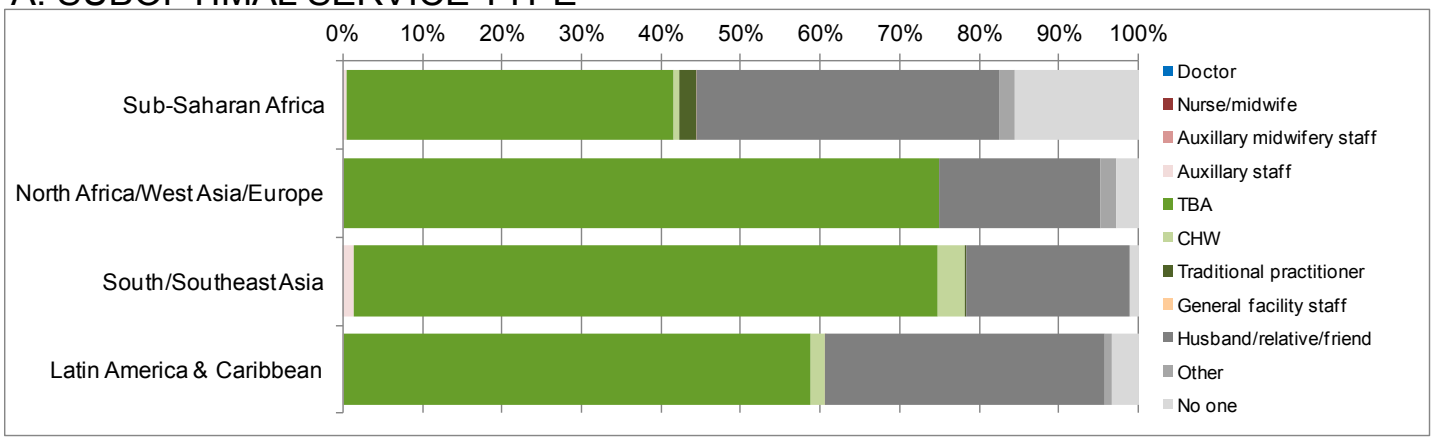

Sub-Saharan Africa
North Africa/West Asia/Europe
South/Southeast Asia
Latin America & the Caribbean
Proportion of all deliveries with appropriate service type
Proportion of deliveries with appropriate service type in private sector
0%
20%
40%
60%
80%
100%
Moldova
Albania
Armenia
Ukraine
Honduras
Maldives
Dominican Republic
Jordan
Colombia
Guyana
Gabon
Azerbaijan
Republic of the Congo
Turkey
Vietnam
Namibia
Benin
Sao Tome & Principe
Senegal
Malawi
Egypt
Swaziland
Cambodia
Bolivia
DRC
Rwanda
Burkina Faso
Nicaragua
Zimbabwe
Cameroon
Burundi
Morocco
Lesotho
Philippines
Peru
Ghana
Uganda
Mozambique
Indonesia
Tanzania
Mali
Liberia
Zambia
India
Kenya
Madagascar
Sierra Leone
Pakistan
Haiti
Nigeria
Guinea
Nepal
Timor-Leste
Bangladesh
Niger
Chad
Ethiopia

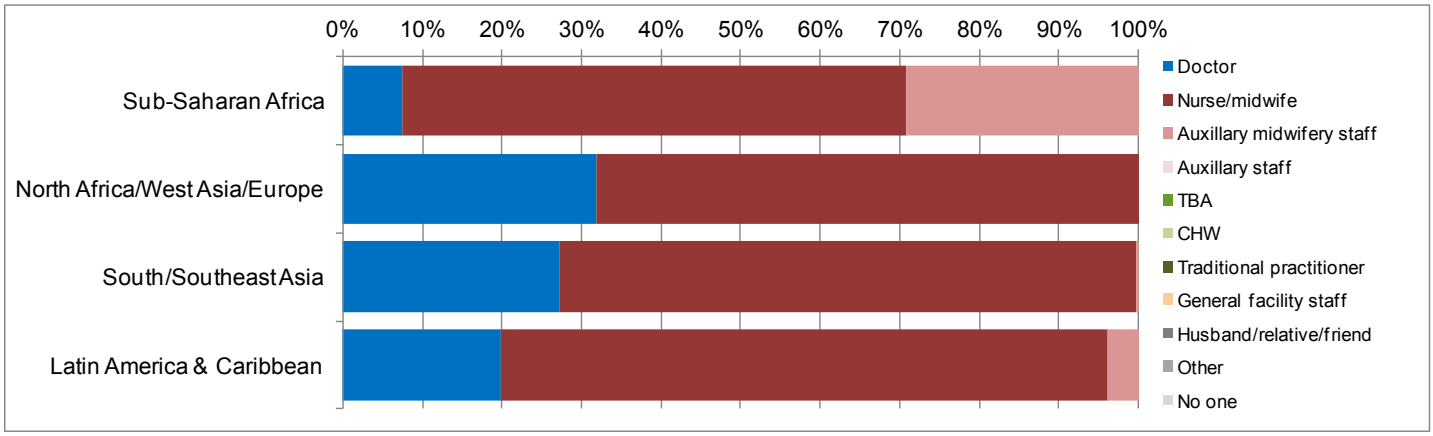
Figure 3.

A: SUBOPTIMAL SERVICE TYPE

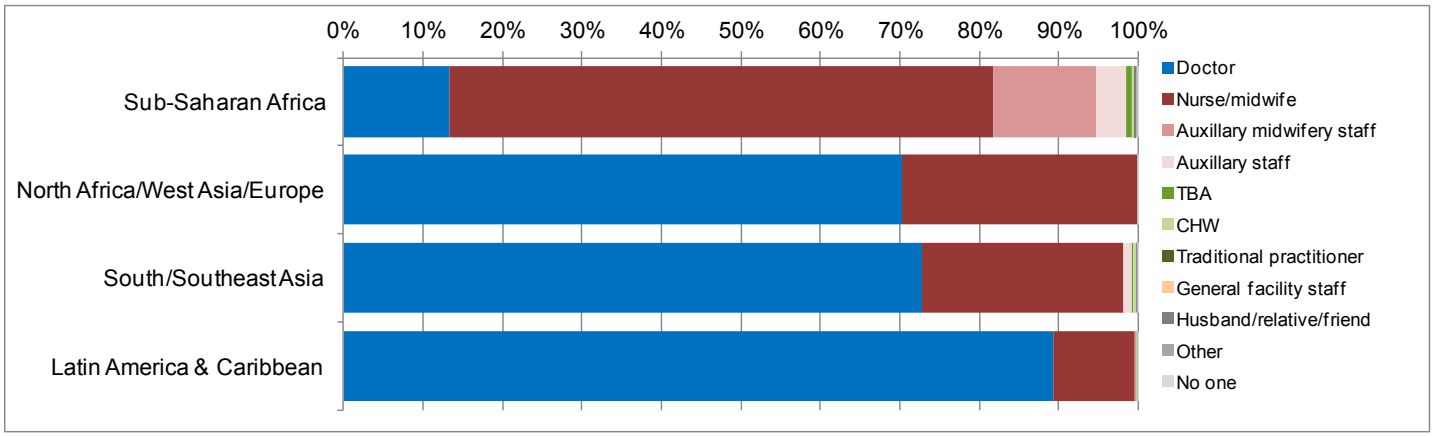


B: APPROPRIATE SERVICE TYPE

Unclassifiable-sector (mainly home) locations



Public sector deliveries



Private sector deliveries

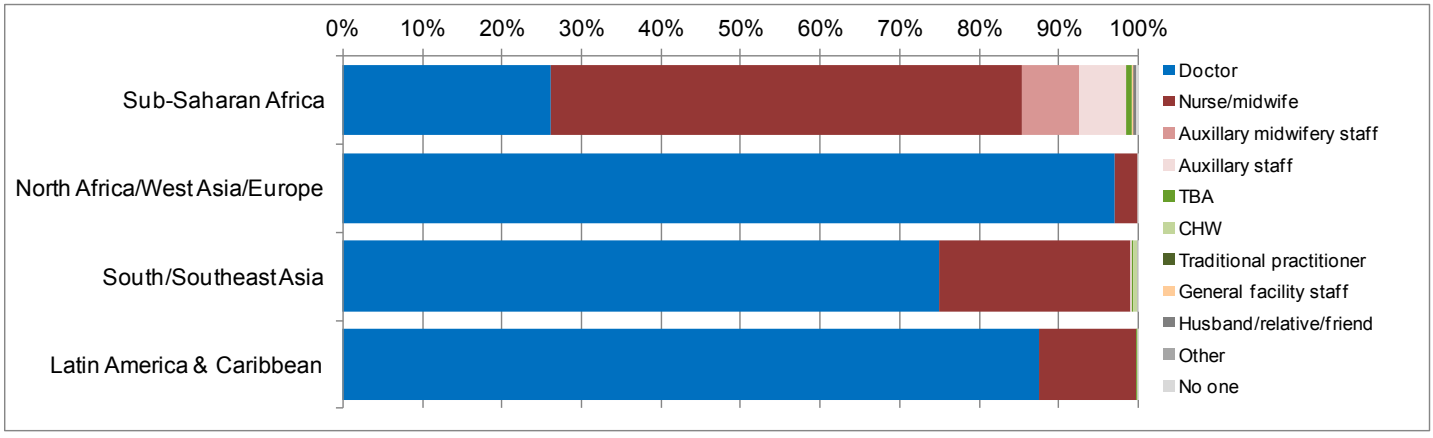
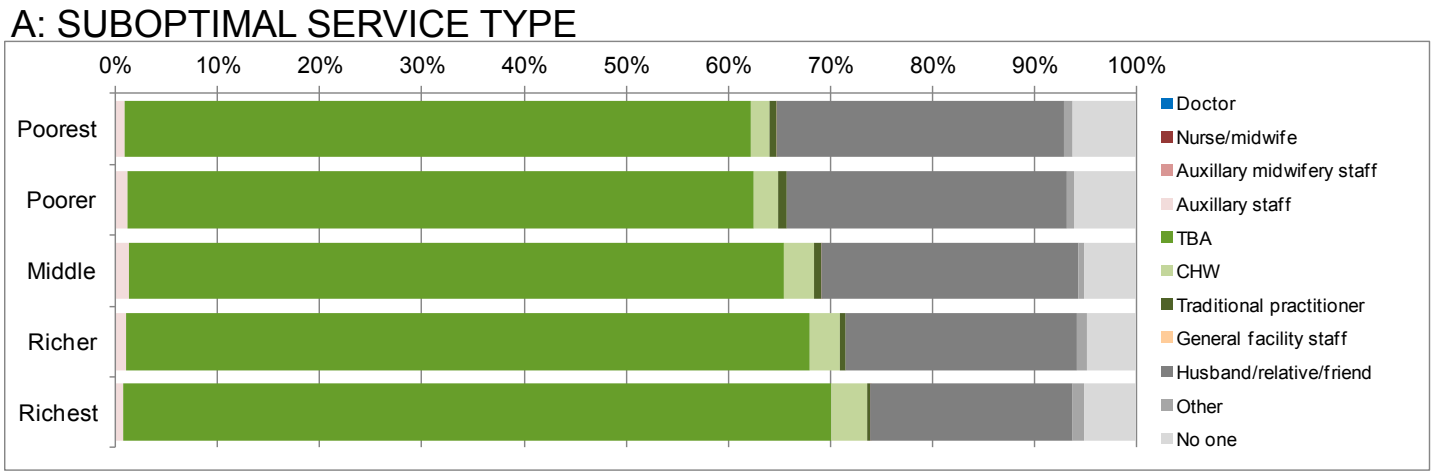
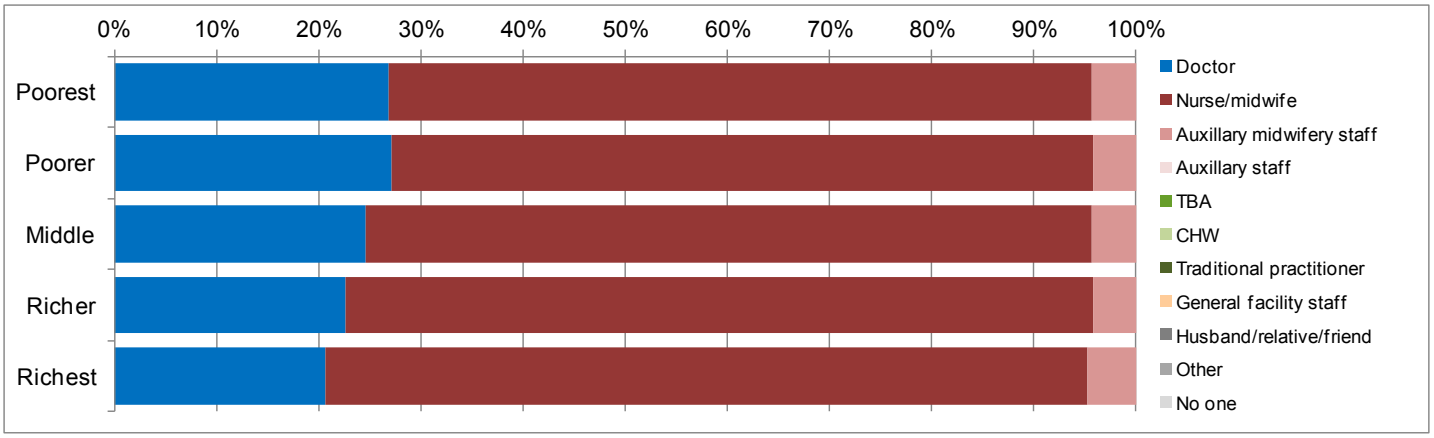
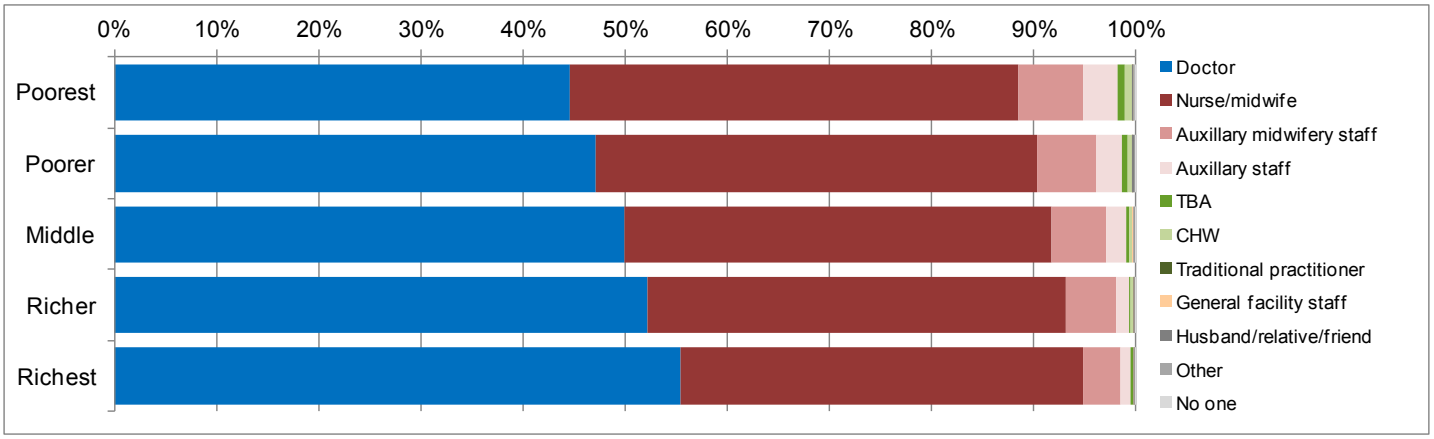


Figure 4.


A: SUBOPTIMAL SERVICE TYPE
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Poorest
Poorer
Middle
Richer
Richest
Doctor
Nurse/midwife
Auxillary midwifery staff
Auxillary staff
TBA
CHW
Traditional practitioner
General facility staff
Husband/relative/friend
Other
No one


B: APPROPRIATE SERVICE TYPE
Unclassifiable-sector (mainly home) locations
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Poorest
Poorer
Middle
Richer
Richest
Doctor
Nurse/midwife
Auxillary midwifery staff
Auxillary staff
TBA
CHW
Traditional practitioner
General facility staff
Husband/relative/friend
Other
No one


Public sector deliveries
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Poorest
Poorer
Middle
Richer
Richest
Doctor
Nurse/midwife
Auxillary midwifery staff
Auxillary staff
TBA
CHW
Traditional practitioner
General facility staff
Husband/relative/friend
Other
No one

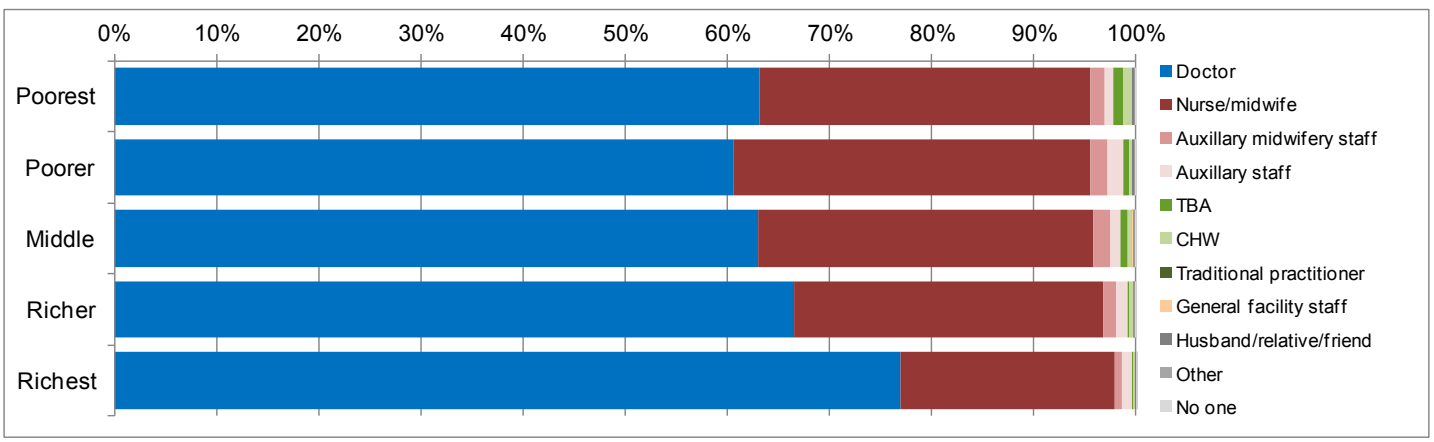

Private sector deliveries
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Poorest
Poorer
Middle
Richer
Richest
Doctor
Nurse/midwife
Auxillary midwifery staff
Auxillary staff
TBA
CHW
Traditional practitioner
General facility staff
Husband/relative/friend
Other
No one

Figure 5.

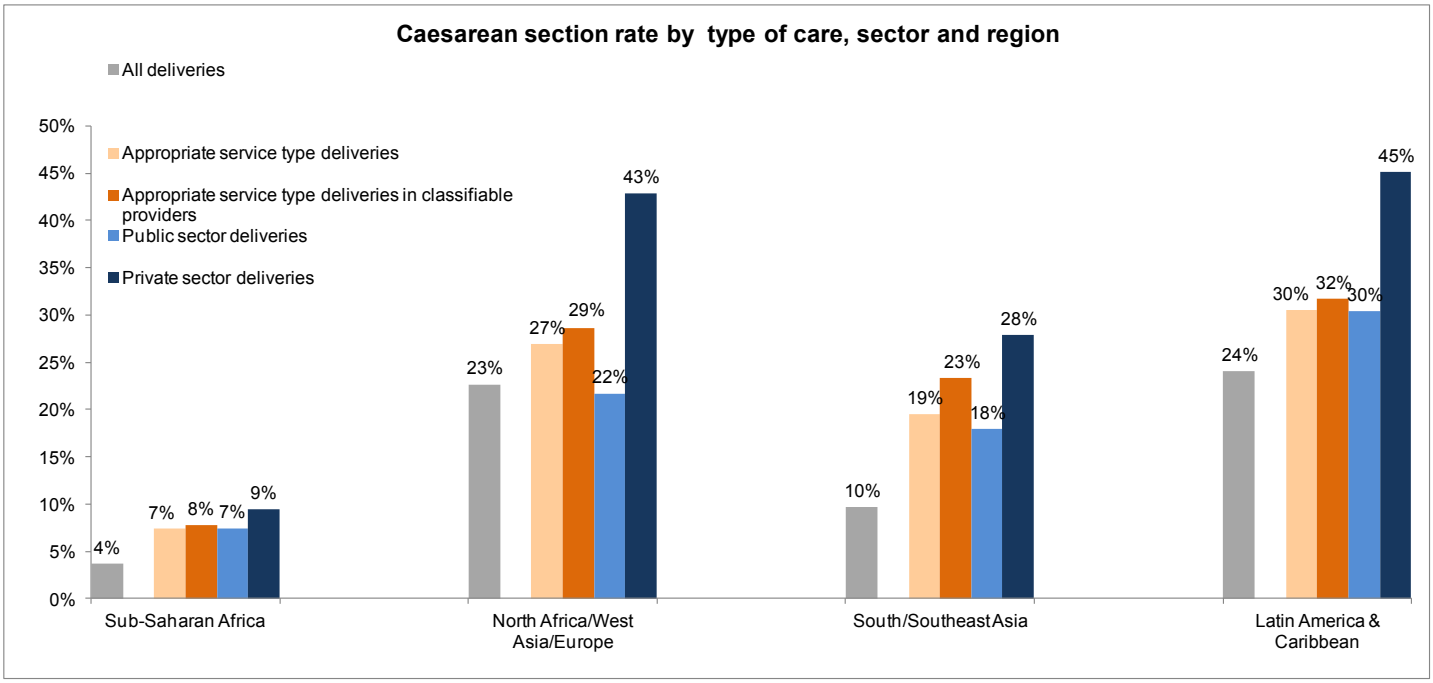
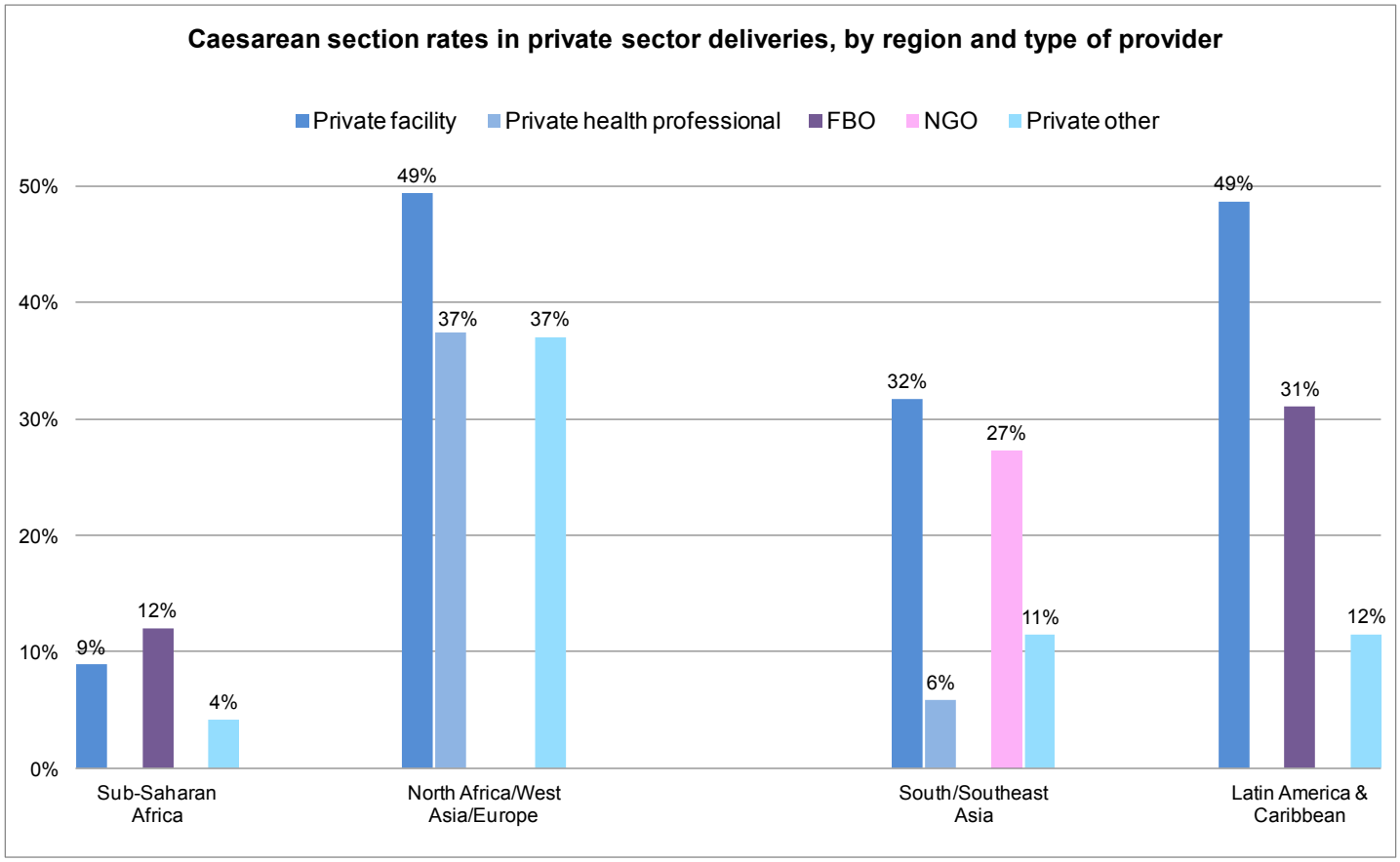
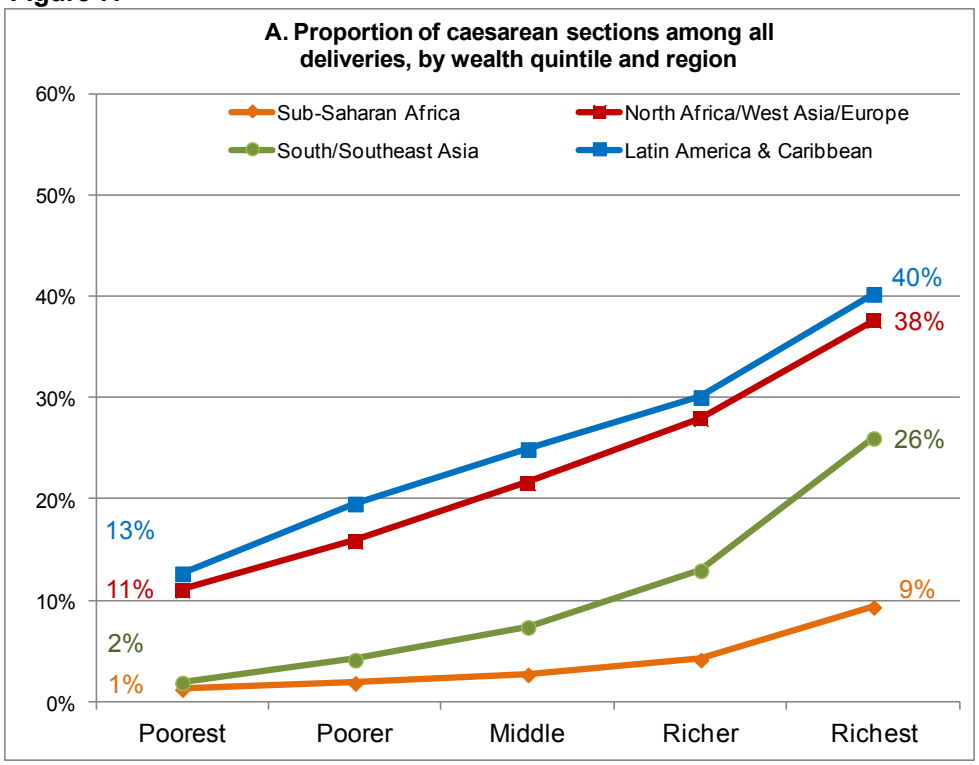

Caesarean section rate by type of care, sector and region
All deliveries
Appropriate service type deliveries
Appropriate service type deliveries in classifiable providers
Public sector deliveries
Private sector deliveries
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
4%
7%
8%
7%
9%
23%
27%
29%
22%
43%
10%
19%
23%
18%
28%
24%
30%
32%
30%
45%
Sub-Saharan Africa
North Africa/West Asia/Europe
South/Southeast Asia
Latin America & Caribbean

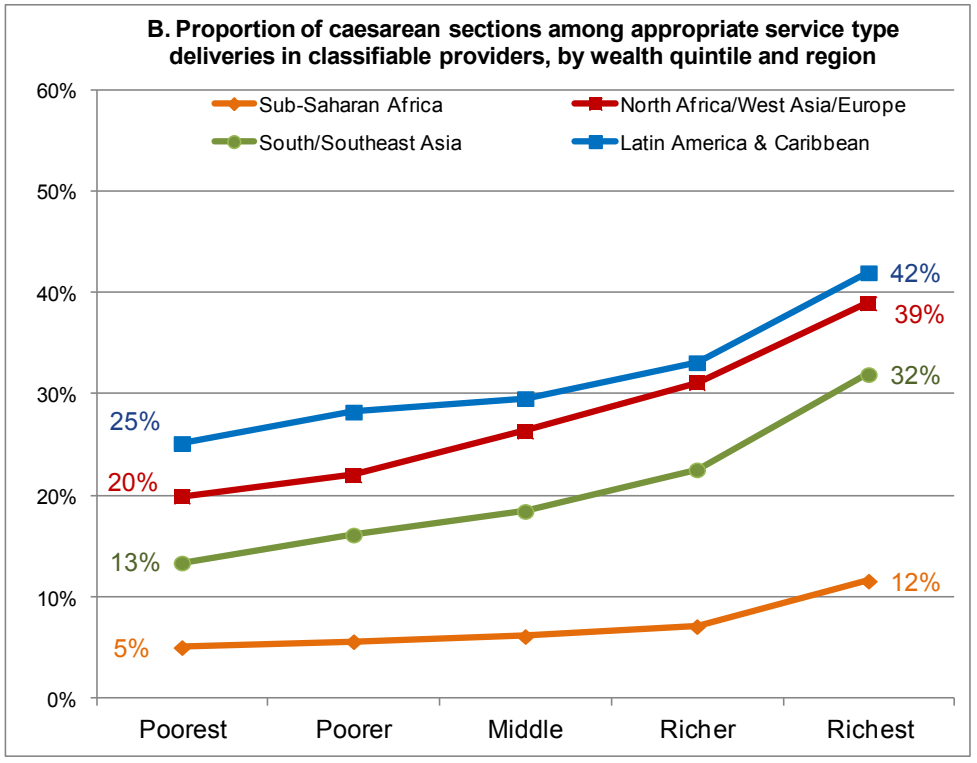
Figure 6.

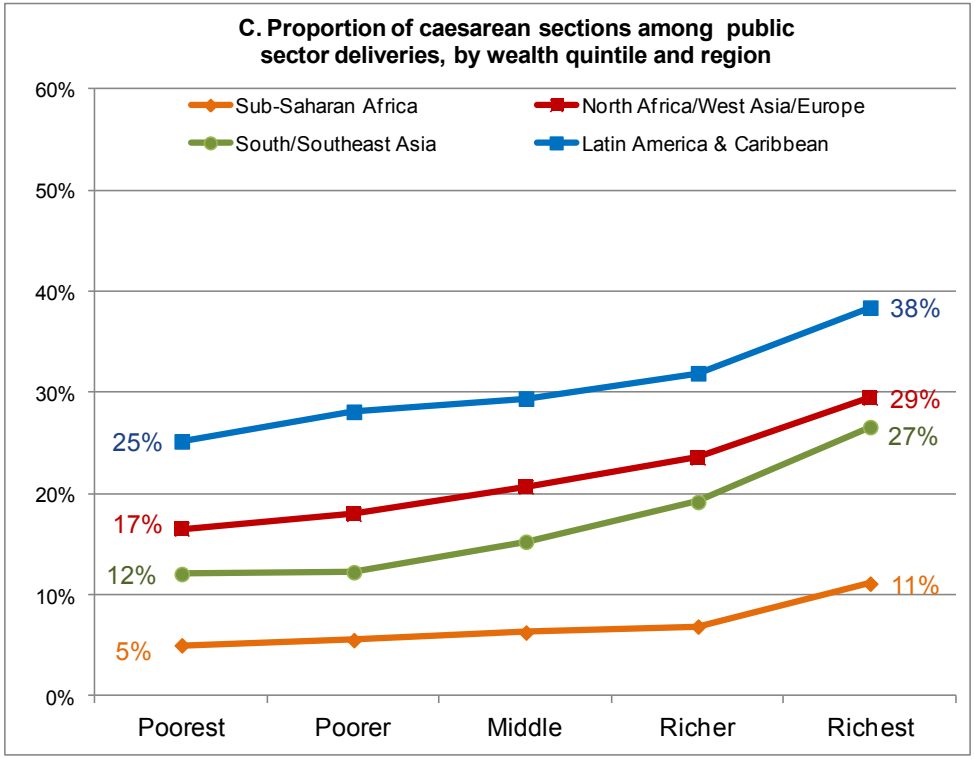


Private provider types not displayed in the above graph had a sample of less than 100 deliveries within region on the basis of which to

Figure 7.


A. Proportion of caesarean sections among all deliveries, by wealth quintile and region
Sub-Saharan Africa
North Africa/West Asia/Europe
South/Southeast Asia
Latin America & Caribbean
60%
50%
40%
30%
20%
10%
0%
40%
38%
26%
13%
11%
9%
2%
1%
Poorest
Poorer
Middle
Richer
Richest


B. Proportion of caesarean sections among appropriate service type deliveries in classifiable providers, by wealth quintile and region
Sub-Saharan Africa
North Africa/West Asia/Europe
South/Southeast Asia
Latin America & Caribbean
60%
50%
40%
30%
20%
10%
0%
42%
39%
32%
25%
20%
13%
12%
5%
Poorest
Poorer
Middle
Richer
Richest


C. Proportion of caesarean sections among public sector deliveries, by wealth quintile and region
Sub-Saharan Africa
North Africa/West Asia/Europe
South/Southeast Asia
Latin America & Caribbean
60%
50%
40%
30%
20%
10%
0%
38%
29%
27%
25%
17%
12%
11%
5%
Poorest
Poorer
Middle
Richer
Richest

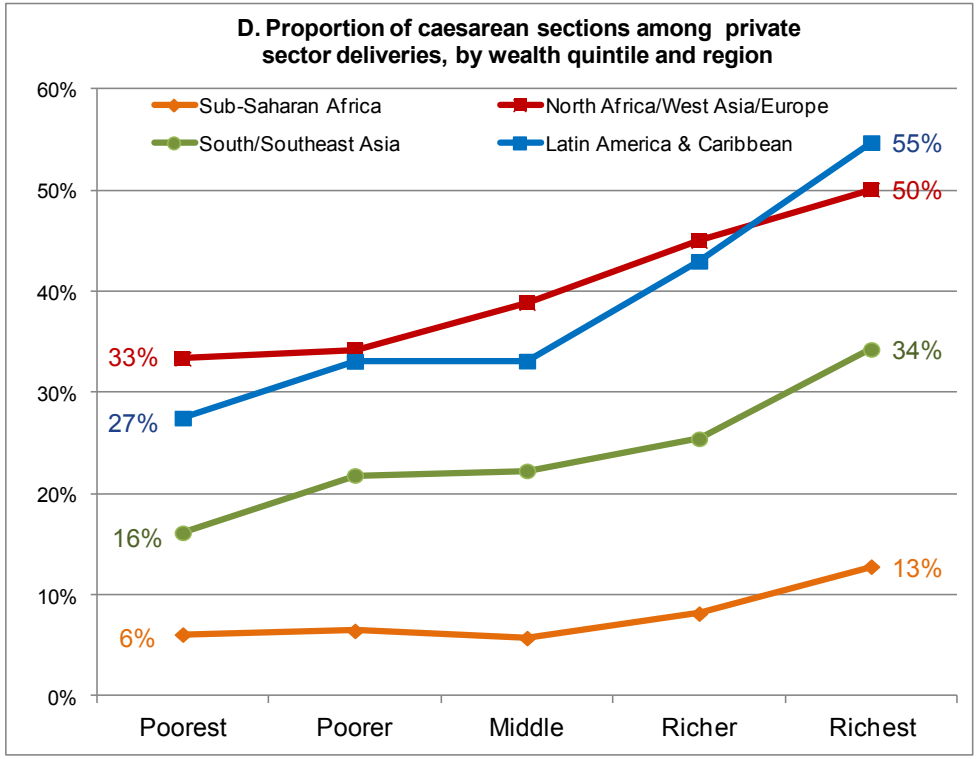
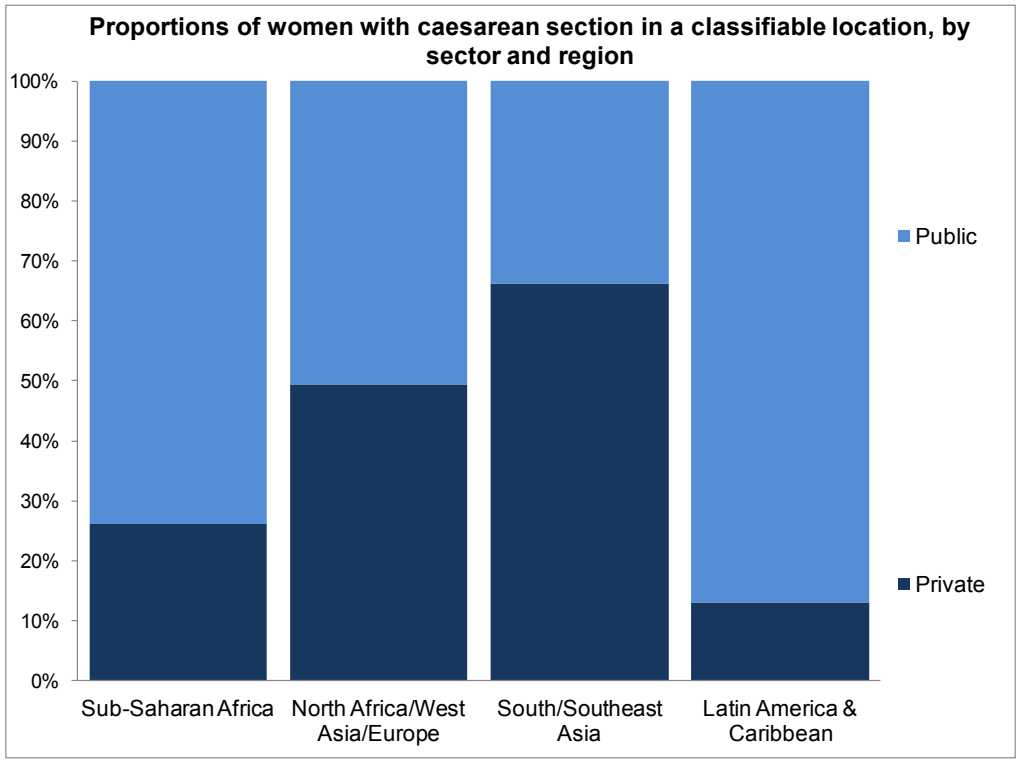
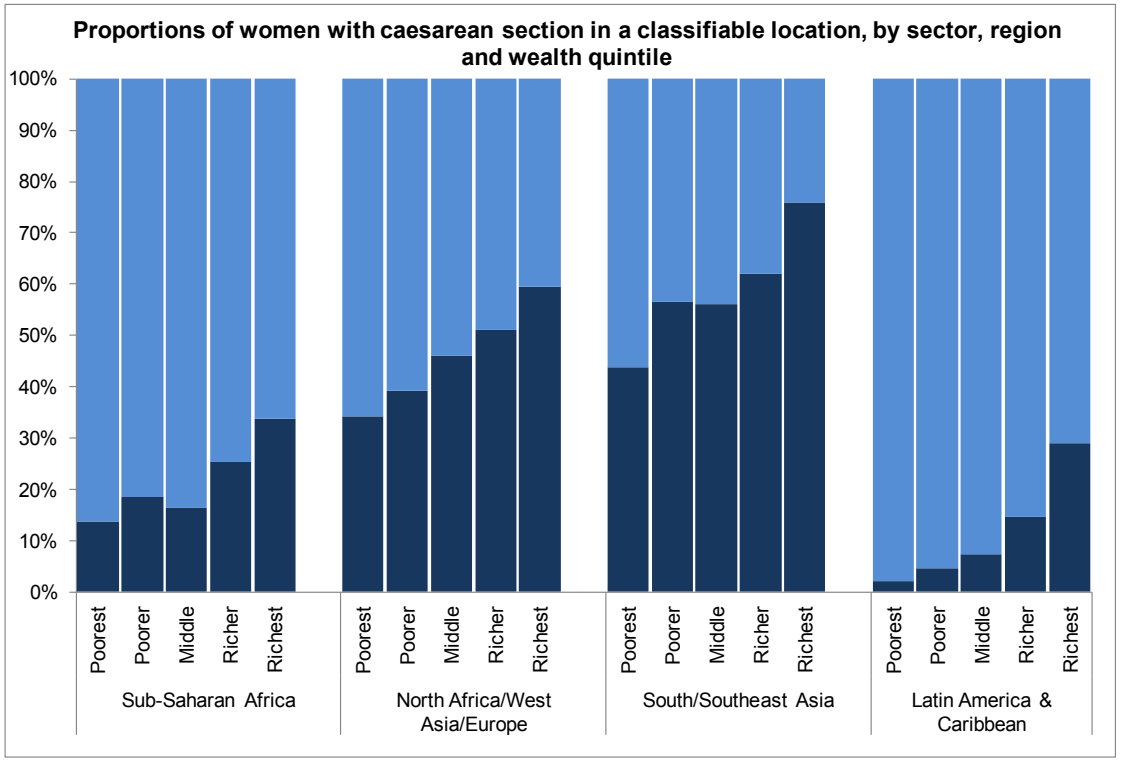

D. Proportion of caesarean sections among private sector deliveries, by wealth quintile and region
Sub-Saharan Africa
North Africa/West Asia/Europe
South/Southeast Asia
Latin America & Caribbean
60%
50%
40%
30%
20%
10%
0%
55%
50%
34%
33%
27%
16%
13%
6%
Poorest
Poorer
Middle
Richer
Richest

Figure 8.


Proportions of women with caesarean section in a classifiable location, by sector and region
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Public
Private
Sub-Saharan Africa
North Africa/West Asia/Europe
South/Southeast Asia
Latin America & Caribbean


Proportions of women with caesarean section in a classifiable location, by sector, region and wealth quintile
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Poorest
Poorer
Middle
Richer
Richest
Sub-Saharan Africa
North Africa/West Asia/Europe
South/Southeast Asia
Latin America & Caribbean

Supplementary Material 1. The 57 countries included, year of survey, union status of women, and recall period

Region	Number	Country	Survey year	Sample of women	Delivery care recall period
Sub-Saharan Africa	1	Benin	2006	all	5 years
	2	Burkina Faso	2010	all	5 years
	3	Burundi	2010	all	5 years
	4	Cameroon	2011	all	5 years
	5	Chad	2004	all	5 years
	6	Republic of the Congo	2005	all	5 years
	7	Democratic Republic of Congo	2007	all	5 years
	8	Ethiopia	2011	all	5 years
	9	Gabon	2012	all	5 years
	10	Ghana	2008	all	5 years
	11	Guinea	2005	all	5 years
	12	Kenya	2008-9	all	5 years
	13	Lesotho	2009	all	5 years
	14	Liberia	2007	all	5 years
	15	Madagascar	2008-9	all	5 years
	16	Malawi	2010	all	5 years
	17	Mali	2006	all	5 years
	18	Mozambique	2011	all	5 years
	19	Namibia	2006-7	all	5 years
	20	Niger	2006	all	5 years
	21	Nigeria	2008	all	5 years
	22	Rwanda	2010	all	5 years
	23	Sao Tome and Principe	2008-9	all	5 years
	24	Senegal	2010-11	all	5 years
	25	Sierra Leone	2008	all	5 years
	26	Swaziland	2006-7	all	5 years
	27	Tanzania	2010	all	5 years
	28	Uganda	2011	all	5 years
	29	Zambia	2007	all	5 years
	30	Zimbabwe	2010-11	all	5 years
					Number of countries analysed in region: 30
North Africa/West Asia/Europe	31	Albania	2008-9	all	5 years
	32	Armenia	2010	all	5 years
	33	Azerbaijan	2006	all	5 years
	34	Egypt	2008	ever-married	5 years
	35	Jordan	2007	ever-married	5 years
	36	Moldova	2005	all	5 years
	37	Morocco	2003-4	all	5 years
	38	Turkey	2003	ever-married	5 years
	39	Ukraine	2007	all	5 years
					Number of countries analysed in region: 9
South/Southeast Asia	40	Bangladesh	2011	ever-married	5 years
	41	Cambodia	2010	all	5 years
	42	India	2005-6	ever-married	5 years
	43	Indonesia	2007	ever-married	5 years
	44	Maldives	2009	ever-married	5 years
	45	Nepal	2011	all	5 years
	46	Pakistan	2006-7	ever-married	5 years
	47	Philippines	2008	all	5 years
	48	Timor-Leste	2009-10	all	5 years
	49	Vietnam	2002	all	3 years
					Number of countries analysed in region: 10
Latin America and the Caribbean	50	Bolivia	2008	all	5 years
	51	Colombia	2010	all	1 year
	52	Dominican Republic	2007	all	5 years
	53	Guyana	2009	all	5 years
	54	Haiti	2012	all	5 years
	55	Honduras	2011-12	all	5 years
	56	Nicaragua	2001	all	5 years
	57	Peru	2000	all	1 year
					Number of countries analysed in region: 8
					Total number of countries analysed: 57

n= weighted number of births (= women). Most recent birth in recall period. Sample includes women with non-missing values in location of delivery, professional attendance at delivery and caesarean section.

Supplementary Material 2. Deriving regional population weights

We used the 57 country datasets to create four regions (Sub-Saharan Africa, Middle East/ Europe, Asia and Latin America). In order to produce region-level estimates, we had to account for the size of each country relative to the size of its region. Each region's overall population was estimated by using UN Population Estimates for 2008 for each included country (country population - Cp) and the region population (Rp).[48] Countries that did not contribute a DHS dataset in this analysis were not included in the calculation of regional and overall population and weights. We then calculated the proportion of the population of the region that was from a given country by dividing Cp by Rp, which we term Zp. The number of observations in the sample from a country (Cs) can be divided by the number of observations in the region (Rs) to give Zs. If $Zs<Zp$, then the country was under-represented in the sample, and if $Zs>Zp$, it was over-represented. To calculate individual-level weights whose application would result in a correct weighting of a country's results within its region, we multiplied the original individual country-level sampling weight by Zp/Zs. To achieve weights representative overall, the process was repeated, with the overall region including all 57 countries in the study. These resulting weights were then used to calculate summary estimates that were representative at the regional and overall levels.