Educational Expansion and Cesarean Prevalence: Decomposing the Social Drivers of Change

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ABSTRACT

The United Nations Goals to improve women's reproductive health and increase women's education typically work in tandem. However, in the specific case of cesarean delivery, this linkage may be in conflict. We use data Demographic and Health Surveys from 49 countries at two points in time to document variation in levels and trends of caesarian usage by education level (as a proxy of socioeconomic status). More specially, we use a decomposition approach that allows us to determine how national change in cesarean usage is driven by the changing size and behavior of different education groups. Overall, we find significant heterogeneity in cesarean usage by education level that is masked by national averages. Even in countries where overall cesarean rates fall into the acceptable or below acceptable rate category, we see large disparities in utilization by education levels, with large parts of the population either dangerously above and below the guidelines.

INTRODUCTION

Past research has documented that gains in women's' education have substantial positive spillover effects for women's health and most researchers and policymakers rightly assume that investments in women's schooling will go a long way towards improving in women's health. However, one area where the linkage between educational expansion and women's health outcomes may not be positive is regarding caesarian sections. In 1985, the WHO established an "ideal" cesarean section reference rate of 10-15% (Betran et al. 2016). The 10% guideline was supported by a 2016 worldwide population-based ecological analysis, which demonstrated that "caesarean section rates higher than around 10% at the population level are not associated with decreases in maternal and neonatal mortality rates, and thus may not be necessary to achieve the lowest maternal and neonatal mortality." (Ye et al. 2016). Much of the past work on caesarian section rates has focused on documenting variation between countries (Betran AP et al. 2016 ; Souza et al. 2010 ; Gibbons et al. 2010) and within countries across time (Yassin and Saida 2012 ; Kottwitz 2014 ; Mumtaz et al. 2018). For example, Betrán et al. (2016) found that (except for Guinea and Nigeria) all countries have increased the use of caesarians, with the absolute and yearly increases most notable in less developed countries. Indeed, while there has been significant policy discussion of high levels of caesarian births in many developed countries, the issue is less explored in the developing world.

The lower concern over cesarean rates in developing settings is likely due to several factors--governments, often with limited resources, face a range of health-related crisis). Caesarean data in these settings has historically been sparse and of questionable quality (Holtz and Stanton 2007). Additionally, in many countries, national averages fall within the WHO-recommended range. However, this national average can mask significant heterogeneity within a population. An overall rate of 15% may reflect a rate that applies across evenly to women across the socioeconomic divide, but it can also stem from a scenario where half the population experiences a 30% rate, while the other half has no access to the procedure.

We hypothesize that the latter scenario is quite likely across the developing world. While much attention has been paid to rising levels of inequality in the United States and Europe, sub-Saharan Africa and Latin America are home to 17 of the top 20 countries with the highest levels of inequality (World Bank 2018). These remarkable levels of income inequality are likely to shape access and usage of health care services. Moreover, the expansion of women's education in these countries has also been dramatic during this time period. The UN SDG goal 3.7 states that they global community is committed to ensuring "universal access to sexual and reproductive health-care services, including for family planning, information and education." We want to qualify this statement by adding that the goal should be to ensure *appropriate* access to care. Moreover, while universal access is ideal, in the interim there should be attention paid to whether care is *uniformly distributed* across all socioeconomic groups.

Using DHS data from 49 developing countries, we document variation in cesarean sections by socioeconomic status to better describe overall usage patterns. We use women's education level as an, admittedly imperfect, proxy for socioeconomic status[1]. We also use a decomposition approach to examine how changes in both the education composition of the population and the patterns of caesarian rate by education level, have contributed to overall changes in the caesarian rates across the developing world. Our data highlight severe variation in caesarean rates by education level—even in countries where the overall rate remains in the "safe zone" there is significant heterogeneity by education level, with women with higher levels of schooling consistently exhibiting higher rates of caesarians.

[1] Income data is not available in the DHS, and the wealth variable is cut into quintiles, making comparisons across time and space

BACKGROUND

Cesarean section rate globally averages 18.6%. Countries in Africa (specifically Western Africa) tend to exhibit the lowest rates, while Latin American, Caribbean, and South American countries tend to exhibit the highest rates (Betran et al. 2016). Cesarean section rates have increased most among less-developed countries, increased considerably among more-developed countries, and have not increased as significantly among least-developed countries (Betran et al. 2016). These observations evidence a large disparity in c-section use among countries of varying socioeconomic strength. Although concern tends to fall on Sub-Saharan Africa and other regions with subpar cesarean rates, we aim to show that developing countries with rising cesarean rates warrant equal concern, as an above-average nationwide cesarean rate is indicative of dangerous overutilization.

Although research has focused on between-nations comparisons, there have been several studies that have analyzed c-section frequency within a nation to discern the factors responsible for rising national cesarean rates. For example, a study of Pakistan's Demographic and Health Survey data reported that "…a greater likelihood of having a cesarean section was observed in the richest, highly educated, and urban-living women" (Mumtaz, Bahk, and Khang 2017). Other national level studies have similarly found that higher socioeconomic status is predictive of c-section overutilization, including work in Ethiopia (Gebremedhin 214) and Tanzania (Nilsen et al. 2014).

Other within-nations studies have similarly evaluated sociodemographic determinants of rising cesarean rates. However, studies conducted in Egypt and Norway did not find statistically significant evidence to support that higher education was predictive of higher cesarean rates (Yassin and Saida 2012; Tollånes et al., n.d.). The Norway study attributed this lack of correlation to a high access to hospital care across the country, maintaining that "a high access to hospital care seems to balance out health inequalities that are related to differences in education" (Tollånes et al., n.d.). In the context of developing nations, access to hospital care is not uniform, and therefore it cannot be assumed that access to care counteracts inequalities arising from differences in education level.

These studies did cite other sociodemographic characteristics as being predictive of cesarean use, demonstrating direct and indirect channels whereby a women's education level plays a role in her reproductive decisions (Martin 1995). On this basis, we use education level as a proxy for socioeconomic status, which has been shown through the above studies to be correlated with national cesarean rates. We theoretically draw upon demographic diffusion theory to make the case that paying attention to the behaviors of vanguard groups, in this case the behavior of the highly educated, is important. Diffusion theory posits that attitudes and behaviors are first adopted by a vanguard population, before spreading to other populations through selective social learning (Cleland 1987; Casterline 2001). In the literature on fertility, changes in national patterns are seen both as an innovation, or novel approach to family planning, and as a contagion which can be spread through populations. Both mass media and face-to-face social networks have been proposed as drivers of this process (Casterline 2001). We propose that the usage of cesarean sections might follow a similar pattern. If elite women begin to view high usage of the procedure as something normal, or even desirable, then we might expect demand to trickle down to other groups over time.

DATA AND METHODS

To examine patterns and trends in cesarean rates, we use Demographic Health Survey data from 49 countries. The Demographic and Health Survey is a nationally-representative survey of women aged 15-49. Only surveys that contained cesarean birth rates were considered. In order to examine change over time, we only selected countries where (1) the earliest year before 2010 for which all data was available, and (2) the most recent year after 2010. Countries that did not have both pre-2010 and post-2010 data

available for comparison were not considered for selection. For example, Turkey had data for 1993, 1998, and 2003, but no data for any years after 2010, so it was removed from consideration.

The primary indicator used was "Delivery by cesarean section", which reports on the percentage of live births delivered by caesarian section in the three years prior to the survey. To determine the percentage of women in each education category, the "Percentage of women" variable was used. The DHS is highly standardized and the sample sizes for all countries are very large (5,000-30,000). In this paper, we will be using a range of 5-15% to demarcate an "appropriate" cesarean rate, as the lower bound of 5 % is considered the medically recommended minimum to avoid material morbidity (Gibbons et al. 2010). National cesarean birth rates from both time periods are presented and used to determine annualized rates of change for comparison between countries.

Cesarean rates for within -nation comparisons are decomposed by education level. A decomposition analysis was selected because it allowed us to evaluate to what extent increases in national cesarean rates were due to compositional or behavioral effects, and whether there is a significant difference in rates between different education levels within the same nation. The national caesarean average (C) at time (t) is a function of group specific caesarean rates for each education group (r_{jt}) multiplied by the size of each education group (w_{jt}) group.

$$C_t = \sum r_{jt} * w_{jt}$$

The above expression can then be decomposed, so we can determine whether changes in caesarean use were driven predominantly by behavioral changes within education group versus changes in the size of each education group:

$$\Delta\, C = \overline{r} * \Delta w_j + \overline{w} * \Delta r_j$$

Term 1 **Term 2**

Where the term 1 represents the change driven by changes in the size of education group groups, while term 2 represents the proportion of change driven by changes in prevalence of caesarians within each education group. More conceptually, term 1 tracks the effect of the general socioeconomic development, while the second term tracks the actual behavioral change (i.e. increasing usage within groups. The decomposition findings can apportion how much of any gain (or decline) in overall rates are due overall compositional vs behavioral change but can also highlight how much of overall change is due to the compositional and behavioral changes within each education grouping.

Findings

Between country variation in cesarean usage. As shown in Figure 1, all countries in the analysis, apart from Nigeria, experienced an increase in cesarean birth rates before and after the reference year 2010. To allow for comparison of cesarean birth rate changes between countries, an annualized rate of change map was created.

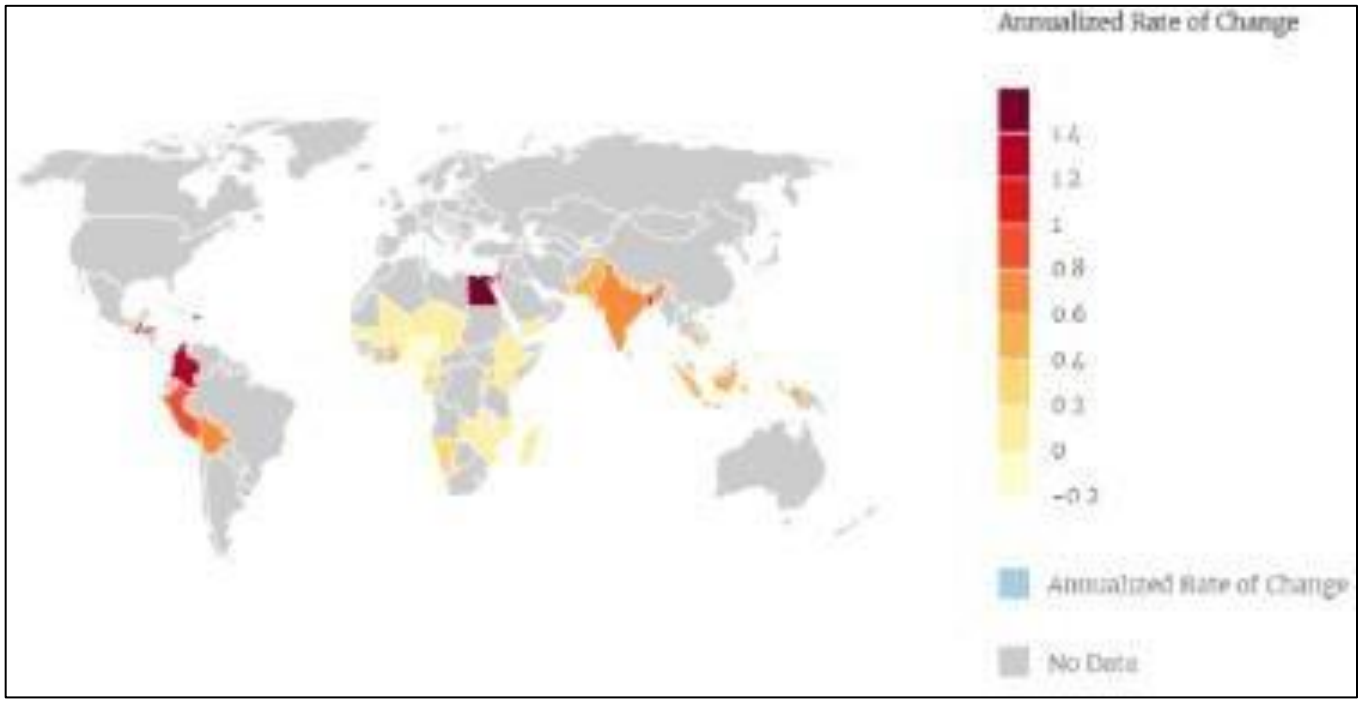


Figure 1. Annualized rate of change in cesarian sections, 49 DHS countries.

Overall, the highest rates of change were seen in Latin America and the Indian subcontinent

***Within country variation in cesarean usage*.**

While the cross national comparisons show wide variation *between* countries, we wanted to further document the variation within countries, specifically by education level. We propose that the national level indicators likely mask significant within country heterogeneity. To summarize the patterns in changing cesarean rates across education level, three plots were created. The first plot depicts countries that were classified as "Below" the WHO guidelines as of the most recent DHS year. The second plot depicts countries that were in an acceptable range as of the most recent DHS year. The third plot depicts countries that were above the WHO guideline as of the most recent DHS year. Each country's cesarean rates are displayed by education level. Two time points are shown for each country—the first being the earliest DHS year for which cesarean data was available, and the second bar represents the most recent DHS year.

Countries with national rates below WHO Guidelines

Figure 2 shows countries that, in their most recent DHS survey (all post 2010), had a national average that falls *below* the WHO guidelines of acceptable rates. Three key takeaways emerge- first, the preponderance of countries on this list are located in sub-Saharan Africa (with the exception of Timor Leste). Second, overall cesarean rates increased in all countries between time 1 and 2 (with the exception of Nigeria). However, this low overall rate masks wide variation between education groups. In 12 out of the 15 countries, there were dramatic increase in the usage among women with higher education. Moreover, in nearly half (7) the countries we see women with higher education currently utilizing cesareans at rates that exceed the WHO recommendations, and almost reaching this level in four cases. In Burkina Faso, cesarean rates increased among women with higher education from 1.2 percent in 1993 to 36.6 percent by 2010. A

similar pattern is evident in Niger, where rates went from .8 percent (1992) to 27.2 percent. (2012). On the positive side, we see evidence that many groups are now able to access cesarean sections at acceptable rates, especially women with primary and secondary degrees. However, there is clear inequality in the findings. In all countries, women with no education have access rates below the recommended threshold. Concurrently we see remarkable evidence that those with higher degrees are utilizing the procedure at rates exceeding the recommended threshold.

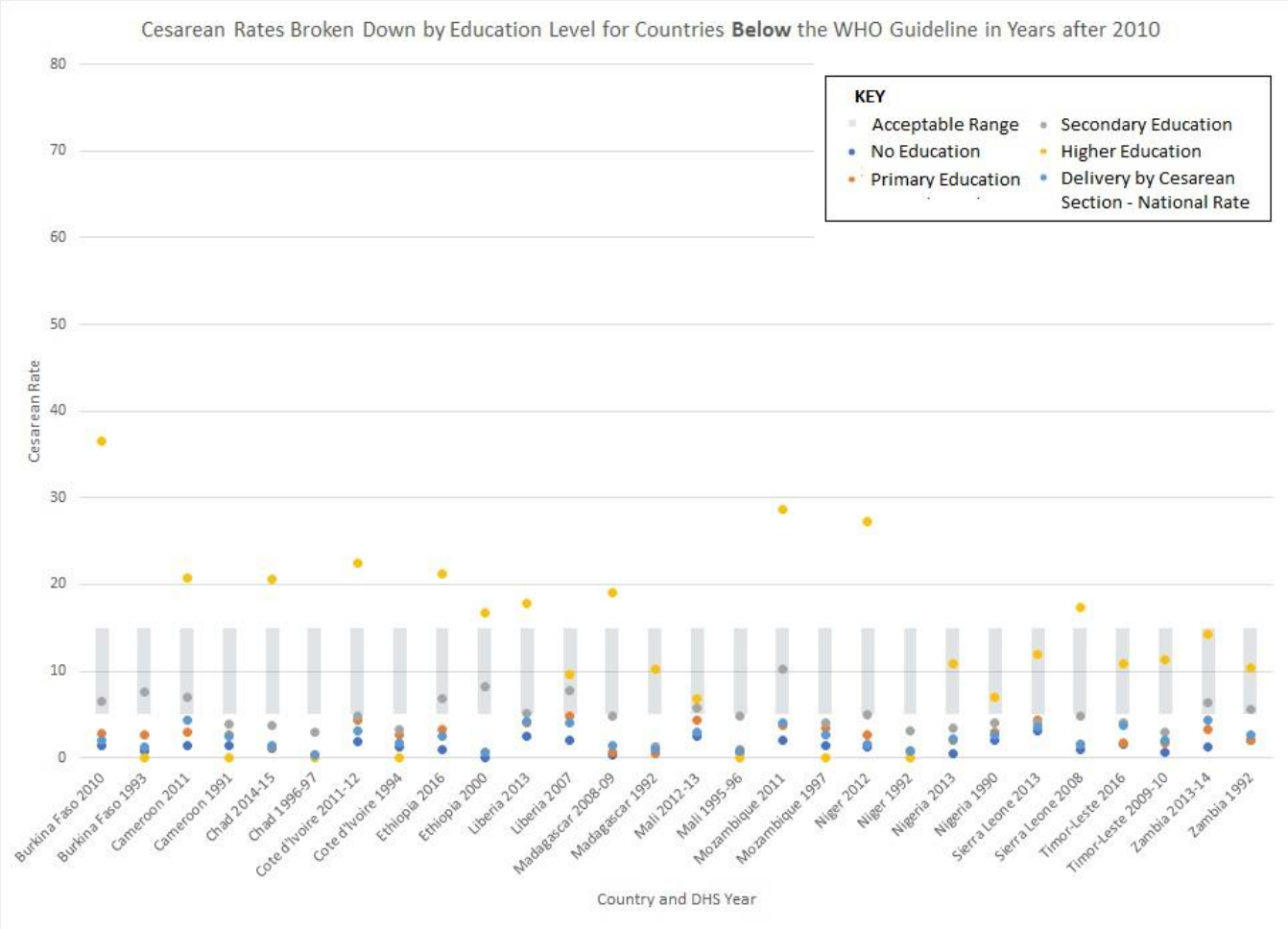


Figure 2. Countries that remained below the WHO guidelines, post-2010.

Countries with national rates within WHO Guidelines Figure 3 shows countries that, in their most recent DHS survey (all post 2010), had a national average that falls *within* the WHO guidelines of acceptable rates. As with the previous plot, the disparity between higher-educated groups and lower-educated groups is notable. While many of the featured countries have achieved acceptable cesarean rates for women with primary and secondary education, of their 4 education levels, significant heterogeneity still exists between the higher and lower educated groups.

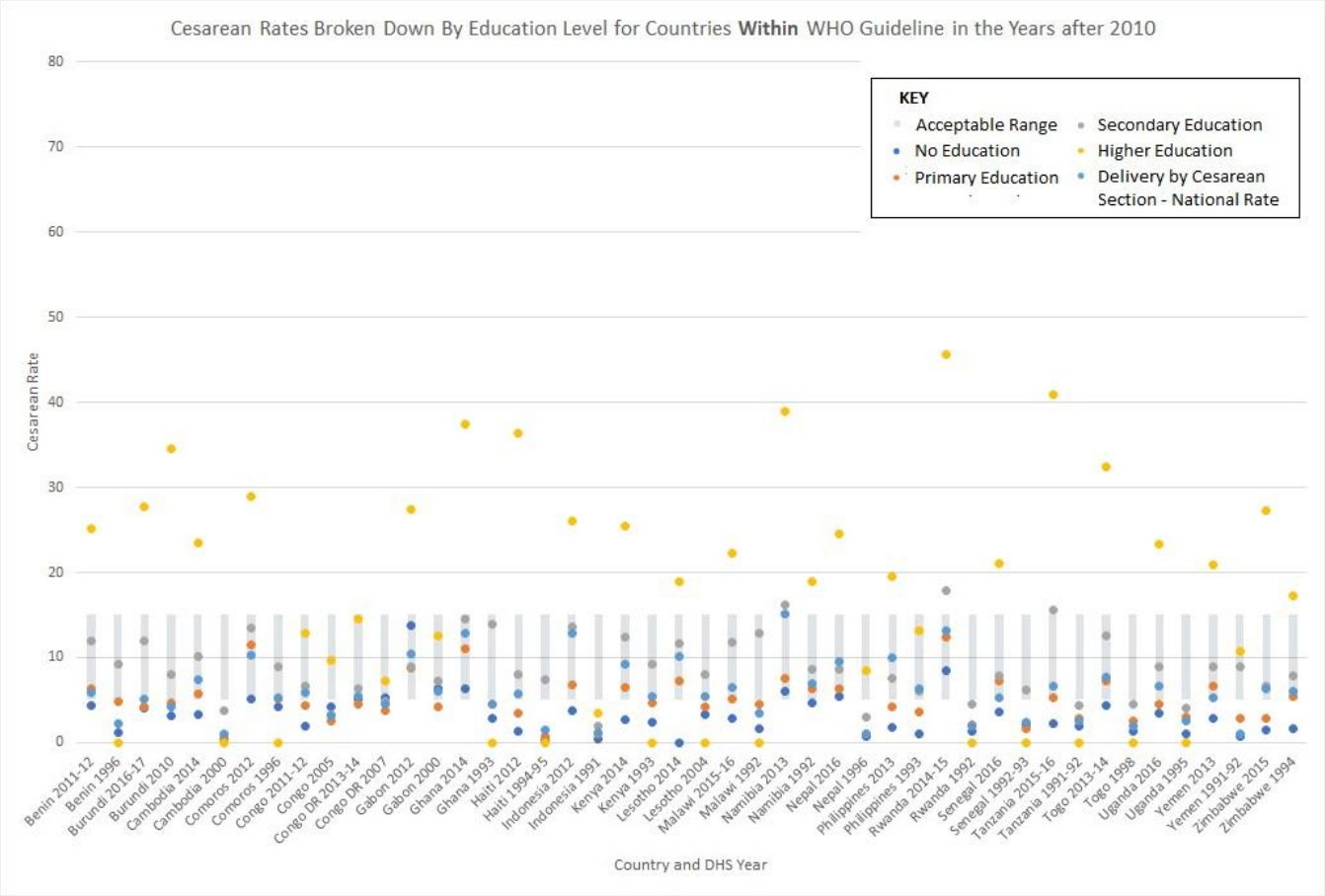


Figure 3. Countries that remained within the WHO guidelines.

Countries that exceeded the WHO guidelines. In this case, it becomes clear that countries have been able to successfully expand access to lower SES groups over time. By time 2, in all countries, there are no groups that remain below the recommended threshold. However, there is increasing concern over the fact that many groups are now vastly exceeding the upper end threshold. In Egypt, we see that all groups are utilizing cesarean at rates well above 40%.

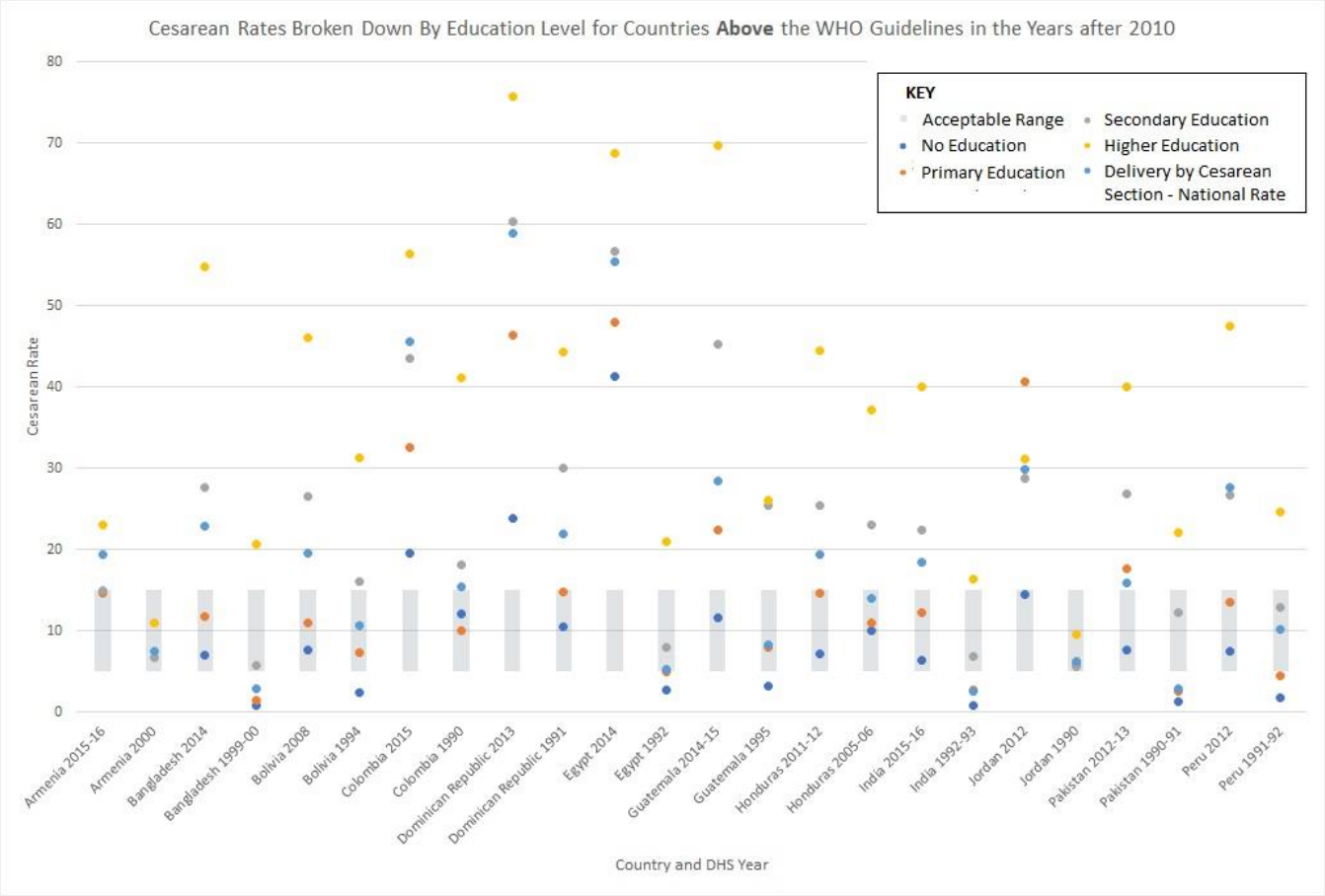


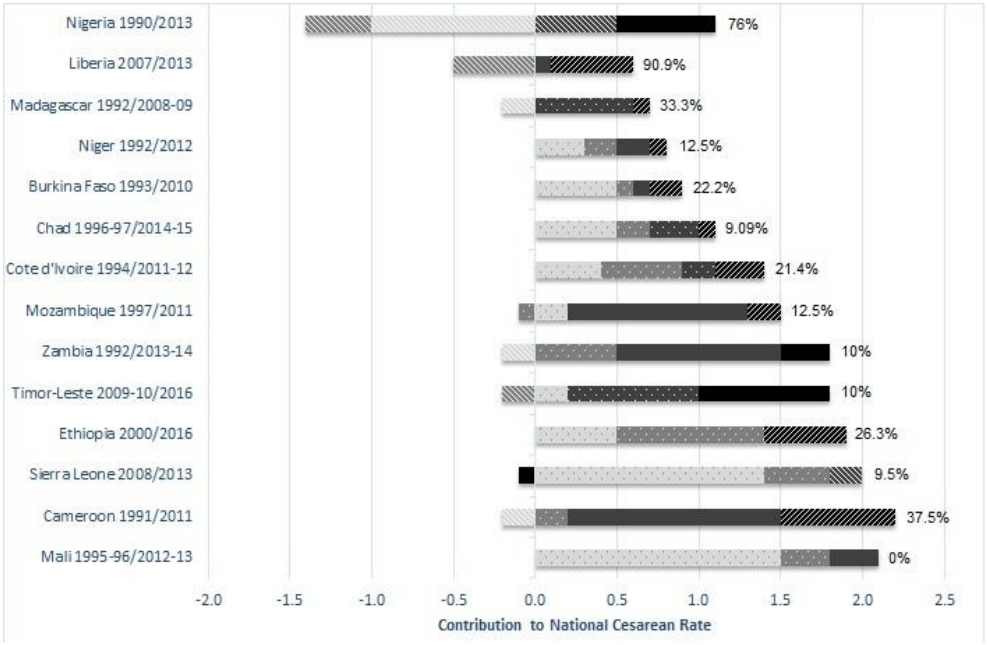
Figure 4. Countries that exceeded the WHO guidelines.

Group drivers of change in cesarean usage.

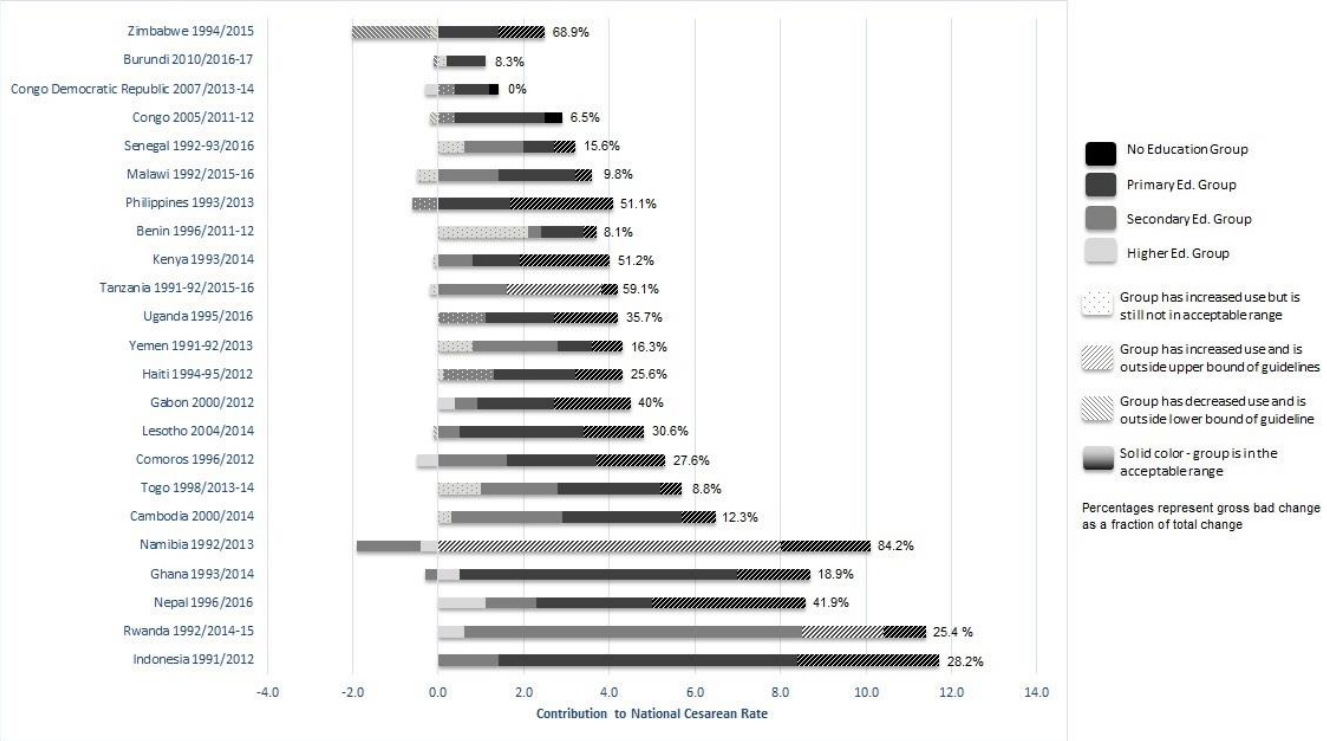
Using a decomposition method, we can evaluate the relative contribution of different SES groups to overall changes national cesarean rates to better understand *who* is driving the change at the national level. Any overall change can be driven both by the compositional change of a particular group (i.e. more women move to a higher education category) and/or by the behavioral change of a group (i.e. the rate of cesarean usage among women in that education category). Below are a series of decomposition findings that highlight 1) the total change in cesarean rates; 2) the social groups driving the change (i.e. highly educated) and 3) whether or not the groups overall contribution to change indicates that they moved the national average is a desirable direction (i.e. groups that increased their usage and are now in the "safe range" or increased usage by remain below of the safe range) vs if the group increased their usage in an undesirable direction (i.e. their change in usage put them out of the safe range).

For each chart, we highlight the variation in drivers and discuss country specific policy and evidence that can help to explain these patterns.

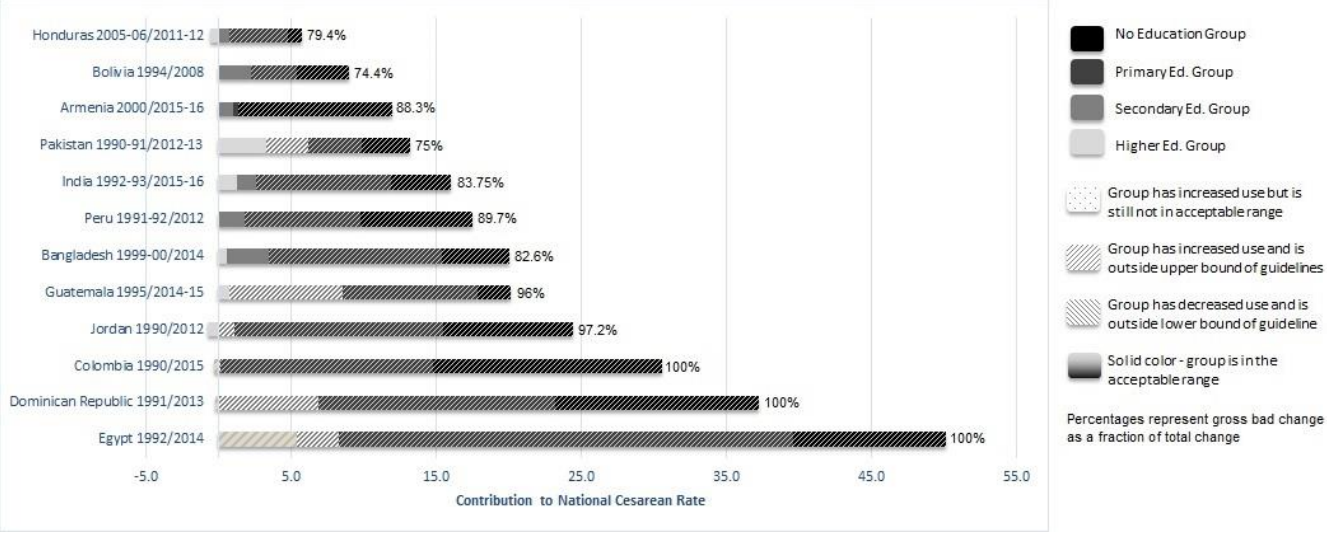
Countries with national rates below WHO Guidelines



Countries with national rates within WHO Guidelines



Countries with national rates above WHO Guidelines



DISCUSSION

Overall, our analysis finds both increasing cesarean rate among higher-educated groups and the relatively stagnant rates among lower-educated groups. This trend likely reflects widening socioeconomic disparities that have negative implications for maternal health at both ends of the spectrum.

A between-countries comparison shows that 23 of the 49 countries in our analysis (46.9%) achieved an acceptable cesarean utilization rate as of the most recent DHS year post-2010. Twelve of the 49 included countries (24.5%) exceeded the acceptable cesarean rate, while 14 of the 49 included countries (28.6%) were below the acceptable cesarean rate.

At the macro-level of comparison, we notice that 13 of the 14 countries with below-acceptable cesarean rates are from the Sub-Saharan Africa regional grouping. This is supported by a 2016 analysis of regional cesarean birth rates by Betrán et al. The stagnancy of cesarean rates in Sub-Saharan Africa can be attributed to deficiencies in the structure of the region's health care system and a paucity of resources, including access to proper equipment and trained professionals during childbirth (Betrán et al. 2016).

At the other extreme, Egypt (2.28) and the Dominican Republic (1.68) lead in terms of annualized rate of change of national cesarean rate. All South Asian countries included in this analysis ranked within the top 20 countries with highest annualized rates of change, and three of these four countries were above the WHO guidelines for appropriate cesarean rate. Overall, Latin American countries had the highest annualized rates of change. There was a wide range of annualized rates of change among Sub-Saharan African countries, with Rwanda accelerating its cesarean use at a rate of 0.51 and Nigeria lagging at a rate of change of -0.01.

Cultural indications for increasing cesarean section rates have been identified in previous research. A study of the cesarean rate in Egypt points to the increase in private-facility deliveries as motivating the overutilization of cesareans in the country (Al Rifai 2017). A study of cultural factors that motivate elective cesarean deliveries in China found that a cesarean delivery gives parents the flexibility to schedule their baby's birth on an auspicious date (Mi and Liu 2014). On the side of the healthcare provider, cesarean deliveries are thought to be safer and more convenient and are a response to increased medical litigation pressures (Betrán et al. 2016). Some other cultural concerns that have contributed to the widespread overutilization of cesareans are "…fear of pain; concerns about genital modifications after vaginal delivery; misconception that CS is safer for the baby…and lower tolerance to any complications or outcomes other than the perfect baby" (Betrán et al. 2016).

Previous studies have recognized these cultural pressures and the alarming rise of cesarean use in countries such as Egypt and the Dominican Republic. However, inappropriate cesarean utilization is not limited to countries with extreme annualized rates of change. Certain countries such as Rwanda, Ghana, and Burundi may be meeting macro-level guidelines for cesarean use, but when the national rates are decomposed there is incredible disparity in utilization across education levels.

A within-countries analysis reveals that a behavioral effect is largely responsible for increases in cesarean rates. A behavioral effect indicates that changes in a subpopulation's decision-making and behavioral habits is motivating the change in rate for that subpopulation. For example, in Guatemala, the primary education subpopulation produced the greatest behavioral effect on the nation's rising cesarean rate. This means that women who had achieved only a primary level of education were beginning to receive cesareans in greater numbers, either because access to healthcare providers and private facilities had increased or because cesarean deliveries were

becoming more favorable among this demographic. By contrast, the compositional effect of education level would attribute the change in cesarean rate to the expansion or shrinking of the subpopulation's size. In the Guatemala example, the compositional effect is less significant than the behavioral effect, indicating that a change in behavior and not a change in population size was responsible for the increase in Guatemala's cesarean rate.

From the data, it can be discerned that behavioral and compositional changes in the primary and secondary education groups tend to be most impactful on a nation's overall cesarean rate, likely because the primary and secondary groups are the largest.

The observed behavioral effects on national cesarean rates stand in support of diffusion theory. It is notable that when a behavioral effect is observed in one group, a behavioral effect of similar direction is observed in all other groups, even though the magnitude of the behavioral effect may differ. Returning to the Guatemala example, the behavioral effect of the primary education group is most obviously responsible for the increase in the nation's overall cesarean rate. However, upon closer look, it is evident that all other education levels were also increasing their cesarean utilization behaviors, albeit at different rates, resulting in positive behavioral effects across the board. Thus, behavioral changes in one group are mimicked by changes in another. While it is not clear from the data which education level adopted the change in behavior first, it is reasonable to hypothesize that as the practice of cesarean deliveries became commonplace among higher-educated groups, lower-educated groups were influenced to adopt these behaviors as well. This would explain why a behavioral effect in one group is often compounded by behavioral effects in all other groups.

Limitations to the Data

While the DHS is one of the most comprehensive surveys of key health indicators in developing countries, it has its limitations. We want to recognize the results of a 2007 study evaluating the quality of cesarean birth data in the DHS, which found that: "In general, DHS cesarean birth rates were found to be about one-third higher than the rates based on hospital data" (Holtz and Stanton 2007).

Additionally, the surveys selected for the analysis were the earliest surveys available before 2010 and the most recent surveys post-2010. We selected this range because we wanted a large range of years for each country during which we could evaluate significant, large-scale changes in cesarean rates. However, in this large period, the survey structure changed in the following way: "surveys conducted prior to 1999 were likely to have asked the cesarean birth questions of all women who had experienced a recent birth, thereby including reports of implausible cesarean deliveries occurring at home or in low-level facilities. From 1999 to the present, the majority of surveys have restricted the question to women who report a facility-based birth" (Holtz and Stanton 2007). Because of this skip pattern, by the standards of the post-2010 surveys, some of the pre-2010 surveys may be overestimating cesarean rates, which could mean the increase in cesarean rates is more dramatic than what is reflected in the data.

Recommendations

The overarching theme of the United Nations SDGs are to minimize inequalities in healthcare, education, and other spheres of life. The cesarean section utilization problem is an extension of this larger issue of inequality. At the global level, inequality is decreasing—countries are becoming more similar. However, there are rising rates of inequality *within* nations. We need to pay attention to this inequality and minimize the damage to all groups that suffer as a result.

The UN SDGs aim to improve education, but education is not a net positive thing across all fronts. If the goal to improve education is seen as an end-all objective, groups that have achieved higher education are no longer prioritized by the government. Particularly in the case of cesarean rates, countries cannot afford to neglect higher-education individuals, who must contend with the unique problem of intervention overuse secondary to their higher sociodemographic standing. Improved education might improve access to care, but not necessarily for the better.

In line with this, it is important to recognize that, while the WHO has macro-level guidelines for cesarean section use, some groups are undershooting these guidelines and some groups are overshooting. The heterogeneity in cesarean rates within nations should be acknowledged by policy-makers. It is imperative that we develop strategies to bring up rates in under-utilizing populations and curb medically-unnecessary usage in higher-educated populations. Equal *access* to care should not be the end goal. There should also be a goal to give *appropriate* care and a uniform level of care across socioeconomic groups.

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