SOCIAL AND ECONOMIC CHANGE AND RISING RATE OF CESAREAN SECTION
DELIVIERIES IN ECUADOR

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ABSTRACT

Johanna R. Jahnke: Social and Economic Change and Rising Rate of Cesarean Section
Deliveries in Ecuador
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Birth by cesarean section is increasing globally, particularly in countries experiencing

rapid social and economic change. While cesarean sections can be imperative for the immediate

health of mother and child, elective cesareans have been associated with increased risk of low

birthweight, metabolic disease, asthma, diabetes, and obesity in children and health risks in

mothers. The Pan American Health Organization (PAHO) recommends a national cesarean

section rate of between 5 and 15% and suggests that a rate higher than 15% may be motivated by

factors other than medical risk. Ecuador's rate of cesarean delivery rose from 17.1% in 1994 to

41.2% in 2012. Using data from Ecuador's 2012 nationally-representative *Encuesta Nacional de
Salud y Nutrición* (ENSANUT), this project explores how socioeconomic factors and access to

prenatal care are associated with the prevalence of cesarean sections in Ecuador and rates of

change over the past two decades.

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INTRODUCTION

Birth by Cesarean section is increasing globally, particularly in countries experiencing

rapid social and economic change (Villar et al. 2006). While cesarean sections can be imperative

for the immediate health of mother and child, elective cesareans have been associated with

increased morbidity and mortality for both mother and child (Villar et al. 2006). The maternal

mortality rate for mothers who deliver by cesarean is four to ten times higher than that for

mothers who deliver vaginally (Runmei et al. 2012). In addition, cesarean sections have been

associated with increased fetal mortality rates (Villar et al. 2006), and they pose increased risk of

low birthweight, reduced breastfeeding initiation and duration, metabolic syndrome, asthma,

diabetes, gastrointestinal disease, respiratory infections, and overweight and obesity in offspring

(Hyde and Modi 2012; Blustein et al. 2013; Merenstein et al. 2011). Obesity and overweight are

of particular concern recently, as obesity worldwide has more than doubled since 1980 (World

Health Organization 2015).

Specifically, in 2014 in Ecuador, 40.6% of adults were overweight and 22.2% were obese

(Freire et al. 2015). The rapid increase in rates of obesity and overweight has affected children

and adolescents as well, and in 2014, 29.9% of school-aged children and 26.0% of adolescents in

Ecuador were overweight or obese (Freire et al. 2015). The Pan American Health Organization

(PAHO) recommends a national cesarean section rate of between 5 and 15% and suggests that a

rate higher than 15% may be motivated by factors other than medical risk. In Ecuador, cesarean

section prevalence rose from 17.1% in 1994 to 41.2% in 2012 (Freire et al. 2015). By education,

24.1% of births to women who did not complete primary education were by cesarean section,

while 55% of births to women who had completed higher education and graduate school were by cesarean section (Freire et al. 2015). By socioeconomic status, 31.4% of births were by cesarean section in the poorest quintile, and 57% of births were by cesarean section in the wealthiest quintile. Despite these stark differences, rates of cesarean section are increasing at all levels of education and socioeconomic status (Freire et al. 2015). The rapid increase in cesarean delivery in Ecuador may be due in part to Ecuador's dramatic recent social and economic change. In this context, Ecuador serves as a case study of socioeconomic changes that are affecting Latin American countries more broadly.

This study will explore how care during pregnancy and birth shape mode of delivery. Specifically, it will assess how receiving care at public institutions, social security institutions, or private institutions influences the type of delivery that a woman has. I will also assess how the number of prenatal visits, regardless of institution, influences whether a woman gives birth by cesarean section or vaginally.

INCREASED CESAREAN SECTION AND SOCIAL AND ECONOMIC CHANGE IN ECUADOR

Economic Development in Ecuador

In recent decades, Ecuador has undergone dramatic economic development. Ecuador has been classified as a middle-income country, but within its own population, steep inequalities nonetheless persist. After an economic crisis in 1999, the percent of the Ecuadorian population living below the national poverty line dropped from 64.4% in 2000 to 22.5 in 2014, and the gross national income (GNI) per capita rose from $1,540 in 2000 to $6,090 in 2014 (World Bank).

This rapid economic change has likely shaped the rates of women who undergo cesarean delivery, the average profiles of women who receive cesarean sections, and the ways that decisions are made about mode of delivery. In a study comparing cesarean section rates and maternal and neonatal mortality in low-, medium-, and high-income countries, Althabe et al. (2006) found that low-income countries generally had much lower rates of cesarean section than middle- and high-income countries, and the authors suggested that in countries with higher income, higher rates of cesarean delivery without an association to improved neonatal and maternal outcomes may demonstrate the use of unjustified cesarean deliveries in healthy populations. Béhague (2002) echoes this sentiment, noting that in Brazil, while wealthier women are more likely to undergo an unnecessary costly and risky cesarean section, the women who are most likely to need one do not have one.

Economic Development and the Health Care System

With economic development, Ecuador has also undergone a re-structuring of its healthcare system to reduce care provided by private institutions and increase access to health care services through public and social security care. Despite this change, Ecuador's medical system has been and remains fragmented into three separate segments: the Ministry of Health (MoH), which serves the public sector, primarily the lowest-income groups; the social security branch, including the *Instituto Ecuatoriano de Seguridad Social* (IESS), which serves workers and employees, and the *Seguro Social Campesino* (SSC), which serves rural poor families that are legally recognized members of peasant organizations; and the private sector, which serves the wealthiest individuals.

Fragmentation within Ecuador's health system has roots in the 1980s, when Ecuadorian leaders pushed neoliberal reforms in attempts to reverse the failing economy, and public health funding was cut in order to rely on the free-market's promise of low-cost, quality health care (Rasch and Bywater 2014). During this time, a biomedical care model that emphasized episodic, emergency-style care became entrenched in Ecuador's health care system (Rasch and Bywater 2014). Private hospitals encouraged patient-centered care in response to pathology, and care in Ecuador increasingly ignored interventions at the population level that could promote health and prevent disease (Rasch and Bywater 2014). This model, while doing little for the health of the population, does reap vast economic reward for private hospitals, which can profit off of individuals who have not received preventative care (Navarro 2008).

Throughout the 1990s, Ecuador struggled to meet the population's health care needs, as private care remained expensive and inaccessible for the majority of the population (Rasch and Bywater 2014). In 1998, Ecuador declared health a human right, and the Organic Law of the

National Health System, which made the national health system responsible for meeting this right, was enacted in 2003 (De Paepe et al. 2012). Despite this legislation, the health care system remained fractured, as the government enacted no social policy to coordinate the three existing sectors of healthcare.

After President Correa was elected into office in 2006, Ecuador installed a drastic overhaul of the MoH realm of the health system. First, a vastly increased budget allowed the MoH to invest in equipment, infrastructure and personnel. Second, as of April 2008, Ecuador's new constitution guarantees access to free, high quality healthcare to all citizens (Rasch and Bywater 2014). Since then, despite the MoH's increased budget, public institutions have had difficulty keeping up with the increased patient demand that has arisen through free healthcare reform. Meanwhile, the private sector, which includes for-profit institutions like hospitals and clinics as well as nonprofit organizations like non-governmental organizations (NGOs), has been expanding over the past few decades, and it has drawn medical staff from public institutions through higher pay (De Paepe et al. 2012).

As a result, the general population, including the poorest groups, who primarily utilize the public sector, perceive public services as bad quality, especially in regard to long wait times and short consultations (De Paepe et al. 2012). Social security services, too, are suffering from decreased budgets and competition with the private sector to retain staff. De Paepe et al. (2012) argue that though Ecuador has not expressly adopted neoliberal reform in the past few decades, the spirit of neoliberalism nonetheless persists through competition with the MoH and social security institutions and contracts with the public sector. Rasch and Bywater (2014) argue that despite developing a universal healthcare system, Ecuador's health system remains riddled with problems due to the continued presence of the interests of private institutions, which are more

focused on curing existing illness than preventing it. In either case, Ecuador's fragmented health care system poses deep-rooted, structural barriers to equal and quality healthcare.

Economic Incentives for Cesarean Delivery

The privatization of hospitals has had consequences on care broadly, but also on rates of cesarean section throughout Latin America (Taljaard et al. 2009; Villar et al. 2006; Béhague 2002). Taljaard et al. (2009) found significant associations with higher risk-adjusted rates of cesarean delivery in private hospitals than public hospitals in Latin America. In a survey of maternal and perinatal health in Latin American countries, Villar et al. (2006) found that 58% of the private institutions in the sample reported economic incentives to cesarean section, while 24% of public institutions did, and only 5% of the social security hospitals did. In her work in Brazil, Béhague (2002) found that while hospitals may not be directly incentivized for performing cesarean sections, indirectly, cesarean sections increase profits due to a decreased birthing time and the subsequent ability of the hospital to attend more births overall.

Medicalization of Pregnancy and Birth

With rapid economic change and re-structuring of the health care system over the past few decades, Ecuador, like many other Latin American countries, has undergone a drastic change in the perception of bodies, health, and the role of medicine. Pregnancy and birth in particular have become increasingly medicalized. In 1998, the Law of Free Maternity and Child Care was passed, increasing funds into maternal and child care services, and likely contributing to the rapid increase in institutional births that took place between 1994 and 2004 (De Paepe et al. 2012). In 1994, only 74.7% of women had at least one prenatal checkup and 47.5% had more

than five, while only 63.5% of births occurred in a healthcare establishment (Freire et al. 2015). By 2012, 95.0% of women had at least one prenatal checkup, 79.5 had more than five, and 95% of births occurred in healthcare establishments (Freire et al. 2015). Over this period, the maternal mortality rate has dropped from 147 women per 100,000 live births in 1994, to 74 per 100,000 in 2012, and to 64 per 100,000 in 2015 (World Bank 2016). Infant mortality has also declined in the past two decades, dropping from 37 deaths per 1,000 live births in 1994 to 20 in 2012, and to 18 in 2015 (World Bank 2016).

The increased use of technology in care has also marked a drastic cultural shift that has made cesarean sections more acceptable, more normalized, and thus more common (Belizán et al. 1999). This shift toward a "culture of cesareans" (Béhague 2002) has been at least partially embraced by both patients and doctors, who increasingly view cesarean sections as modern and safe (Villar et al. 2006). Thus physicians' decisions to perform cesarean sections may not be motivated purely by financial incentive, but could also be motivated by a fear of litigation in the case of poor maternal or neonatal outcomes of a vaginal delivery, which is increasingly viewed as unpredictable (Béhague 2002).

Diagnostics provided by new technologies throughout prenatal care establishes expectations for the birth experience and mode of delivery. Ultrasounds, in particular, allow women and doctors to view the positioning of the fetus months in advance, sometimes prompting the assumption for cesarean delivery. In Brazil, Béhague (2002) found that expectant mothers spoke of prenatal care as a "treatment" for pregnancy that has consequences on the birth itself, and that good prenatal care, in their opinion, could predict or alter the mode of delivery. Overall, prenatal care, and the technologies of prenatal care, gave expectant mothers a sense of control over their pregnancies (Béhague 2002).

Medical Indication and Misrecognition

The decision to perform a cesarean section is the work of complex consideration of knowledge from many sources, including a patient's personal preference, family and community influence, and medical opinion.

The primary indications for cesarean delivery are a previous cesarean delivery, breech presentation, dystocia, and fetal distress (Notzon et al. 1994). Non-medically indicated cesareans are often cited as a primary factor for the increase in cesarean deliveries globally (Penna and Arulkumaran 2003), but perceptions of medical safety and misrecognition about what medical indication truly *is* have complicated this issue. Increased medicalization of pregnancy and delivery over the past few decades further complicates the classification of medically indicated.

Some authors have used the concept of misrecognition to understand how women perceive birthing safety and medical indication in making decisions regarding mode of delivery. In interviews with English women, Tully and Ball (2013) found that many women who had unscheduled cesarean sections without medical indication expressed that they had, in fact, wanted to avoid a cesarean delivery, but that it had become necessary. Citing authoritative knowledge, women expressed that they underwent cesarean sections in response to their physician's suggestion that their labor was prolonged, non-progressing, or failed, despite the lack of indication of fetal distress (Tully and Ball 2013). In these cases, cesarean section was presented as "the way forward" (Tully and Ball 2013). While these circumstances were not "medically-indicated," the language used by doctors suggested to mothers that a cesarean section was their best option. Mothers felt a responsibility to abandon vaginal delivery and resort to a cesarean delivery for the physical and psychological safety of both their own and their child's health (Tully and Ball 2013).

In an era of increased medicalization and control over the body, birthing stands out as unpredictable. Béhague (2002) found that women in Brazil whose labors were "prolonged" or deviated from the norm self-identified their experience as problematic, and they desired to conform to biomedical expectations of standard birthing performance. Women whose labors were particularly long often suggested afterward that they should have had a cesarean delivery, and that they felt they had received poor care (Béhague 2002).

These two cases demonstrate how birthing, due largely to its unpredictability, is often misrecognized by doctors and patients as problematic. In these instances, despite no technical medical-indication, cesarean delivery is often performed to garner control over a birth.

While this misrecognition during labor may account for a piece of Ecuador's rising cesarean rate, the WHO found that most of Ecuador's cesarean deliveries are "elective" (Villar et al. 2006). In this paper, "elective" cesareans are planned prior to labor usually due to a complication (Villar et al. 2006). In fact, in their survey of maternal and perinatal health in Latin American countries, Villar et al. (2006) found that less than one percent of cesarean sections are performed on maternal request with no medical indication. The most common indications for cesarean delivery are cephalopelvic disproportion, dystocia, and failure of labor to progress (Villar et al. 2006).

Patient Request for Cesarean Section

Some anthropologists have found that women prefer cesarean sections and speak about them in positive terms. These anthropologists report that women who request a cesarean section have discussed their perception of vaginal delivery as frightening, unpredictable, and dangerous for both the mother and the infant (Fenwick et al. 2010; Tully and Ball 2013). Many women also

express skepticism and concern that such a large child could come out of the narrow vaginal canal without causing irreparable damage to the infant or the mother (Fenwick et al. 2010). In contrast, women expressed the predictable, safe, and controlled nature of a cesarean delivery (Béhague 2002; Fenwick et al. 2010; Tully and Ball 2013). Béhague (2002) has also suggested that in Brazil, giving birth by cesarean section increases a woman's status through the implication that she has the resources to afford private health care or that she is delivering a large and healthy infant.

Other studies have shown that cesarean section is not the preferred method of delivery in Brazil and elsewhere. Kasai et al. (2010) found that among a group of women in their third trimester, most expressed a preference for a vaginal delivery due to its perceived shorter recovery period. Similarly, Karlström et al. (2011) found that in a cohort of 1506 Swedish women in late pregnancy, only 7.0% reported a desire to have a cesarean section.

Some researchers propose that women use technology, cesareans in particular, to negotiate more control over their own bodies and their own health (Browner and Press 1997; Chachum and Perpetuo 1998; Lazarus 1994), while others suggest that women use cesarean sections and medical technologies to assert their medicalized positions and modernity (Béhague 2002).

Developmental Origins of Health and Disease and Cesarean Section

From a biological perspective, delivery has been shown to be a critical phase in perinatal experience that shapes long-term development. Specifically, cesarean section has been associated with increased risk of low birthweight, reduced breastfeeding initiation and duration, metabolic syndrome, asthma, diabetes, gastrointestinal disease, respiratory infections, and overweight and obesity in offspring later in life (Hyde and Modi 2012; Blustein, et al. 2013; Merenstein et al. 2011; Cho et al. 2013).

The developmental origins of health and disease (DOHaD) hypothesis presents a compelling framework to consider the long-term influences of mode of delivery on child health. This hypothesis is based on epidemiological and experimental literature documenting that fetal and neonatal environment can shape the occurrence of disease risk throughout the life course (Barker 2004). The DOHaD phenomenon can be considered a subset of developmental plasticity, the process by which an individual adapts to its environment throughout the life course (Gluckman et al. 2007). It is thought that through integrated epigenetic changes, individuals take cues from the environment and adjust development, and thus adult phenotype, to be better suited for the predicted future environment (Gluckman et al. 2007). Several pathways have been proposed to explain these epidemiological findings. Some findings suggest that cesarean delivery increases risk of preterm birth and low birth weight, introducing a suite of cardiovascular and metabolic diseases. Others find that cesarean section deliveries bypass the beneficial stress of

vaginal delivery, posing consequences for development. Cesarean section may also alter the foundational gut microbiome in infants, causing a lasting dysbiosis between infant and gut bacteria that may alter development (Goulet 2015). After birth, cesarean delivery shapes breastfeeding practices that affect infant early nutrition, another crucial pathway to healthy early development.

Preterm Birth and Birth Weight

Preterm labor poses a challenge for practitioners, since preterm birth has been associated with increased risk for fetal and neonatal morbidity and mortality (Goldenberg et al. 2008). Though the optimal mode of delivery for women in preterm labor is still contested (Alfirevic et al. 2013), many practitioners opt for cesarean section, which has been associated with improved neonatal outcomes in some studies (Werner et al. 2012; Lee and Gould 2006; Högberg and Holgren 2007). This practice is based on the assumption that preterm birth can be accurately diagnosed and intervened upon with cesarean section very early in labor or even prior to labor, which is not usually the case (Alfirevic et al. 2013). In fact, often mothers thought to be in preterm labor do not give birth until many weeks later (Alfirevic et al. 2013). As a result, intervening with cesarean section on signs of preterm labor may actually increase rates of preterm birth and low birth weight.

Planned cesarean deliveries also increase risk for preterm and low birth weight, since often a cesarean is scheduled for a date a few weeks before an infant's due date. Typically cesareans are scheduled for a date less than 39 weeks of gestation, but since exact gestational age is not easily measured, some of these cesarean sections will result in preterm birth or low birth weight.

Thus, increased rates of cesarean delivery, both planned and in response to signs of preterm labor, increase rates for preterm and low birth weight, each of which poses a separate suite of developmental risks. Preterm birth has been associated with insulin resistance (Hofman et al. 2004), and low birth weight has been associated with metabolic and cardiovascular diseases, obesity, and non-insulin dependent diabetes (Godfrey 1998).

It remains unclear whether the associations between disease risk and preterm birth are caused by early exposure to postnatal environment itself, by a stressful intrauterine environment that initiates a preterm birth, or by a combination of these two (Gluckman et al. 2005). Nonetheless, both prematurity and impaired fetal growth may be symptoms of an unfavorable intrauterine environment and cannot then be understood as entirely distinct form one another (Gluckman et al. 2005).

Benefits of Labor for Development

The experience of birth through labor may be critical to a neonate's development, and several authors have proposed that cesarean delivery interferes with the physiologically and immunologically beneficial experience of labor (Thilaganathan et al. 1994; Cho et al. 2013).

Authors have consistently found an association between cesarean section and the development of asthma (Xu et al. 2001), and a meta-analysis of 23 studies showed that children and adults delivered by cesarean have a 20% higher risk of asthma than those born vaginally (Thavagnanam et al. 2008). While specific mechanisms for this relationship remain unclear, consistent associations between cesarean section and respiratory distress syndrome (RDS) (Buhimschi and Buhimschi 2006) have demonstrated that a potential physiological mechanism may exist. Many studies have shown that cesarean section is an independent risk factor for RDS

(Gerten et al. 2005), the leading cause of admission to neonatal intensive care units (Zupancic and Richardson 1998) and the second leading cause of neonatal mortality in the US (Gerten et al. 2005). When survived, RDS poses developmental consequences throughout life, and it has been associated with asthma diagnosis in children (Smith et al. 2004). These results imply a protective effect of labor itself for the development of lung function.

Immunologically, altered levels of stress hormones at birth may alter immune response in infants born vaginally or by cesarean. During a vaginal birth, both contractions of the uterus and fetal hypoxia stimulate a measurable stress response in neonates, showing increased catecholamine and cortisol concentrations after birth (Lagercrantz 1996). Elevated circulating cortisol in neonates is an indicator of hypothalamic-pituitary-adrenal (HPA) axis activation (Gitau et al. 2001) and is associated with increased maturation of organs (Siggers et al. 2008). In response to physical or psychological stressors, HPA axis activation increases levels of corticosteroids, which serve as both the central component of physiological response to stress and as suppressors of immune response (McDade 2005). Thus, the HPA axis and corticosteroids are both key mediators of stress and immune function (McDade 2005). Infants delivered by cesarean do not experience this stress response at birth (Lagercrantz and Slotkin 1986), and therefore they develop poorer HPA axis activation and a less mature immune system (Cho et al. 2013). Some authors have proposed that another mechanism that may contribute to a developmentally stunted immune system in those born by cesarean section is duration of stress during birth, as infants delivered by cesarean experience immediate stress while those born vaginally experience a prolonged stress throughout labor (Hyde et al. 2012).

Maternal Characteristics Shape Cesarean Section Risk and Development

Maternal characteristics that increase a woman's risk of cesarean section may also increase risk of disease development in offspring, serving as confounders for the relationship between cesarean section and development of disease.

Maternal pre-pregnancy overweight and obesity has shown moderate associations with unplanned cesarean section rates (Vahratian et al. 2005). In their meta-analysis of maternal obesity and risk of cesarean delivery, Chu et al. (2007) estimated that obese and severely obese women are two and three times more likely, respectively, to give birth by cesarean section than normal weight women. The mechanism for this association is not well understood (Dietz et al. 2005). Many authors have suggested that obesity affects risk of cesarean section by increasing risk of other pregnancy complications, especially the risk of gestational diabetes (Yang et al. 2002; Greene and Solomon 2005), though Chu et al.'s (2007) meta-analysis as well as other authors (Kaiser and Kirby 2001; Ray et al. 2001; Linne 2004) have found that obesity is an independent risk factor for cesarean delivery. Others have suggested that obesity may narrow a mother's pelvic soft tissue, narrowing the birth canal, and increasing risks associated with dystocia (Crane et al. 1997; Schmid et al. 2004; Kaiser and Kirby 2001) or cephalopelvic disproportion (Witter et al. 1995). Still others propose that obese women may have more difficulty with labor progression or oxytocin administration, leading to cesarean section (Vahratian et al. 2004).

Maternal obesity is also associated with many of the developmental conditions associated with cesarean section, such as asthma in childhood (Forno et al. 2014), obesity, metabolic disease, diabetes and cardiovascular disease in offspring (Santangeli et al. 2015). Thus, maternal

obesity serves as a confounder in the relationship between cesarean delivery and disease development in offspring.

DOHaD and the Microbiome

The development of the infant gut microbiome is a key pathway that links early environment to future risk of disease (Edwards and Parrett 2002), and it is shaped by prenatal events, mode of delivery, infant feeding, postnatal environment, and antibiotic use (Goulet 2015). Most microbial species develop a symbiotic relationship with their host, promoting healthy development that educates the immune system, supports the development of gut function, regulates intestinal barrier function, protects against infection, and promotes food tolerance (Goulet 2015). However, unfavorable changes in the composition of gut microbiota, termed dysbiosis, may contribute to disease risk for obesity, metabolic disease, autoimmune disease and allergy, and intestinal inflammation (Cho et al. 2013; Goulet 2015). Dysbiosis early in life can be considered to be a part of the larger phenomenon of DOHaD.

A few mechanisms have been proposed to link cesarean section to increased adiposity, BMI, and metabolic disease in offspring later in life, including the proposal that mode of delivery differentially shapes the foundational gut microbiome in infants, which may alter energy harvesting and contribute to increased risk of obesity and overweight (Ajslev, et al. 2011). Mode of delivery introduces critical microbiota that rapidly colonize the infant intestine through ingestion (Guarner and Malagelada 2003). Since mammals are born with otherwise sterile intestines, this interaction is crucial to laying down initial microbiota.

Infants born vaginally are exposed to and colonized by their mothers' vaginal and fecal bacteria, while infants born by cesarean are more likely to be colonized by epithelial bacteria

(Dominguez-Bello, et al. 2010). As a result, infants born vaginally exhibit a bacterial composition similar to that of their mothers' vaginal and intestinal microbiota (Goulet 2015). Cesarean delivery disrupts the natural acquisition of these gut microbiota and introduces novel microbiota from other sources. During a C-section (with no rupture of the membrane) the infant is not exposed to vaginal microbes at birth (Kabeerdoss, et al. 2013). Instead, the infant is exposed to epithelial bacteria that colonize the infant gut microbiome (Dominguez-Bello, et al. 2010). Studies have also shown increased levels of *Clostridium difficile*, a species of gut microflora that has been associated with the development of asthma, in infants born by cesarean (van Nimwegen, et al. 2011). Notably, the microbiota of infants born by cesarean section does not exhibit bifidobacteria, a bacteria that has been associated with reduced risk for allergic disease (Björkstén, et al. 2001) and excessive weight gain (Kalliomäki, et al. 2008; Dogra, et al. 2015), and the infant's microbiome may not be colonized by bifidobacteria for up to six months after birth (Biasucci et al. 2008).

It is important to note that antibiotic treatment may confound some of these results. A mother delivering by cesarean and her infant are more likely to be treated with antibiotics around the time of birth than a mother delivering vaginally. Antibiotic treatment can disturb intestinal microflora with effects lasting years (Jernberg et al. 2007; Jakobsson et al. 2010), and thus antibiotics may be the root cause of some associations found between cesarean section and changes in the microbiome, not the cesarean section itself. Nonetheless, as antibiotic treatment and cesarean section are tightly linked, antibiotic treatment may be considered another mechanism by which long-term development is shaped by cesarean delivery.

Breastfeeding and DOHaD

Breastfeeding is another key determinant of DOHaD, and studies have shown that mode of delivery differentially shapes both breastfeeding practices and breast milk composition itself. Many studies have shown that breastfeeding is protective against obesity (Dewey 2003; Dietz 2001). Differences in breastfeeding practices have been shown to be strongly associated with mode of delivery, showing delayed breastfeeding (Prior et al. 2012) and worse breastfeeding outcomes for mothers who delivered by cesarean (Hyde and Modi 2012). Mothers report a variety of obstacles to breastfeeding after a cesarean, including difficulty with mobility, incision pain, positioning difficulties, and the need for rest and recovery from surgery (Tully and Ball 2014).

While differential breastfeeding practices are critical to differences in infant gut microbiota, breast milk composition itself may be responsible for some differences in gut microbiota between infants born via cesarean section and infants born vaginally. One study showed that breast milk from mothers who delivered by cesarean section exhibits higher microbial diversity but reduced frequency of beneficial bifidobacteria (Khodayar-Pardo, et al. 2014). Differences in both breastfeeding practices and breast milk composition between mothers who deliver vaginally and mothers who deliver by cesarean may alter infant growth and development in the long-term.

METHODS

Quantitative data from Ecuador's nationally-representative demographic health survey, *Encuesta Nacional de Salud y Nutrición* (ENSANUT), were analyzed to examine how sociodemographic factors and care shape cesarean section prevalence. The surveys contain demographic information and data on maternal and child health, breastfeeding, infant health, risk factors for adults and children, and nutrition. The following datasets were used for the analysis: *Información General*, *Mujeres en edad fértil (MEF)*, and *Salud en la Niñez*. Specifically, socio-demographic data are from the *Información General* dataset. Data on place of birth and complications during pregnancy and birth are from *Sección III: Servicios asociados a la salud marterna* of the *MEF* dataset. Data on prenatal care are from *Sección II: Control Prenatal* of the *Salud en la Niñez* dataset. Data on mode of delivery is from *Sección III: Atención del Parto* of the *Salud en la Niñez* dataset, and birth weight and preterm birth data are from *Sección IV: Atención al recien nacido* of the *Salud en la Niñez* dataset.

This analysis is limited to women ages 12 to 49 who reported having a live birth in the period between July 2007 and June 2012 (n=6,929). A subset of analyses further limited the sample to women who have only ever had one live birth (n=2,252), in order to analyze primiparous women whose mode of delivery would not be affected by that of a previous birth, since performing a vaginal delivery after cesarean section (VBAC) is rare in Ecuador.

All statistical analyses were conducted with STATA (Version 13). To test the hypothesis that care experience shapes mode of delivery, we focused on three care variables: the

establishment visited for the last prenatal care visit, the number of prenatal care visits, and the establishment where the birth occurred. Logistic regressions were used to estimate odds ratios (ORs) with 95% confidence intervals (CIs) for the relationships between the care variables and mode of delivery. In addition, I calculated chi-squared tests to measure the association between socio-demographic variables and care experience. Separate analyses were run for the full sample (all women between the ages 12 to 49 who reported having a life birth in the period between July 2007 and June 2012) and for the subset of primiparous women.

Responses regarding institution of care, both prenatal and during birth, were divided into three categories: public, social security, and private (see Appendix A and Appendix B for detailed categorization). Those who did not receive care at any of these institutions, including those who sought care at home, with a midwife, or elsewhere, were excluded (n= 52 excluded from prenatal care analysis; n=885 excluded from birth care analysis). These excluded groups accounted for less than one percent of the total population in the analysis for prenatal care and less than 13% of the population for care during birth. The number of prenatal care visits was divided into five categories: 1-3, 4-6, 6-9, and more than 10. The WHO recommends at least four prenatal visits, and the MSP of Ecuador recommends at least five (Freire et al. 2015). In our analyses, these recommendations are both met within the same category (4-6 visits).

The socio-demographic characteristics that were considered in this analysis include area (urban vs. rural), maternal age, primary language, self-identified ethnicity, literacy, level of education, marital status, weekly work, and income. For primary language, responses "extranjero" and "no habla," which totaled 12 individuals, were marked as missing, limiting the primary languages spoken to just two categories, Spanish/Castilian and Indigenous. Level of education was categorized into none, primary school, secondary school, and superior/postgrado.

For details on education categorization, see Appendix C. Monthly gross income was recorded in US dollars, and was divided into quartiles in this analysis. Categories for monthly gross income include: ≤$50, >$50 and ≤$160, >$160 and ≤$300, and >$300.

This analysis was constructed to reflect our hypothesis about the pathways to cesarean section. Figure 1 represents this model. After the initial analysis, two socio-demographic characteristics, area (urban vs. rural) and primary language, were analyzed in greater depth to elucidate a better picture of cesarean section rates and access to care.

Figure 1. Conceptual Diagram

Socio-Demographic Characteristic → Care (Prenatal Care Institution, Number of Prenatal Care Visits, Birth Institution) → Cesarean Section

RESULTS

Sample Characteristics and Complications

The full sample of women between the ages 12 to 49 who reported having a live birth in the period between July 2007 and June 2012 included 6,929 women. Table 1 summarizes 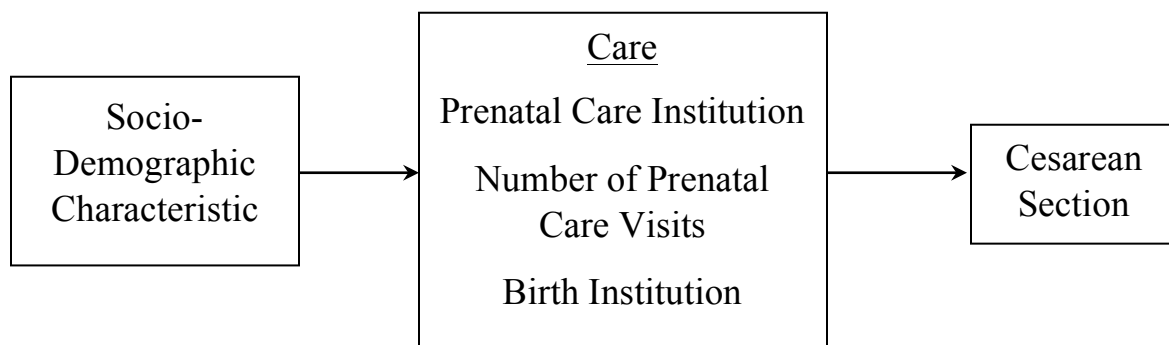socio-demographic characteristics with cesarean delivery, showing that region, age, primary language, self-identified ethnicity, level of education, marital status, hours worked, and gross income were all significantly associated with cesarean delivery. Notably, literacy was not significantly associated with cesarean delivery.

Table 2 summarizes complications during pregnancy and birth with cesarean delivery, which may provide context for which medical complications may determine a medically indicated cesarean section. The following complications during pregnancy were each significantly associated with cesarean delivery: swelling of hands and feet; dizziness, nausea, and vomiting; fever; preeclampsia and eclampsia; urinary tract infection (UTI); and bleeding or hemorrhage. During birth, the following complications were associated with increased risk of cesarean delivery: lack of pain or contractions; the birth was early; the baby was badly positioned; the mother had narrow hips; heavy bleeding; generalized infection or sepsis; multiple births; the baby was not moving; the cord was wrapped around the baby's neck; the birth was preterm.

Table 1. Socio-Demographics and Mode of Delivery

Socio-Demographic Characteristic	Vaginal Birth % (N)	C-Section % (N)	P-Value
Area			<0.001
Urban	55.49 (2,419)	44.51 (1,940)	
Rural	68.87 (1,770)	31.13 (800)	
Total	60.46 (4,189)	39.54 (2,740)	
Age (Mean ± deviation)	27.60 ± 6.81	29.09 ± 7.08	<0.001
Primary Language			<0.001
Indigenous	81.47 (255)	18.53 (58)	
Castilian/ Spanish	59.47 (3,926)	40.53 (2,676)	
Total	60.46 (4,181)	39.54 (2,734)	
Self-Identified Ethnicity			<0.001
Indigenous	82.50 (575)	17.50 (122)	
Afroecuatoriano	65.04 (80)	34.96 (43)	
Negro(a)	71.05 (54)	28.95 (22)	
Mulato (a)	63.30 (69)	36.70 (40)	
Montubio (a)	41.95 (86)	58.05 (119)	
Mestizo (a)	58.29 (3,261)	41.71 (2,333)	
Blanco (a)	47.66 (51)	52.34 (56)	
Otro (a)	70.59 (12)	29.41 (5)	
Total	60.45 (4,188)	39.55 (2,740)	
Literacy			0.240
Can read and write	60.36 (4,113)	39.64 (2,701)	
Cannot read and write	65.79 (75)	34.21 (39)	
Total	60.45 (4,188)	39.55 (2,740)	
Level of Education			<0.001
None	72.15 (57)	27.85 (22)	
Primary School	68.24 (1,330)	31.76 (619)	
Secondary School	59.75 (1,590)	40.25 (1,071)	
Superior/Postgrado	51.50 (926)	48.50 (872)	
Total	60.17 (3,903)	39.83 (2,584)	
Marital status			<0.001
Casado (a)	58.22 (1,608)	41.78 (1,154)	
Unido (a)	63.11 (1,726)	36.89 (1,009)	
Separado (a)	54.47 (335)	45.53 (280)	
Divorciado (a)	50.00 (33)	50.00 (33)	

Viudo (a)	71.79 (28)	28.21 (11)	
Soltero (a)	64.42 (458)	35.58 (253)	
Total	60.45 (4,188)	39.55 (2,740)	
Work in Last Week			<0.001
Does not work	61.00 (2,474)	39.00 (1,582)	
Has had a job and is looking for a job	57.89 (33)	42.11 (24)	
Did not work but has a job	52.94 (18)	47.06 (16)	
Less than one hour	58.59 (1,500)	41.41 (1,060)	
At least one hour	73.76 (163)	26.24 (58)	
Total	60.45 (4,188)	39.55 (2,740)	
Monthly Gross Income (US dollars)			<0.001
≤ $50	67.18 (395)	32.82 (193)	
> $50, ≤ $160	62.94 (433)	37.06 (255)	
> $160, ≤ $300	60.56 (476)	39.44 (310)	
> $300	49.52 (360)	50.48 (367)	
Total	59.66 (1,664)	40.34 (1,125)	

Table 2. Complications During Pregnancy and Birth, and Mode of Delivery

Complication	Vaginal Birth % (N)	C-Section % (N)	P-value
Complications During Pregnancy			
Swelling of hands and feet	56.09 (1,911)	43.91 (1,496)	<0.001
Fainting	58.54 (514)	41.46 (364)	0.210
Severe or permanent headache	59.22 (1,487)	40.78 (1,024)	0.109
Convulsions	63.55 (197)	36.45 (113)	0.265
Severe belly aches	61.93 (1,472)	38.07 (905)	0.077
Dizziness, nausea, vomiting	59.34 (2,698)	40.66 (1,849)	0.007
Fever	57.01 (610)	42.99 (460)	0.011
Preeclampsia or Eclampsia	49.06 (494)	50.94 (513)	<0.001
UTI	57.72 (2,427)	42.28 (1,778)	<0.001
Bleeding or Hemorrhage	54.24 (544)	45.76 (459)	<0.001
Complications During Birth			
Did not have pains or contractions	53.29 (908)	46.71 (796)	<0.001
Delivery took longer than normal	62.06 (849)	37.94 (519)	0.300
The birth was early	40.75 (454)	59.25 (660)	<0.001
Baby badly positioned (crossed	27.55 (232)	72.45 (610)	<0.001

shoulder, buttocks, feet)			
Narrow hips	34.95 (404)	65.05 (752)	<0.001
Heavy bleeding	70.83 (806)	29.17 (332)	<0.001
Generalized infection/Sepsis	53.32 (249)	46.68 (218)	0.001
Twins or multiple births	27.27 (15)	72.73 (40)	<0.001
The baby was not moving	52.49 (306)	47.51 (277)	<0.001
Cord wrapped around the baby's neck	44.79 (288)	55.21 (355)	<0.001
Low birth weight	55.1 (162)	44.9 (132)	0.039
Preterm	36.57 (313)	63.43 (543)	<0.001

Institution of Prenatal Care

Logistic regression was used to analyze the relationship between the institution of prenatal care and cesarean delivery. Table 3 shows that women who last attended prenatal care appointments at social security institutions or private institutions were at significantly increased risk of having a cesarean delivery than those who attended prenatal care at public institutions, with private institutions posing the highest risk.

Table 4 elaborates on this relationship, demonstrating the association between the socio-demographic factors that influence where a woman receives prenatal care. Results show that a woman's region, primary language, self-identified ethnicity, literacy status, level of education, marital status, weekly work, and gross monthly income are each significantly associated with the type of institution where she received prenatal care. Notably, a much smaller proportion of rural women attend prenatal care in private institutions than the proportion of urban women, and the reverse holds for attending care at a public institutions. Similarly, the proportion of indigenous speakers that receives care in private institutions is much smaller than the proportion of Castilian and Spanish speakers. By ethnicity, indigenous and black women account for the largest proportions of women who receive prenatal care in public settings. White women, followed by Montubia and Mestiza women, account for the highest proportions in private care. In terms of education, the proportion of women who receive prenatal care in private settings increases as

level of education increases. This holds true, but to a lesser degree, for social security care.

Socioeconomic status, measured by gross monthly income, is also associated with where women receive prenatal care. Though the proportion of women in the lowest quartile who receive care at a private institution is slightly higher than in the proportion in the second quartile, generally, as income increases, the proportion of women who receive care in private institutions also increases.

Table 3. Institution of Prenatal Care and Cesarean Delivery

	OR	p-value	95% CI
Social Security	2.29	≤ 0.001	$1.81 - 2.90$
Private	2.68	≤ 0.001	$2.37 - 3.03$

Note: The reference group is public institutions.

N = 6762, p-value ≤ 0.001

Table 4. Socio-Demographics and Institution of Prenatal Care

Socio-Demographic Characteristic	Public Institution %(N)	Social Security Institution % (N)	Private Institution % (N)	P-Value
Area				<0.001
Urban	71.32 (3,163)	4.94 (219)	23.74 (1,053)	
Rural	86.10 (2,571)	3.25 (97)	10.65 (3.25)	
Total	77.27 (5,734)	4.26 (316)	18.47 (1,371)	
Primary Language				<0.001
Indigenous	94.69 (446)	1.70 (8)	3.61 (17)	
Castilian/ Spanish	76.06 (5,274)	4.44 (308)	19.50 (1,352)	
Total	77.25 (5,720)	4.27 (316)	18.49 (1,369)	
Self-Identified Ethnicity				<0.001
Indigenous	92.29 (874)	2.43 (23)	5.28 (50)	
Afroecuatoriano	83.59 (107)	0.78 (1)	15.62 (20)	
Negro(a)	91.11 (82)	4.44 (4)	4.44 (4)	
Mulato (a)	79.82 (91)	3.51 (4)	16.67 (19)	
Montubio (a)	75.47 (160)	3.30 (7)	21.23 (45)	
Mestizo (a)	74.72 (4,330)	4.64 (269)	20.64 (1,196)	
Blanco (a)	63.96 (71)	5.41 (6)	30.63 (34)	

Otro (a)	77.27 (17)	9.09 (2)	13.64 (3)	
Total	77.26 (5,732)	4.26 (316)	18.48 (1,371)	
Literacy				0.001
Can read and write	77.03 (5,613)	4.32 (315)	18.65 (1,359)	
Cannot read and write	90.15 (119)	0.76 (1)	9.09 (12)	
Total				
Level of Education				<0.001
None	87.23 (82)	1.06 (1)	11.70 (11)	
Primary School	89.06 (1,979)	2.61 (58)	8.33 (185)	
Secondary School	76.52 (2,131)	3.59 (100)	19.89 (554)	
Superior/Postgrado	60.73 (1,115)	8.17 (150)	31.10 (571)	
Total	76.50 (5,307)	4.45 (309)	19.04 (1,321)	
Marital status				<0.001
Casado (a)	72.41 (2,192)	6.05 (183)	21.54 (652)	
Unido (a)	82.35 (2,384)	2.49 (72)	15.16 (439)	
Separado (a)	77.76 (500)	4.67 (30)	17.57 (113)	
Divorciado (a)	66.67 (44)	4.55 (3)	28.79 (19)	
Viudo (a)	91.30 (42)	0.00 (0)	8.70 (4)	
Soltero (a)	76.82 (570)	3.77 (28)	19.41 (144)	
Total	77.26 (5,732)	4.26 (316)	18.48 (1,371)	
Work in Last Week				<0.001
Does not work	80.48 (3,464)	2.46 (106)	17.05 (734)	
Has had a job and is looking for a job	70.00 (42)	10.00 (6)	20.00 (12)	
Did not work but has a job	64.86 (24)	13.51 (5)	21.62 (8)	
Less than one hour	72.23 (1,992)	7.07 (195)	20.70 (571)	
At least one hour	80.77 (210)	1.54 (4)	17.69 (46)	
Total	77.26 (5,732)	4.26 (316)	18.48 (1,371)	
Monthly Gross Income (US dollars)				<0.001
≤ $50	82.48 (593)	2.50 (18)	15.02 (108)	
> $50, ≤ $160	86.76 (1.74)	1.74 (13)	11.50 (86)	
> $160, ≤ $300	72.67 (601)	7.01 (58)	20.31 (168)	
> $300	50.07 (367)	15.55 (114)	34.38 (252)	
Total	73.01 (2,210)	6.71 (203)	20.28 (614)	

Number of Prenatal Care Visits

Table 5 shows the odds ratios for the number of prenatal care visits a woman attends and cesarean delivery. Results show that the number of prenatal care visits was significantly associated with mode of delivery, and that the more prenatal visits a woman attended, the higher her risk of delivering by cesarean section. The odds ratios presented in Table 5 compare the odds of cesarean section to a group of women who attended 1 – 3 prenatal care visits.

Table 6 elaborates on the socio-demographic characteristics that influence the number of prenatal visits that a woman attends. Results show that a woman's region, primary language, self-identified ethnicity, literacy status, level of education, marital status, weekly work, and gross monthly income are each significantly associated with the number of prenatal visits a woman attends. Notably, the greatest proportions of both urban and rural women attend 7-9 prenatal care visits. The greatest proportion of indigenous speakers attend 4-6 visits, while the greatest proportion of Castilian or Spanish speakers attend 7-9 visits. Also, a much larger proportion of indigenous speakers attend 1-3 visits than the proportion of Castilian or Spanish speakers. Women who self-identify as indigenous have the highest proportion of only attending 1-3 prenatal visits. In terms of education, the proportion of women who receive only 1-3 prenatal care visits decreases as level of education increases, and the proportion of women who receive more than ten prenatal visits is highest for women with the highest education level. Socio-economic status influences the number of prenatal care visits that a woman has. The proportion of women who have only 1-3 prenatal care visits decreases as gross monthly income increases. Further, women with the highest income account for the largest proportion of women who attend ten or more prenatal care visits.

Table 5. Number of Prenatal Care Visits and Cesarean Delivery

	OR	p-value	95% CI
4 – 6 visits	1.54	≤ 0.001	1.25 – 1.89
7 – 9 visits	1.97	≤ 0.001	1.62 – 2.41
≥10 visits	3.09	≤ 0.001	2.44 – 3.91

Note: The reference group is public institutions.

N = 6780, p-value ≤ 0.001

Table 6. Socio-Demographics and Number of Prenatal Care Visits

Socio-Demographic Characteristic	1-3 Visits %(N)	4-6 Visits % (N)	7-9 Visits % (N)	≥10 Visits % (N)	P-Value
Area					<0.001
Urban	7.59 (339)	27.30 (1,220)	51.91 (2,320)	13.20 (590)	
Rural	13.97 (419)	33.17 (995)	46.10 (1,383)	6.77 (203)	
Total	10.15 (758)	29.66 (2,215)	49.58 (3,703)	10.62 (793)	
Primary Language					<0.001
Indigenous	28.78 (137)	40.13 (191)	28.78 (137)	2.31 (11)	
Castilian/ Spanish	8.86 (618)	28.95 (2,020)	51.05 (3.562)	11.14 (777)	
Total	10.13 (755)	29.67 (2,211)	49.63 (3,699)	10.57 (788)	
Self-Identified Ethnicity					<0.001
Indigenous	24.53 (234)	35.43 (338)	35.43 (338)	4.61 (44)	
Afroecuatoriano	6.15 (8)	26.15 (34)	52.31 (68)	15.38 (20)	
Negro(a)	8.89 (8)	20.00 (18)	57.78 (52)	13.33 (12)	
Mulato (a)	13.04 (15)	26.09 (30)	49.57 (57)	11.30 (13)	
Montubio (a)	6.13 (13)	25.47 (54)	58.02 (123)	10.38 (22)	
Mestizo (a)	7.94 (463)	29.15 (1,700)	51.37 (2,996)	11.56 (673)	
Blanco (a)	9.82 (11)	33.04 (37)	50.00 (56)	7.14 (8)	
Otro (a)	22.73 (5)	18.18 (4)	54.55 (12)	4.55 (1)	
Total	10.14 (757)	29.66 (2,215)	49.58 (3,702)	10.62 (793)	
Literacy					<0.001
Can read and write	9.96 (730)	29.54 (2,166)	49.75 (3,648)	10.75 (788)	
Cannot read and write	20.00 (27)	36.30 (49)	40.00 (54)	3.70 (5)	
Total	10.14 (757)	29.66 (2,215)	49.58 (3,702)	10.62 (793)	
Level of Education					<0.001
None	19.79 (19)	37.50 (36)	39.58 (38)	3.12 (3)	
Primary School	14.34 (320)	33.96 (758)	45.97 (1,026)	5.73 (128)	
Secondary School	9.20 (258)	28.46 (798)	50.46 (1,415)	11.88 (333)	

Superior/Postgrado	5.31 (98)	24.80 (458)	53.22 (983)	16.68 (308)	
Total	9.96 (695)	29.37 (2,050)	49.61 (3,462)	11.06 (772)	
Marital status					<0.001
Casado (a)	8.78 (267)	26.97 (820)	51.28 (1,559)	12.96 (394)	
Unido (a)	10.38 (303)	30.16 (880)	50.62 (1,477)	8.84 (258)	
Separado (a)	11.42 (74)	30.56 (198)	49.54 (321)	8.49 (55)	
Divorciado (a)	7.35 (5)	35.29 (24)	45.59 (31)	11.76 (8)	
Viudo (a)	10.87 (5)	30.43 (14)	45.65 (21)	13.04 (6)	
Soltero (a)	13.79 (103)	37.35 (279)	39.22 (293)	9.64 (72)	
Total	10.14 (757)	29.66 (2,215)	49.58 (3,702)	10.62 (793)	
Work in Last Week					<0.001
Does not work	9.62 (416)	29.62 (1,281)	51.47 (2,226)	9.29 (402)	
Has had a job and is looking for a job	6.67 (4)	38.33 (23)	40.00 (24)	15.00 (9)	
Did not work but has a job	5.41 (2)	29.73 (11)	40.54 (15)	24.32 (9)	
Less than one hour	10.35 (288)	29.57 (823)	47.50 (1,322)	12.58 (350)	
At least one hour	17.94 (47)	29.39 (77)	43.89 (115)	8.78 (23)	
Total	10.14 (757)	29.66 (2,215)	49.58 (3,702)	10.62 (793)	
Monthly Gross Income (US dollars)					<0.001
≤ $50	16.35 (119)	32.83 (239)	42.58 (310)	8.24 (60)	
> $50, ≤ $160	12.73 (96)	32.10 (242)	45.76 (345)	9.42 (71)	
> $160, ≤ $300	9.34 (78)	28.98 (242)	50.06 (418)	11.62 (97)	
> $300	5.56 (41)	24.42 (180)	49.66 (366)	20.35 (150)	
Total	10.94 (334)	29.57 (903)	47.12 (1,439)	12.38 (378)	

Institution of Birth

Table 7 shows that women who gave birth in social security institution or a private institution were at significantly higher risk of delivering by cesarean than women who delivered in a public establishment, with birth in a private institution posing the highest risk.

Table 8 demonstrates how socio-demographic characteristics are associated with the place where a woman gives birth. Results show that a woman's region, primary language, self-identified ethnicity, literacy status, level of education, marital status, weekly work, and gross monthly income are each significantly associated with the type of institution in which she gives

birth. Table 8 shows that a higher proportion of urban women give birth in private institutions than the proportion of rural women, and in reverse, a higher proportion of rural women give birth in public institutions than the proportion of urban women. The proportion of indigenous speakers that give birth in a private institution is much smaller than the proportion of Castilian or Spanish speakers that do, and a higher proportion of indigenous speakers give birth in public institutions than Castilian or Spanish speakers. By ethnicity, the proportion of women who give birth in public institutions is highest for indigenous and black women. The proportion of women who give birth in private institutions is highest for white and Mestiza women. As level of education increases, the proportion of women who give birth in public institutions decreases, and the proportion of women who give birth in private institutions increases. In terms of socioeconomic status, generally as gross monthly income increases, the proportion of women who give birth in public institutions decreases, and the proportion of women who give birth in private institutions decreases. Notably, like for the institution where women receive prenatal care, this trend does not hold true for the first quartile, in which the proportion of women who receive care in a private institution is higher than that of the second quartile. Nonetheless, for the most part, women who both receive prenatal care and give birth in the same type of institution. In fact, only 52% of women who give birth in a private institution attended their last prenatal care visit in a private institution, and 45% of those who gave birth in a private institution received prenatal care at a public institution.

Table 7. Institution of Birth and Cesarean Delivery

	OR	p-value	95% CI
Social Security	3.24	≤ 0.001	2.60 – 4.05
Private	4.26	≤ 0.001	3.79 – 4.80

Note: The reference group is public institutions.

N = 6879, p-value ≤ 0.001

Table 8. Socio-Demographics and Institution of Birth

Socio-Demographic Characteristic	Public Institution %(N)	Social Security Institution % (N)	Private Institution % (N)	P-Value
Area				<0.001
Urban	66.66 (2,901)	5.61 (244)	27.73 (1.207)	
Rural	78.11 (1,995)	4.11 (105)	17.78 (454)	
Total	70.89 (4,896)	5.05 (349)	24.05 (1,661)	
Primary Language				<0.001
Indigenous	91.86 (282)	3.91 (12)	4.23 (13)	
Castilian/ Spanish	69.93 (4,604)	5.12 (337)	24.95 (1,643)	
Total	70.90 (4,886)	5.06 (349)	24.03 (1,656)	
Self-Identified Ethnicity				<0.001
Indigenous	89.88 (622)	3.90 (27)	6.21 (43)	
Afroecuatoriano	82.64 (100)	4.96 (6)	12.40 (15)	
Negro(a)	89.47 (68)	5.26 (4)	5.26 (4)	
Mulato (a)	73.87 (82)	7.21 (8)	18.92 (21)	
Montubio (a)	54.11 (112)	3.38 (7)	42.51 (88)	
Mestizo (a)	68.73 (3,831)	5.24 (292)	26.03 (1,451)	
Blanco (a)	68.68 (66)	4.67 (5)	33.64 (36)	
Otro (a)	82.35 (14)	0.00 (0)	17.65 (3)	
Total	70.89 (4,895)	5.05 (349)	24.06 (1,661)	
Literacy				<0.001
Can read and write	70.60 (4,793)	5.14 (349)	24.26 (1,647)	
Cannot read and write	87.93 (102)	0.00 (0)	12.07 (14)	
Total	70.89 (4,895)	5.05 (349)	24.06 (1,661)	
Level of Education				<0.001
None	87.50 (70)	0.00 (0)	12.50 (10)	
Primary School	80.43 (1,562)	3.24 (63)	16.32 (317)	
Secondary School	69.69 (1,846)	3.89 (103)	26.43 (700)	
Superior/Postgrado	58.54 (1,052)	9.74 (175)	31.72 (570)	
Total	70.04 (4,530)	5.27 (341)	24.69 (1,597)	
Marital status				<0.001
Casado (a)	65.74 (1,813)	7.61 (210)	26.65 (735)	
Unido (a)	74.61 (2,033)	2.72 (74)	22.68 (618)	
Separado (a)	69.77 (427)	4.25 (26)	25.98 (159)	
Divorciado (a)	70.31 (45)	4.69 (3)	25.00 (16)	
Viudo (a)	79.49 (31)	2.56 (1)	17.95 (7)	
Soltero (a)	77.23 (546)	4.95 (35)	17.82 (126)	

	70.89 (4,895)	5.05 (349)	24.06 (1,661)	
Total	70.89 (4,895)	5.05 (349)	24.06 (1,661)	
Work in Last Week				<0.001
Does not work	72.83 (2,941)	3.00 (121)	24.17 (976)	
Has had a job and is looking for a job	60.34 (35)	8.62 (5)	31.03 (18)	
Did not work but has a job	58.82 (20)	11.76 (4)	29.41 (10)	
Less than one hour	67.66 (1,728)	8.38 (214)	23.96 (612)	
At least one hour	77.38 (171)	2.26 (5)	20.36 (45)	
Total	70.89 (4,895)	5.05 (349)	24.06 (1,661)	
Monthly Gross Income (US dollars)				<0.001
≤ $50	76.71 (448)	2.40 (14)	20.89 (122)	
> $50, ≤ $160	81.51 (560)	1.60 (11)	16.89 (116)	
> $160, ≤ $300	67.64 (531)	8.28 (65)	24.08 (189)	
> $300	50.48 (367)	17.88 (130)	31.08 (230)	
Total	68.49 (1,906)	7.91 (220)	23.61 (657)	

**Socio-Demographic Characteristics and Care Practices**

General trends identified in this analysis may inform how women shape their care practices during pregnancy and birth. Typically, women who are rural, indigenous, and have lower education and incomes receive more public care, and less antenatal care specifically, than women who are urban, white or Mestiza, and have higher education and income. Two socio-demographic variables, region and primary language, may be able to increase our understanding of these care differences, as they may representative of these larger trends.

Figure 2, Figure 3, and Figure 4 show how region influences care. Figure 2 shows the number of urban and rural women who receive certain types of care and the number of those women who deliver by cesarean section for each care type. Notably, there are many more urban than rural women, and a larger proportion of urban women deliver by cesarean section in every category.

Figure 3 elaborates, showing this relationship in terms of the percentage of urban and rural women that receive a particular type of care. Figure 3 shows that most women, whether urban or rural, receive prenatal and birth care in public institutions; however a larger proportion of urban women use private care services than rural women, and a larger proportion of rural women use public care services than urban women. Notably, the majority of both rural and urban women attend 7-9 prenatal care appointments. Despite this, overall larger proportions of rural women attend fewer visits, while larger proportions of urban women attend more visits.

Figure 4 shows the percentage of women of a particular region and type of care who deliver by cesarean section. For example, Figure 4 shows that 38.11% of urban women who utilize public prenatal care deliver by cesarean section, while only 28.94% of rural women who utilize public prenatal care deliver by cesarean. Figure 4 shows that in every category of care, a larger percentage of urban women have cesarean sections.

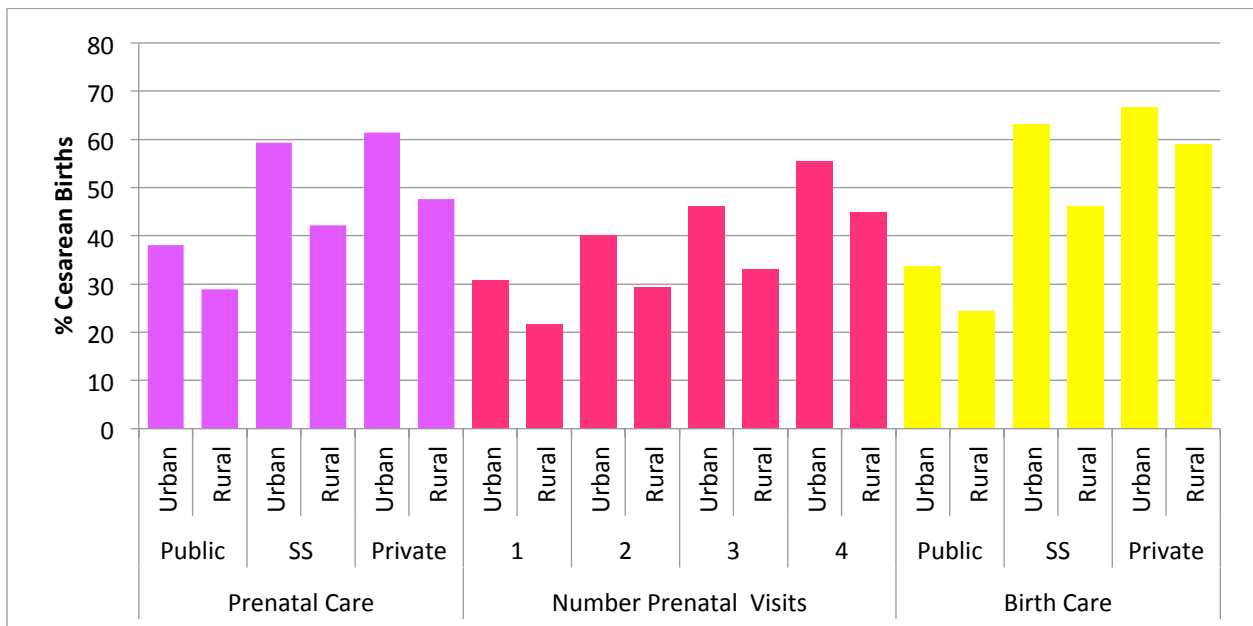**Figure 2. Care Practices and Cesarean Section: Urban vs. Rural Women**
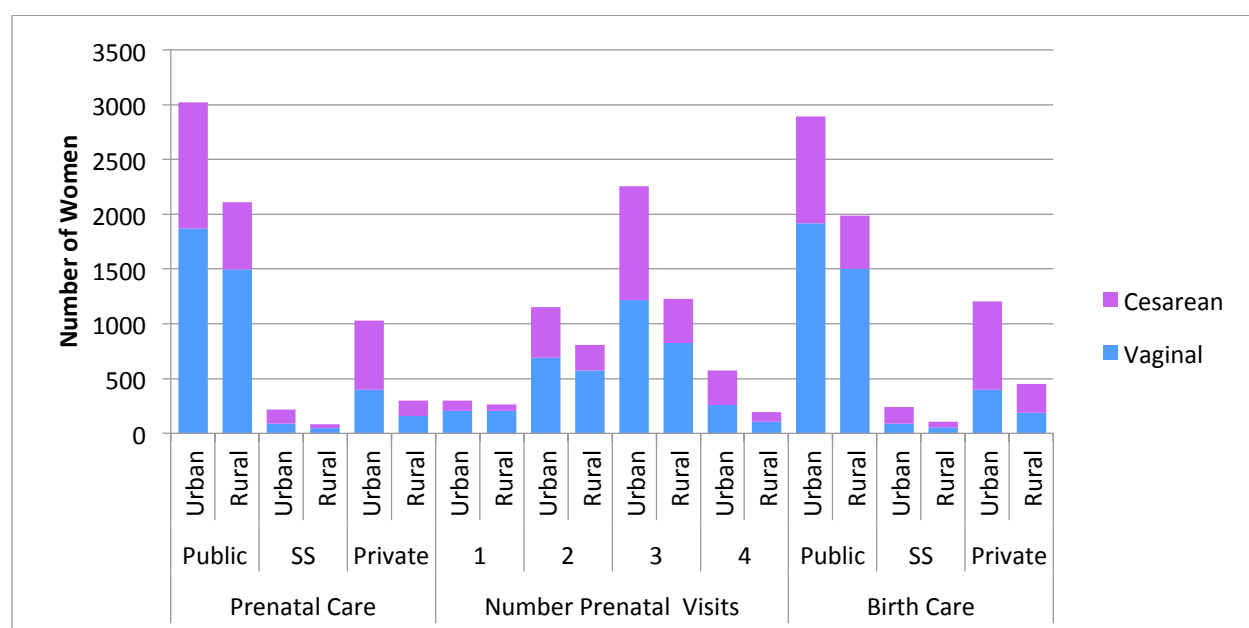
Note. Number of Prenatal Visit categories: 1: 1-3 visits, 2: 4-6 visits, 3: 7-9 visits, 4: 10 or more visits

Figure 3. Care Practices of Urban and Rural Women
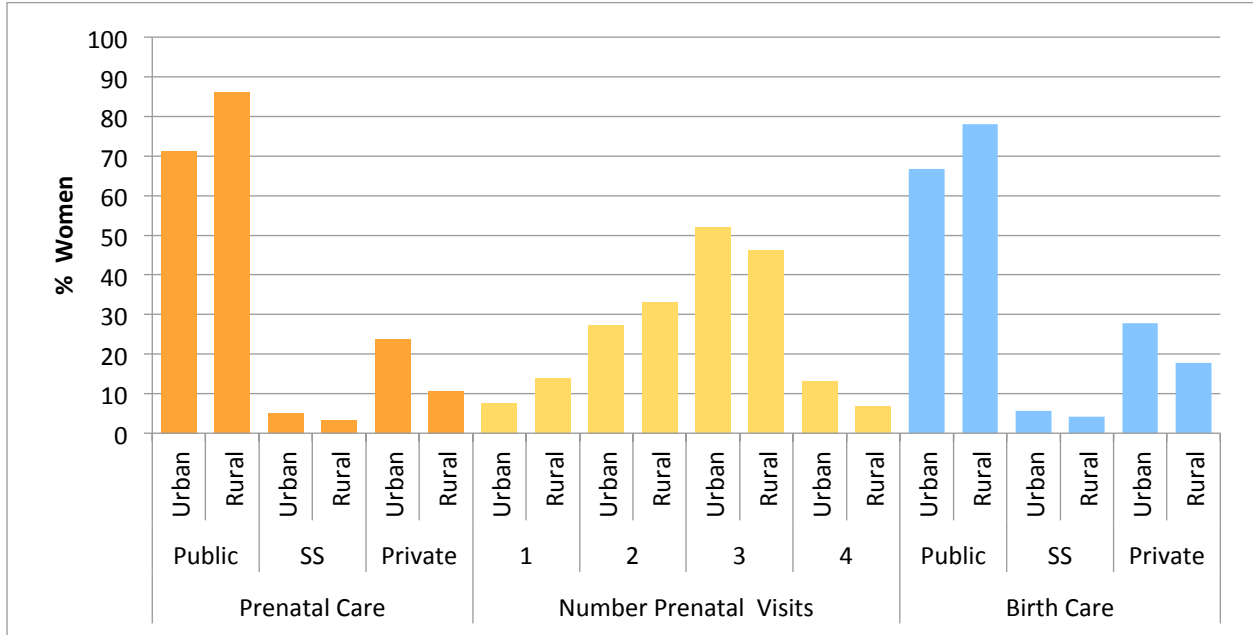
Note. Number of Prenatal Visit categories: 1: 1-3 visits, 2: 4-6 visits, 3: 7-9 visits, 4: 10 or more visits

Figure 4. Percent Cesarean Births: Urban vs. Rural

Note. Number of Prenatal Visit categories: 1: 1-3 visits, 2: 4-6 visits, 3: 7-9 visits, 4: 10 or more visits

Region addresses a broad characteristic that may shape care practices. An analysis of the women who differ based on primary language provides a narrower snapshot of women who may be even more remote than those captured in the rural category above, given that the number of women who speak indigenous languages is much smaller than the number of rural women in this analysis. This will provide a clearer picture of who is delivering by cesarean section, and it may also elucidate a better understanding of limits in access to care. Figures 5 – 7 address how primary language is associated with care practices and cesarean delivery rates.

Figure 5 shows that there are many more Castilian and Spanish speakers than indigenous language speakers, and that the proportion of Castilian and Spanish speaking women who deliver by cesarean section is larger than the proportion of indigenous speakers in every care category.

Figure 6 shows that a greater percentage of indigenous speakers seek prenatal and birth care at public institutions than Castilian and Spanish speakers. The opposite also holds, that a greater percentage of Castilian and Spanish speakers than indigenous speakers seek care at private institutions. The graph also shows that a larger percentage of indigenous speakers receive only 1-3 prenatal care visits, while a larger percentage of Castilian and Spanish speakers receive ten or more visits.

Figure 7 shows the percentage of women who speak a particular language and receive a particular type of care who deliver by cesarean section. For example, 35.34% of Castilian or Spanish speaking women who attend prenatal care at a public institution give birth by cesarean section, while 16.17% of indigenous language speakers who attend prenatal care at a public institution give birth by cesarean section. Notably, cesarean delivery rates are higher in every care category for Castilian and Spanish speaking women than for indigenous speakers.

Figure 5. Care Practices and Cesarean Section: Castilian/Spanish vs. Indigenous Speakers
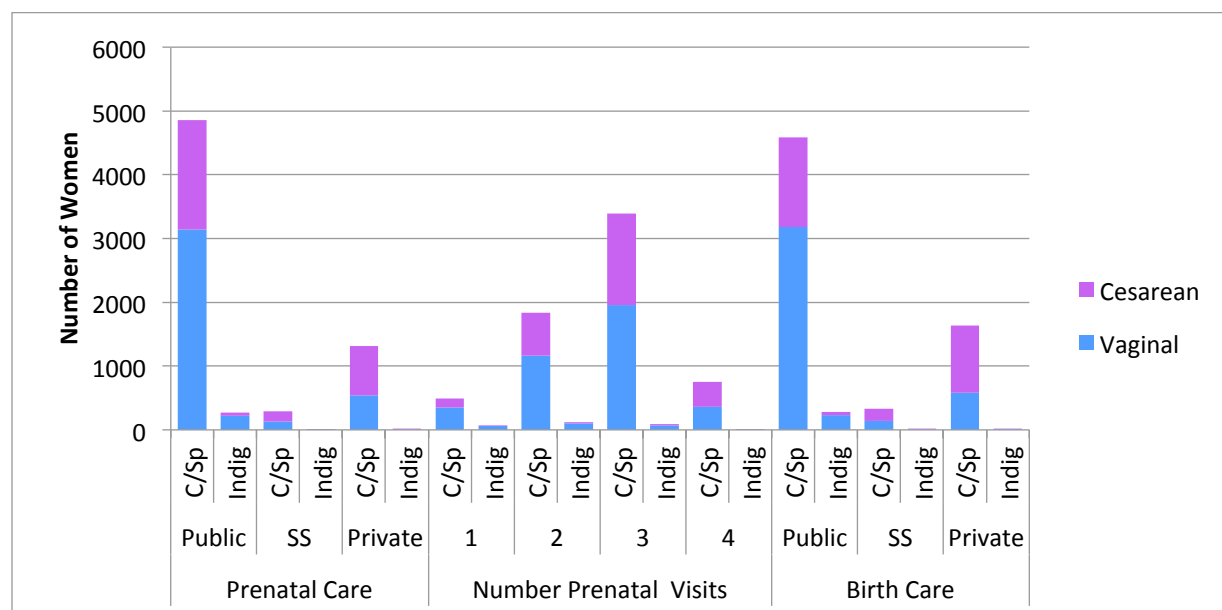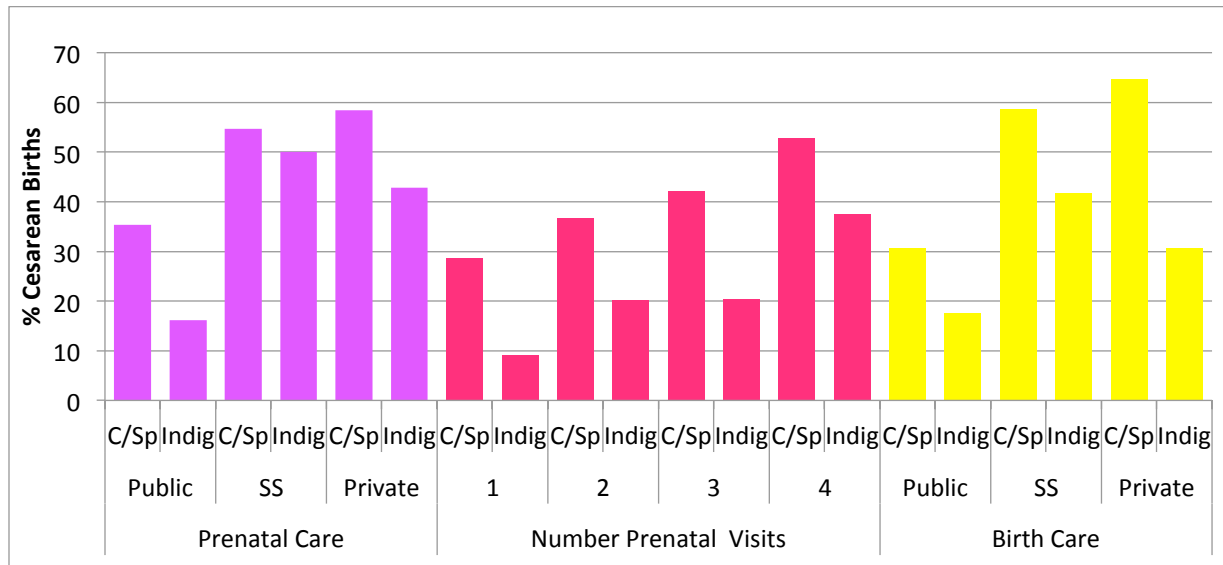

Note. Number of Prenatal Visit categories: 1: 1-3 visits, 2: 4-6 visits, 3: 7-9 visits, 4: 10 or more visits

Figure 6. Care Practices of Castilian/Spanish and Indigenous Speaking Women
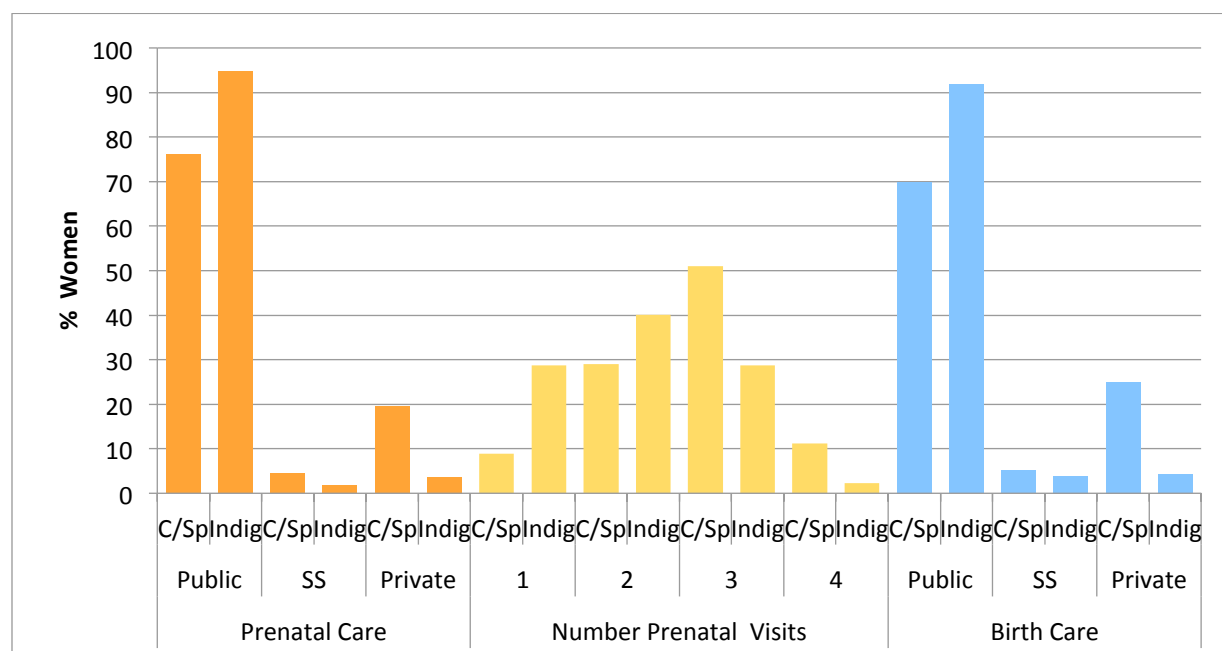
Note. Number of Prenatal Visit categories: 1: 1-3 visits, 2: 4-6 visits, 3: 7-9 visits, 4: 10 or more visits

**Figure 7. Percent Cesarean Births: Castilian/Spanish vs. Indigenous Speakers**

Note. Number of Prenatal Visit categories: 1: 1-3 visits, 2: 4-6 visits, 3: 7-9 visits, 4: 10 or more visits

Motivations for Selecting Institution of Birth

Figure 8 summarizes the motivations that women voiced for selecting the establishment where they delivered their child. Women were able to select more than one motivation. Results show that the primary consideration for giving birth in a public institution was economic, with 49.65% of women citing economic factors. The primary reason for giving birth in a social security institution (73.93%) was that it was affiliated or covered, and the primary motivation for giving birth in a private institution was confidence in the staff (35.28%).

Figure 8. Motivation for Selection of Birth Establishment
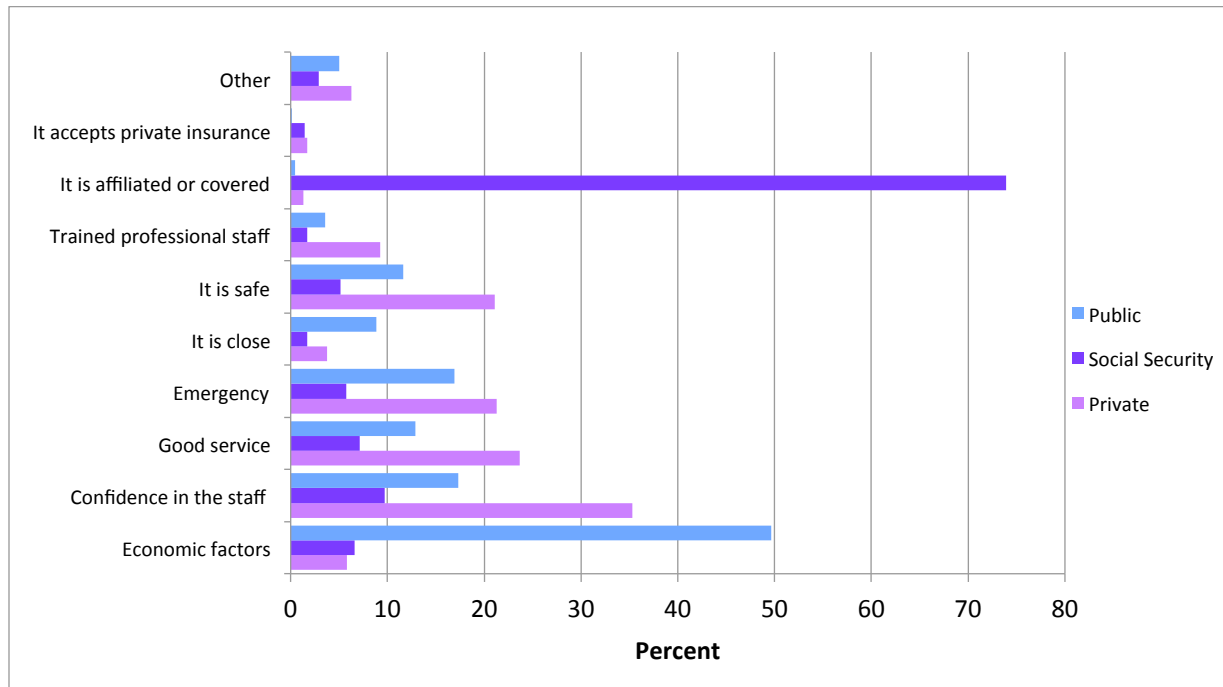
Subset Analysis: Primiparous Women

A subset analysis of exclusively primiparous women was run to assess the influence that a previous cesarean section may have had on the risk of cesarean in the full sample. This analysis was limited to 2,252 women. Table 9 summarizes complications during pregnancy and birth with cesarean delivery, analyzing medical indication for cesarean section. Unlike in the full sample, severe headaches during pregnancy were associated with cesarean section, and neither "dizziness, nausea, and vomiting," nor fever during pregnancy were. In this subset, unlike the full sample, the complications "generalized infection or sepsis" and "the baby was not moving" were not significant. The dataset only analyzed women who had only ever had one child, so the complication "multiple births" was irrelevant, since any woman having twins or triplets would be excluded from this subset.

Table 9. Complications During Pregnancy and Birth, and Mode of Delivery Primiparous Women

Complication	Vaginal Birth % (N)	C-Section % (N)	P-value
Complications During Pregnancy			
Swelling of hands and feet	54.03 (570)	45.97 (485)	<0.001
Fainting	58.58 (140)	41.42 (99)	0.652
Severe or permanent headache	55.35 (362)	44.65 (292)	0.004
Convulsions	56.96 (45)	43.04 (34)	0.562
Severe belly aches	59.33 (391)	40.67 (268)	0.709
Dizziness, nausea, vomiting	58.94 (847)	41.06 (590)	0.190
Fever	55.07 (152)	44.93 (124)	0.075
Preeclampsia or Eclampsia	44.01 (125)	55.99 (159)	<0.001
UTI	56.05 (727)	43.95 (570)	<0.001
Bleeding or Hemorrhage	50.00 (139)	50.00 (139)	<0.001
Complications During Birth			
Did not have pains or contractions	51.06 (289)	48.94 (277)	<0.001
Delivery took longer than normal	60.49 (274)	39.51 (179)	0.922
The birth was early	44.44 (160)	55.56 (200)	<0.001
Baby badly positioned (crossed shoulder, buttocks, feet)	23.37 (68)	76.63 (223)	<0.001
Narrow hips	34.68 (163)	65.32 (307)	<0.001
Heavy bleeding	70.72 (227)	29.28 (94)	<0.001
Generalized infection/Sepsis	52.63 (70)	47.37 (63)	0.079
The baby was not moving	53.59 (82)	46.41 (71)	0.081
Cord wrapped around the baby's neck	33.18 (73)	66.82 (147)	<0.001
Low birth weight	71.82 (79)	28.18 (31)	0.005
Preterm	39.25 (104)	60.75 (161)	<0.001

Like the full sample, women who most frequently received prenatal care at social security institutions and private institutions were associated with a higher risk of delivering by cesarean (Table 10), and the number of prenatal care visits that a woman attended was significantly associated with risk for cesarean section, with the most visits posing the highest risk for cesarean delivery (Table 11). Similarly, logistic regression showed that women who gave birth in social security institutions or private institutions had a higher risk of cesarean section than those who gave birth at a public institution (Table 12). In contrast to the full sample, for both prenatal care

and care during the delivery, the OR for care at a social security institution was higher than the

OR for care in a private institution. Overall, this subset analysis did not differ drastically from

the analysis of the full sample.

Table 10. Institution of Prenatal Care and Cesarean Delivery
Primiparous Women

	OR	p-value	95% CI
Social Security	2.93	≤ 0.001	1.79 – 4.78
Private	2.52	≤ 0.001	2.06 – 3.08

N = 2125, p-value ≤ 0.001

Table 11. Number of Prenatal Care and Cesarean Delivery
Primiparous Women

	OR	Std. Error	z-score	p-value	95% CI
4 – 6 visits	2.41	0.52	4.04	≤ 0.001	1.57 – 3.69
7 – 9 visits	2.75	0.58	4.81	≤ 0.001	1.82 – 4.14
$\geq$10 visits	5.19	1.23	6.97	≤ 0.001	3.27 – 8.25

N = 2134, p-value ≤ 0.001

Table 12. Institution of Birth and Cesarean Delivery
Primiparous Women

	OR	p-value	95% CI
Social Security	5.12	≤ 0.001	3.21 – 8.16
Private	4.60	≤ 0.001	3.76 – 5.62

N = 2159, p-value ≤ 0.001

DISCUSSION

Summary of Results

Our findings indicate that the number of prenatal visits, which may serve as an indicator of how medicalized a woman's pregnancy is, is an important predictor of cesarean delivery. Findings also showed that both the institution where a woman receives prenatal care and the institution where she gives birth are important indicators of the type of delivery she will have. Last, it seems that the type and frequency of care are both mediators between socio-demographic variables and mode of delivery. Analysis of these socio-demographic characteristics demonstrates that there may be barriers in access to care, which contributes to our understanding of how Ecuadorian women are navigating the re-structured health care system.

The Role of Prenatal Care

While prenatal care is ultimately beneficial to the health of both mother and child, the number of prenatal care visits, independent of the care provider, is significantly associated with risk of cesarean delivery. The increased medicalization of pregnancy and birth in recent decades likely plays a crucial role in this relationship. The Law of Free Maternity and Child Care increased funding for maternal and child health care services and likely influenced the rapid increase of both prenatal care visits and births that took place in healthcare institutions since 1998. Currently, the MoH encourages women to seek prenatal care at least five times throughout

their pregnancies, beginning the first trimester (Freire et al. 2015). Since this legislation was passed, maternal and infant mortality have dropped dramatically (World Bank 2006).

Nonetheless, the number of prenatal care visits may be an indicator for how medicalized a pregnancy is. Increased medicalization increases the use of technology throughout pregnancy, making medical technologies, including cesarean section, more normalized and more common (Belizán et al. 1999). Increased medicalization of pregnancy, and an increased number of prenatal care visits, also provides more opportunity for the technologies of prenatal care to influence the mode of delivery. Ultrasounds, used at many prenatal care appointments, may indicate a badly positioned fetus or that the umbilical cord is wrapped around the fetus' neck. Despite the fact that these circumstances may change by delivery, diagnostics before birth influence both the patient's and the doctor's assumptions that cesarean section may be best (Béhague 2002).

Another explanation for the trend that an increased number of prenatal care visits increases risk of cesarean section could be that a woman who has concerns about her pregnancy schedules more prenatal visits. In this case, the medical concerns of eventual cesarean delivery may be influencing care behavior.

Despite this association, as the number of prenatal visits has increased over the past few decades in Ecuador, maternal and child health statistics have improved drastically (World Bank 2016). Thus, frequent prenatal visits in its own right should be considered a positive change, despite its association with cesarean sections. These findings emphasize that women should continue to attend regular prenatal visits, and it is the broader "culture of cesareans" that must be addressed. To this end, physicians must adhere to standards for medically-indicated cesarean sections more strictly and must be selective in suggesting this option to patients.

Three Tiers of Care

Attending prenatal care at a social security or private institution significantly and dramatically increases a woman's risk of delivering by cesarean section. These results are consistent with the results of a WHO study on maternal and perinatal health in Latin America, which showed that cesarean deliveries are most common in private centers, followed by social security centers, and least common in public institutions throughout Latin America (Villar et al. 2006). The WHO study also found that characteristics of institutions, such as whether they are public or private or receive economic incentive for cesarean deliveries, explained 48% of the variability among risk-adjusted rates of cesarean section (Taljaard et al. 2009). Our results also echo Béhague's (2002) findings in Brazil, that wealthier women, who can afford private care, are more likely to undergo an unnecessary, costly, and risky cesarean section, while the women who are most likely to need one do not have one. While Ecuador has recently adopted universal healthcare coverage, neoliberal structures, specifically private health care providers, persist from the 1980s and 1990s and still wield great influence on Ecuador's health care system.

Socio-Demographic Characteristics Shape Care

Ecuador's fragmented health care system poses deep-rooted, structural barriers to equal, quality healthcare. For each care variable analyzed (place of prenatal care, number of prenatal care visits, and place of birth), socio-demographic variables (a woman's region, primary language, self-identified ethnicity, literacy status, level of education, marital status, weekly work, and gross monthly income) were significantly associated with care.

Socio-demographic characteristics may influence the care that a woman receives in a variety of ways. First, socio-cultural factors may influence the kind of care that a woman seeks

or desires throughout her pregnancy. Women in more remote regions or those who feel strong ties to indigenous communities may not be as likely to desire a highly medicalized pregnancy and may instead favor traditional options. Torri (2013) found that prenatal care services in Ecuador are often independent from (and in conflict with) traditional belief systems, causing barriers to care, particularly among indigenous women who primarily rely on midwifery. In contrast, women in urban areas may desire modernity and technology in their care. Second, *access* to care, whether financially, geographically, or otherwise may continue to pose barriers to the type of care that is desired.

Results from figures 2 – 7 show how women in more remote regions (both geographically and culturally) differ in their care practices and rates of cesarean section. Results from region and language-specific analyses show that more geographically remote (rural women) and culturally remote (indigenous speakers) are less likely to utilize private care services than those in urban areas or who speak Castilian or Spanish. Figure 4 shows that women in rural regions are less likely to deliver by cesarean section than women in urban regions, and Figure 7 shows that indigenous speakers are less likely to delivery by cesarean section than Castilian and Spanish speakers. These results support the theory that women in more remote areas do not have as highly medicalized pregnancies. Nonetheless, it remains unclear whether these differences are due to choice or limitations in access to care.

Based the results from Figure 8, women's motivations for the place of their delivery, those who gave birth in public and social security institutions were primarily motivated by financial factors, indicating an economic constraint, and perhaps a barrier in access to the care that they desire. In contrast, women who gave birth in a private institution most often cited their

confidence in the staff at the institution, indicating that the choice was made based on perception of the quality and type of care.

These results are consistent with Rasch and Bywater's (2014) findings that private care services remain financially inaccessible for most of the population and that public health services are failing to deliver high-quality of care. In their study, Rasch and Bywater (2014) found that of those who use public health services in Las Mercedes, Ecuador, only 11% of heads of households responded positively about the care they received. Our results support the assertion that financial concerns prevent many individuals from accessing the kind of quality care that they may desire.

Limitations and Future Directions

This study has several limitations. First, though we have data on complications during pregnancy and birth, we do not have data on whether a cesarean delivery was technically medically indicated, which limits our understanding of which cesareans were performed in excess.

Further, odds ratios are calculated based on existing standards of practice, not on ideal standards of practice. In our study, the odds ratios presented for delivering by cesarean section based on care in a social security institution or in a private institution are measured against the odds of delivering by cesarean section based on care in a public institution, not against the PAHO recommendations for national rate of cesarean section. This may give the impression that care in public institutions produces cesarean rates that do not exceed recommended rates, which is, in this case, incorrect. PAHO recommends a national cesarean section rate of between 5 and 15%. While the odds of delivering by cesarean section after receiving prenatal care in a social

security institution or private institution are much higher than that of receiving care in a public institution, the rate of cesarean section for those who received prenatal care in a public institution was still well above the recommended rate, at 34.34%. Similarly, the rate of cesarean section for those who *delivered* in a public institution was also above the recommended rate, at 29.94%. Similarly, though risk of delivering by cesarean increased significantly as the number of prenatal care visits increased, the rate of cesarean section for women who received 1 – 3 visits, the category that odds were measured against, was still above the recommended rate, at 26.51%. This insight suggests that while rates of cesarean are dramatically higher for particular circumstances of care, the problem of excess cesarean section is endemic to the entire health system of Ecuador.

Conclusion

Our findings indicate that both the institution where a woman receives prenatal care and the institution where she gives birth are important predictors of her mode of delivery. Women who attend prenatal care visits at private institutions are most likely to deliver by cesarean section, followed by women who attend prenatal care visits at social security institutions. Women who receive prenatal care at public institutions are least likely to deliver by cesarean section, but nonetheless, 34.34% of women who receive prenatal care at public institutions give birth by cesarean, which is well above the recommended rate. Similarly, women who give birth at private institutions are most likely to delivery by cesarean section, followed by women who give birth in social security institutions. Women who deliver in public institutions are least likely to give birth by cesarean, but the rate of cesarean section is still 29.94%, again well over the recommended rate. Further, the number of prenatal visits regardless of type of institution, which

may serve as an indicator of how medicalized a woman's pregnancy is, is another important predictor of cesarean delivery, as women who attend more prenatal care visits have higher rates of cesarean delivery. Despite this, increased prenatal care is essential for mother and child. Thus, it is the broader sense of cesareans as normal that must be addressed, and physicians should be strict in their distinction of medically indicated cesarean sections. Notably, for primiparous women, rates of delivering by cesarean section are highest for women who receive prenatal or birth care in social security institutions, followed closely by care in private institutions. Women who receive prenatal or birth care in public institutions are far less likely to deliver by cesarean section.

Finally, it seems that the type and frequency of care are both mediators between socio-demographic variables and mode of delivery. Analysis of socio-demographic characteristics demonstrates that there may be barriers in access to care, which contributes to our understanding of how Ecuadorian women are navigating the re-structured health care system. To address this, Ecuador should invest research and infrastructure to make public health care not only available in even the most rural settings, but also of high quality. Ecuador should also consider providing incentives to physicians who work in public institutions so that they will not be poached by private institutions that can afford higher salaries. To address the excess of cesarean sections, Ecuador should enact policy for stricter diagnosis of the medical indication for cesarean section. Though private institutions can profit indirectly from cesareans, Ecuador should also enact policy to prevent physicians from receiving economic incentives for cesarean deliveries.

Future projects should address how care has shaped risk for cesarean section over the past few decades and project how cesarean rates will develop in coming years. Other work should

aim to better understand the "cesarean culture" in Ecuador more broadly and analyze how

decision-making regarding cesarean delivery is made within various health institution.

APPENDIX A: INSTITUTION OF PRENATAL CARE CATEGORIES

I.   Public Institution
   a.   Hospital MSP
   b.   Centros de Salud MSP
   c.   Consejo Provincial/ Unidad Municipal de Salud
II. Social Security Institution
   a.   Hospital/Clinica/Dispensario del IESS
   b.   Seguro Social Campesino (SSC)
   c.   Hospital FFAA/Police
III. Private Institution
   a.   Junta de Beneficencia
   b.   Fundación/ONG
   c.   Private Hospital/Clinic

APPENDIX B: INSTITUTION OF BIRTH CATEGORIES

I. Public Institution
   a. Hospital MSP
   b. Centros de Salud MSP
   c. Subcentro de Salud MSP
   d. Puesto de Salud MSP
   e. Consejo Provincial/ Unidad Municipal de Salud
II. Social Security Institution
   a. Hospital/Clinica IESS
   b. Dispensario IESS
   c. Hospital FFAA/Police
III. Private Institution
   a. Private Hospital/Clinic
   b. Junta de Beneficencia
   c. Fundación/ONG

APPENDIX C: EDUCATION CATEGORIES

I. None
   a. Ninguna
II. Primario
   a. Primario
III. Secundario
   a. Secundario
IV. Superior/Postgrado
   a. Educación Básica
   b. Bachillerato- Educación Media
   c. Ciclo Postbachillerato
   d. Superior
   e. Postgrado
V. Missing
   a. Centro de alfabetización/EBA
   b. Educación Básica

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