

Full Length Research Paper

Method of birth in nulliparous women with single, cephalic, term pregnancies: The WHO global survey on maternal and perinatal health, 2004 – 2008

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To determine risk factors associated with cesarean birth in nulliparous women with single, cephalic, term pregnancies in spontaneous labor, also known as the Robson Group 1 population. We used the facility-based, multi-country, cross-sectional WHO Global Survey of Maternal and Perinatal Health conducted in 2004 – 2008 to examine the association between woman-, labor/obstetric-, and facility-level characteristics and cesarean birth among Robson Group 1 women using adjusted bivariate comparisons and multivariable logistic regression. We analyzed outcomes of 82,280 women in Robson Group 1, 82% of whom gave birth vaginally (67,698 women) and 18% of whom gave birth by primary cesarean (14,578 women). In adjusted analyses, woman-level factors associated with cesarean birth included age greater than 18 years old, above-normal body mass index (overweight or obese), being married or cohabitating, having attended four or more prenatal visits, and being medically high-risk ($p < 0.01$). Women who were obstetrically high-risk, were referred during the course of labor, or were at 39 weeks or more gestational age were also more likely to undergo cesarean birth (p -value < 0.001). The facility-level variables associated with method of birth was birth at a facility that had anesthesia service in the facility 24/7, was a teaching facility, required fees for cesarean birth, had electronic fetal monitoring available, and had providers skilled in operative vaginal birth ($p < 0.01$). Strategies to reduce the frequency of cesarean rates globally include avoidance of medically unnecessary primary cesarean birth. Our analysis of Robson Group 1 women who are at risk of primary cesarean birth highlights the importance of maintaining a healthy pre-pregnancy and pregnancy weight, optimizing management of women with medical problems, and ensuring clear referral mechanisms that ensure women are transferred earlier in the labor course (when warranted). Consideration of removing or reducing fees for cesarean birth warrants further exploration.

Keywords: cesarean birth, low- and middle-income countries, Robson group 1.

INTRODUCTION

Cesarean birth rates are increasing, globally.¹ The World Health Organization (WHO) has recommended the use of the Robson Classification system to better understand these rising rates.² This classification system utilizes

common obstetric variables normally used in the clinical care of the women (parity, history of prior cesarean birth, onset of labor, number of fetuses, gestational age, fetal lie and presentation) to categorize women admitted for birth into ten mutually exclusive, all-inclusive groups.² Classifying women in this way has shown that nulliparous women with single, cephalic, term pregnancies tend to be one of the largest contributor to the overall caesarean

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section rate.^{3,4} As a result, there is a heightened focus on preventing primary cesarean birth, or developing interventions to prevent unnecessary primary cesarean birth, as a strategy to reduce caesarean rates.⁴ Once a woman has undergone a cesarean birth, preventing subsequent cesareans is a more complex challenge.⁵ Therefore, in response to the global health priority of preventing medically unnecessary primary cesarean births in nulliparous women with a full-term, singleton fetus in cephalic presentation, who go into labor spontaneously, our analysis focused on this population, also known as Robson Group 1.²

While the Robson Classification system has been useful to understanding subpopulations and how they contribute to cesarean birth rates at the facility and national level, we hypothesize that there are additional actionable, modifiable risk factors associated with cesarean birth in the Robson Group 1 population that can be explored.^{3,6,7} As such, we present here a secondary analysis of the WHO Global Survey on Maternal and Perinatal Health dataset, which compares women in Robson Group 1, who went into labor spontaneously and were delivered vaginally to those who went into labour spontaneously but delivered by cesarean birth.⁸ We considered sociodemographic variables, obstetric and labor variables, and hospital factors that may be associated with method of birth in these women.

METHODS

Study Overview: This was a secondary analysis of the prospectively collected World Health Organization (WHO) Global Survey of Maternal and Perinatal Health (WHOGS) data. Our study population were women in Robson Group 1 (nulliparous women at term with a singleton fetus in cephalic presentation, who go into labor spontaneously). We compared women who underwent vaginal birth to those who underwent cesarean birth.

Dataset: The methodology of the WHOGS has been published.⁸ In brief, WHOGS was undertaken in 2004–05 (in 8 Latin America and 7 African countries) and in 2007–08 (in 9 Asian countries).⁸ Data were gathered for 2 months in institutions with at least 6000 deliveries per year and for 3 months in institutions with fewer than 6000 annual deliveries.⁸ Data about the sociodemographic, obstetric, birth, and labor characteristics, and a range of maternal and perinatal outcomes, were captured from all women who gave birth in participating institutions during the data collection period.⁸ Data were collected for 290,610 deliveries in 373 facilities in 24 countries.⁸ Data were collected prospectively from the time of maternal presentation at the facility until discharge, or the seventh day postpartum, whichever occurred first.⁸ Data collectors reviewed medical records daily and abstracted de-identified data from these records into an individual data form.⁸ Additionally, an institutional data form was

completed for each participating facility via an interview with the head of the obstetrics/gynaecology department.⁸

Primary Outcome: Our primary outcome of interest was method of birth. We wished to compare Robson Group 1 women who experienced vaginal birth to those who underwent cesarean birth, after the onset of spontaneous labor, to determine what additional risk factors were associated with cesarean birth.

Analysis: Covariates considered in our analysis were sociodemographic characteristics (age, education, body mass index, marital status, human development index (2008) of country where woman gave birth), antenatal profile (number of antenatal visits, medical risk level), and obstetric profile (obstetric complications, referral to a higher level of care during the course of labor, gestational age).⁹ Facility-level covariates considered in the analysis were: availability of the partogram, anesthesia 24/7 in the facility, being a teaching facility, whether or not the facility levied fees for cesarean birth, whether electronic fetal monitoring was available, and whether providers available in the facility were skilled in operative vaginal birth.

Women were categorized into the “high” maternal medical risk category if the survey reported they had HIV, chronic hypertension, cardiac or renal disease, respiratory disease, diabetes, malaria, anemia, urinary tract infection, genital ulcers, condyloma, or thalassemia; this pragmatic definition was devised for this analysis and not previously defined elsewhere. We defined obstetric risk level as “high” for women who experienced pregnancy-related hypertension, pre-eclampsia or eclampsia, or suspected fetal growth impairment. This definition was also used strictly for this analysis and has not been previously used elsewhere.

Comparisons were made between Robson Group 1 women by method of birth in both bivariate and multivariable comparisons, that were adjusted for country and facility of birth. A p-value of < 0.01 (bivariate logistic regression adjusted for multi-level random effects) was used to determine statistical significance given the large sample size and multiple comparisons. Variables significant in the bivariate analysis to $p < 0.05$ were included in the multivariable model. Stata software version 15.2 (StataCorp LP, College Station, TX, USA) was used for analysis.

Ethics Statement: The study protocol was reviewed and approved by the Specialist Panel on Epidemiological Research and the WHO ethics review committee, as well as relevant ethical clearance bodies in participating countries and facilities. This de-identified data analysis was reviewed and approved by the Colorado Multiple Institutional Review Board, 18-0875.

RESULTS

From a total 290,610 births included in the WHOGS, this analysis concerns 82,280 (28% of all births), which repre-

sents all women in the WHOOGS database who were Robson Group 1. The CONSORT diagram in Figure 1 illustrates which women were included in the analysis. 67,698 women, or 82% percent of this group, gave birth vaginally. The remaining 18%, or 14,578 women, gave birth by primary cesarean.

Indication for Cesarean Birth (data not shown): The leading indications for cesarean for Robson Group 1 women who gave birth by cesarean were reported as cephalopelvic disproportion or failed operative vaginal birth, and fetal distress, which accounted for 44% and 21% of cesareans that occurred in the population of interest, respectively. All other indications accounted for less than 10% of all cesareans. Unspecified maternal, fetal, or other obstetric complications accounted for 6, 7, and 8% percent of births, respectively. Cesarean birth for pre-eclampsia or eclampsia occurred in 4% of women and cesarean birth on maternal request was reported in 3% of women. All remaining indications accounted for 2% or less of cesarean births in the cohort. Indication for cesarean birth was not included in the analysis.

Bivariate Comparisons: Table 1 shows the bivariate comparisons performed between Robson Group 1 women who gave birth vaginally compared to those who experienced cesarean birth. All comparisons were adjusted for multi-level random effects accounting for country and facility where the woman gave birth. Women were compared by method of birth on sociodemographic, maternal medical and obstetric, and hospital characteristics.

In our comparisons, we found that rates of cesarean birth were higher for women with a maternal age greater than 18 years old (compared to less than or equal to 18 years), educational level greater than or equal to thirteen years of education, body mass index (BMI) 25.0 kg/m² or greater, and women who were married or cohabitating (compared to single women). Additionally, women who attended four or more antenatal care visits (compared to less), were medically high-risk, were referred during the course of labor for a higher level of care, were obstetrically high-risk, or gave birth in a medium or high human development index country also had higher rates of cesarean birth. Women with gestational age greater than or equal to 41 weeks had higher rates of birth by cesarean as compared to women who were term.

Facility-level factors associated with a higher rate of cesarean birth in Robson Group 1 women included: availability of electronic fetal monitoring, 24/7 availability of anesthesia in the facility, available providers skilled in operative vaginal birth (forceps or vacuum), delivering at a teaching facility, and requiring women to pay fees for cesarean birth ($p < 0.01$).

Multivariable Model: Table 2 illustrates the results of our unadjusted and adjusted multi-level random effects logistic regression that adjusted for country and facility of birth. We found that all covariates significant in the patient and

obstetric bivariate comparisons increased the odds of cesarean birth in the multivariable mode as well, except for years of education and human development index of the country of birth. Age greater than 18 was associated with increased odds of cesarean birth by at least 30%, overweight or obese BMI by at least 50%, and married or cohabitating status by 10% ($p < 0.01$). Of note, age greater than or equal to 35 years old was associated with increased odds of cesarean birth by 3.4 times compared to women age 18 or under (CI 3.0, 3.8, p -value < 0.001). Attending more prenatal visits (≥ 8) and being medically high-risk increased the odds of cesarean by 20% ($p < 0.001$). Finally, being referred during labor, having an obstetrical high-risk condition, or being greater than 39 weeks gestation were associated with increased odds of cesarean birth in the population by 60%, 110%, and at least 10%, respectively ($p < 0.001$).

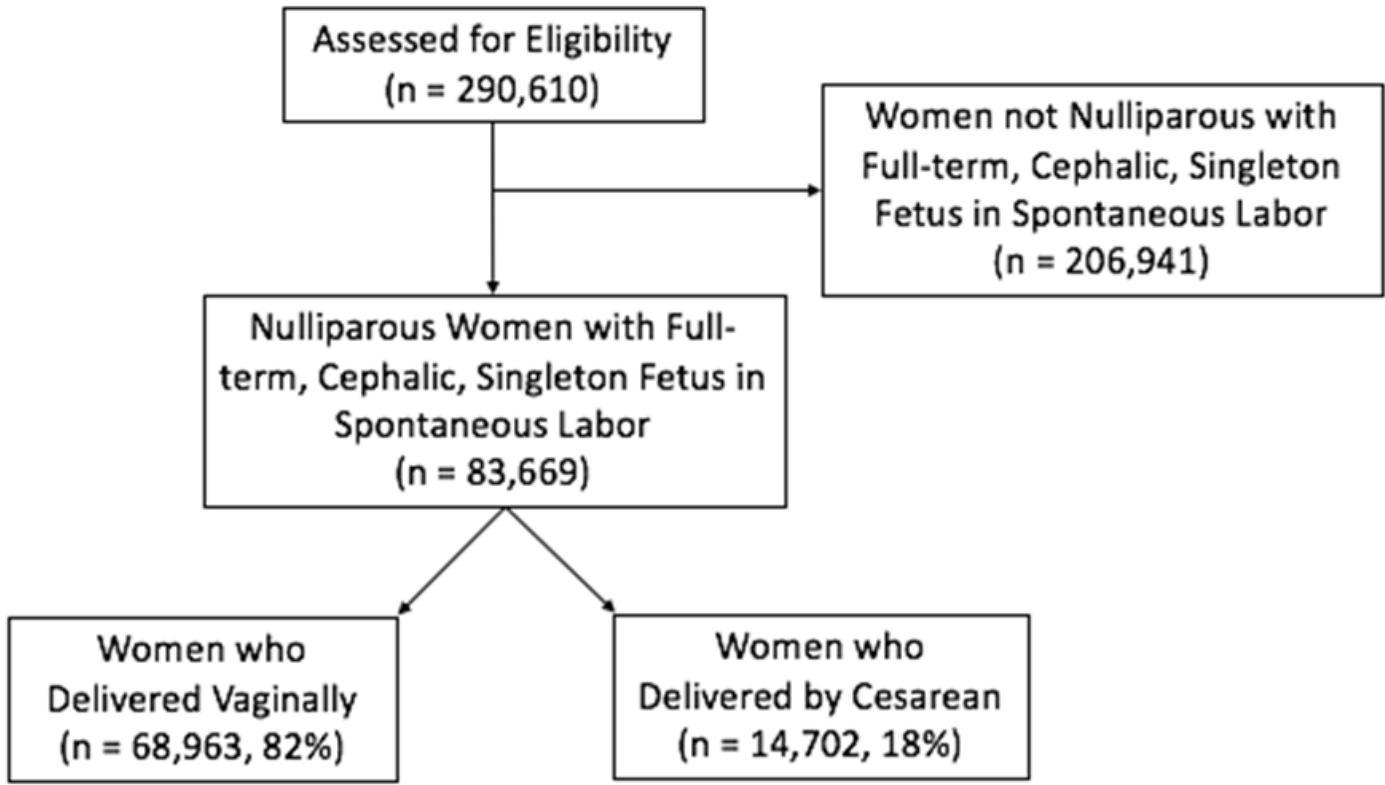
Facility-level variables associated with an increased odds of cesarean birth included giving birth in a facility with 24/7 availability of anesthesia (AOR 1.5 [CI 1.1,1.9]), that is a teaching facility (AOR 1.5 [CI 1.2,1.9]), that levies fees for cesarean birth (AOR 1.5 [CI 1.1,1.9]), or has electronic fetal monitoring capability (AOR 1.6 [CI 1.2,2.2]), $p < 0.01$. The risk factors most highly associated with an increased odds of cesarean birth was the availability of providers skilled in operative vaginal birth, which had an AOR of 2.1 for cesarean birth [CI 1.5,3.0], $p < 0.001$.

DISCUSSION

In this analysis of over 80,000 Robson Group 1 women (nulliparous in spontaneous labor with a single, cephalic term pregnancy) in 24 countries in Africa, Asia, and Latin America, we were able to identify several factors independently associated with cesarean birth. Those that are potentially actionable and modifiable include BMI, management of medical complications, time of referral in labor, gestational age at birth, and levying fees for cesarean birth. Additionally, two-thirds of all cesareans were performed for cephalopelvic disproportion (or failed operative vaginal birth) and reported fetal distress, accounting for 44 and 21% of cesareans, respectively.

Obese women were more likely to undergo cesarean birth.¹⁰⁻¹³ This is a common finding in the literature, and in our cohort, we found that the odds of intrapartum cesarean birth were increased for overweight and obese women, and reduced for underweight women, when both were compared to normal weight women. The National Academy of Medicine in the US has developed guidelines for healthy weight gain in pregnancy, although this may not apply to all global populations.¹⁴ What is clear, though, is that the global population, and the global pregnant population, is trending toward obesity, including in low- and middle-income countries.¹⁵⁻¹⁸ Strategies to reduce obesity in women intending to become pregnant and interventions to maintain an appropriate gestational weight

Figure 1. CONSORT Diagram.



gain during pregnancy are likely to reduce the use of caesarean section, and should be essential components of the research agenda, globally.¹⁹⁻²¹

Unsurprisingly, women with medical problems such as chronic hypertension, cardiac or renal disease, pulmonary pathology, diabetes, malaria, sickle cell disease, severe anemia, urinary tract infection, severe condylomatous disease, HIV or a condition associated with HIV, or thalassemia were found to have a higher risk of cesarean birth in our study cohort. We hypothesize that optimizing management or prevention of these medical issues may allow some women to benefit from achieving a vaginal birth. Medical problems such as chronic hypertension or severe anemia, which could have implications for fetal growth and subsequent resilience in labor (that otherwise might lead to cesarean birth for fetal or maternal indications), can be properly managed with medical treatment such as anti-hypertensives and iron supplementation, or prevented altogether with proper screening and intervention.^{22,23}

Our analysis showed no association between availability of the partogram at the facility and cesarean birth, but did show that women referred during the course of labor had a higher odds of cesarean birth. Use of the partogram has shown mixed effects in its ability to impact method of birth,

suggesting that it may not be the ideal intervention to respond to the issue that women in Robson Group 1 referred during labor have a higher odds of cesarean birth.²⁴ WHO has asserted that assessment of cervical dilatation over time is a poor predictor of severe adverse birth outcomes and that the validity of the alert line in the partogram based on the “one-centimeter-per-hour” rule should be evaluated.²⁵ Also, labor may not naturally accelerate until a cervical dilatation threshold of 5 cm is reached.²⁶ The use of medical interventions to accelerate labor and birth (augmentation or caesarean section) before this threshold is not recommended, provided fetal and maternal conditions are reassuring.^{25,27} A study from rural India found that conditions associated with referral during labor and delivery were often known before the onset of labor.²⁸ They concluded that improvement in pregnancy outcomes, although they were not specifically looking at method of birth, requires women with conditions that put them at high-risk for referral to be delivered in a high-risk setting, and women with complications of labor and delivery need prompt detection and transfer.²⁸ This suggests that to reduce the cesarean birth rate among low-risk women, earlier or improved adherence to referral guidelines might be useful.

Our analysis also suggests that women pregnant at gesta-

Table 1. Women-, Obstetric/Labor-, and Available Facility-Level Factors and Method of Birth in Robson Group 1 Women, After the Onset of Spontaneous Labor.

Robson Group One			
	Vaginal Birth (n = 67,698)	Cesarean Birth (n = 14,578)	P-Value*
Woman-Level Factors			
	n = 67,698	n = 14,578	
Age			<0.001
≤ 18	12,971 (19%)	2,024 (14%)	
19 – 34	53,505 (79)	11,956 (82)	
≥ 35	1,222 (2)	598 (4)	
	n = 67,698	n = 14,578	
Education (years)			<0.001
0 – 6	14,832 (22%)	2,657 (18%)	
7 – 12	39,618 (58)	8,340 (57)	
≥ 13	13,248 (20)	3,581 (25)	
	n = 66,721	n = 14,336	
Body Mass Index (kg/m ²)			<0.001
< 18.5	745 (1%)	83 (<1%)	
18.5 – 24.9	26,012 (39)	3,986 (28)	
25.0 – 29.9	22,621 (34)	5,968 (42)	
≥ 30.0	17,343 (26)	4,299 (30)	
	n = 67,505	n = 14,543	
Marital Status			<0.001
Single/Separated/Divorced/Widowed/Other	13,582 (20%)	2,106 (15%)	
Married/Cohabiting	53,923 (80)	12,437 (85)	
	n = 67,698	n = 14,578	
Antenatal Visits			<0.001
<4	18,510 (27%)	2,708 (19%)	
≥ 4	49,188 (73)	11,870 (81)	
	n = 67,698	n = 14,578	
Medically high risk **	9,898 (15%)	2,834 (19%)	<0.001
	n = 67,698	n = 14,578	
Human Development Index 2008			0.006
Low	5,877 (9%)	533 (4%)	
Medium	48,236 (71)	10,845 (74)	
High	13,585 (20)	3,200 (22)	
Obstetric & Labor-Level Factors			
	n = 67,698	n = 14,578	
Obstetrically High Risk***	2,821 (4%)	1,363 (9%)	<0.001
	n = 67,689	n = 14,575	
Referred During Labor	12,100 (18%)	3,617 (25%)	<0.001
	n = 67,698	n = 14,578	
Gestational Age at Birth			<0.001
37 – 38+6 weeks	21,712 (32%)	27%	
39 – 40+6 weeks	39,879 (59)	8,435 (58)	
≥ 41 weeks	6,107 (9)	2,236 (15)	
Available Facility-Level Factors			
	n = 67,695	n = 14,578	
Electronic Fetal Monitor Available	45,547 (67%)	11,940 (82%)	<0.001
	n = 67,692	n = 14,578	

Table 1. Contd.

Anesthesia 24/7 In Facility (n = 82,270, 2% missing data)	47,962 (71%)	12,301 (84%)	<0.001
	n = 67,698	n = 14,578	
Providers Skilled in Operative Vaginal Birth(Forceps or Vacuum)	59,739 (88%)	13,522 (93%)	<0.001
	n = 67,348	n = 14,577	
Teaching Facility	50,091 (74%)	12,053 (83%)	<0.001
	n = 66,568	n = 14,489	
Patient Fees Levied for Cesarean Birth	37,993 (57%)	9,193 (63%)	0.001
	n = 66,695	n = 14,578	
Partogram Available	60,344 (89%)	13,367 (92%)	0.03
	n = 67,695	n = 14,578	
Patients to Bring/Pay for Surgical Equipment for Cesarean Birth	22,757 (34%)	3,938 (27%)	0.06
	n = 67,555	n = 14,571	
Intrapartum Guidelines Available	56,595 (84%)	13,062 (90%)	0.1
	n = 67,521	n = 14,571	
Fetal Scalp pH Sampling Available	8,255 (12%)	3,029 (21%)	0.2

*P-value represents bivariate comparison adjusted for multi-level random effects at country and facility level

**Medically High Risk is a dichotomous variable whereby women are considered to be medically high risk if they have chronic hypertension, cardiac or renal disease, pulmonary pathology, diabetes, malaria, sickle cell disease, severe anemia, urinary tract infection, severe condylomatous disease, HIV or a condition associated with HIV, or thalassemia

***Obstetrically High Risk is a dichotomous variable whereby women are considered obstetrically high risk if they experience hypertension in pregnancy, pre-eclampsia, eclampsia, or have suspected fetal growth impairment.

tional ages at or more than 39 weeks were more likely to be delivered by cesarean birth, with the odds increasing almost by a factor of 2 for women at 41 weeks or later. This is another common finding in the literature, which was recently tested in a prospective, randomized controlled trial of nulliparous women with a term, cephalic, singleton fetus.²⁹ While women in the trial were randomized to induction versus expectant management, whereas our population went into labor spontaneously, the trial did show a significant reduction in the frequency of cesarean birth compared to the expectant management group.²⁹ While not all healthcare settings may be able to handle the volume of systematic induction of labor of nulliparous women at 41 weeks, induction of labour may result in other complications such as increased use of instrumental delivery, and we are not recommending systematic induction for women at 41 weeks, the literature does suggest that gestational age may be a modifiable risk factor for use of cesarean birth in some women.^{30,31}

In settings where maternity care is not provided free-of-charge, economic incentives for performing cesarean birth, as opposed to vaginal birth, may be associated with the decision for method of birth.³¹ A study of over four million women found that those who deliver at private hospitals had a 1.4 higher adjusted odds of birth by

cesarean birth, regardless of women's risk and contextual factors such as country, year, or study design.³² Our results showed that in facilities where fees are required for cesarean birth, women had an increased risk of cesarean birth. Economic incentives have been identified as factors driving the cesarean rate but remain controversial in terms of the effectiveness and potential interactions with other factors.^{31,33-35} The WHO guideline on non-clinical interventions to reduce unnecessary caesarean sections, notes: "financial strategies (i.e. insurance reforms equalizing physician fees for vaginal births and caesarean sections) for health-care professionals or health-care organizations are recommended only in the context of rigorous research."^{36,37}

Finally, the availability of electronic fetal monitoring (the actual use in each women was not recorded in the dataset) in facilities was found to be associated with an increased odds of cesarean birth in women in Robson Group 1. It is known that increased use of this technology has been associated with increased cesarean birth rates.³⁷ WHO has recommended intermittent auscultation of the fetal heart rate with either a Doppler ultrasound device or a Pinard fetal stethoscope be used for healthy pregnant women in labour.²⁵

Table 2. Odds of Cesarean Birth in Robson Group 1 Women by Various Women-, Obstetric/Labor-, and Facility-Level Factors After the Onset of Spontaneous Labor.

Robson Group 1						
	Adjusted Odds Ratio for Cesarean	95% Confidence Interval	P-Value	Unadjusted Odds Ratio for Cesarean	95% Confidence Interval	P-Value*
Woman-Level Factors and Odds of Cesarean Birth						
Age						
≤ 18 (reference group)	1			1		
19 – 34	1.3	1.2,1.4	<0.001	1.4	1.3,1.5	<0.001
≥ 35	3.4	3.0,3.8	<0.001	3.8	3.3,4.2	<0.001
Education (years)						
0 – 6 (reference group)	1			1		
7 – 12	0.9	0.9,1.0	0.07	1.0	0.9,1.0	0.2
≥ 13	1.1	1.0,1.2	0.04	1.2	1.1,1.3	<0.001
Body Mass Index (kg/m ²)						
< 18.5	0.7	0.5,0.9	0.002	0.7	0.5,0.9	0.002
18.5 – 24.9 (reference group)	1			1		
25.0 – 29.9	1.5	1.5,1.6	<0.001	1.6	1.5,1.7	<0.001
≥ 30.0	2.2	2.0,2.4	<0.001	2.4	2.3,2.6	<0.001
Marital Status						
Single/Separated/Divorced/Widowed/Other	0.9	0.8,0.9	<0.001	0.8	0.8,0.9	<0.001
Married/Cohabiting(reference group)	1			1		
Antenatal Visits ≥ 4	1.2	1.2,1.3	<0.001	1.3	1.3,1.4	<0.001
Medically High Risk**	1.3	1.2,1.4	<0.001	1.4	1.3,1.4	<0.001
Human Development Index 2008						
Low	0.7	0.2,1.8	0.4	0.2	0.1,0.5	0.001
Medium	1.4	0.7,2.8	0.4	0.9	0.4,2.0	0.8
High (reference group)	1			1		
Obstetric & Labor-Level Factors and Odds of Cesarean Birth						
Referred During Labor	1.6	1.5,1.7	<0.001	1.7	1.6,1.8	<0.001
Obstetrically High Risk***	2.1	2.0,2.3	<0.001	2.3	2.1,2.5	<0.001
Gestational Age at Birth						
37 – 38+6 weeks (reference group)	1			1		
39 – 40+6 weeks	1.1	1.1,1.2	<0.001	1.1	1.1,1.2	<0.001
≥ 41 weeks	1.9	1.8,2.0	<0.001	1.9	1.8,2.0	<0.001
Available Facility-Level Factors and Odds of Cesarean Birth						
Partogram Available	1.0	0.7,1.4	0.9	1.5	1.0,2.1	0.03
Anesthesia 24/7 In Facility	1.5	1.1,1.9	0.009	2.3	1.7,3.0	<0.001
Teaching Facility	1.5	1.2,1.9	0.002	2.2	1.7,2.9	<0.001
Patient Fees Levied for Cesarean Birth	1.5	1.1,1.9	0.009	1.8	1.3,2.4	0.001
Electronic Fetal Monitor Available	1.6	1.2,2.2	0.003	2.7	2.0,3.6	<0.001
Providers Skilled in Operative Vaginal Birth Available	2.1	1.5,3.0	<0.001	3.5	2.4,5.1	<0.001

*P-value multivariable model adjusted for multi-level random effects at country and facility level

**Medically High Risk is a dichotomous variable whereby women are considered to be medically high risk if they have chronic hypertension, cardiac or renal disease, pulmonary pathology, diabetes, malaria, sickle cell disease, severe anemia, urinary tract infection, severe condylomatous disease, HIV or a condition associated with HIV, or thalassemia

***Obstetrically High Risk is a dichotomous variable whereby women are considered obstetrically high risk if they experience hypertension in pregnancy, pre-eclampsia, eclampsia, or have suspected fetal growth impairment.

The limitations of this study include the fact that the data were collected ten years ago, that multiple comparisons were performed with the data, and that unmeasured facility, sociodemographic, or obstetric variables may confound the results. Additionally, in terms of the body mass index data, it was not always clear at what point in the pregnancy the weight was taken, so this is a significant limitation of that variable that should be considered when reviewing our analysis. The large sample size, multiple available covariates, the fact that the survey

was designed to assess method of birth, and that the multi-country data was collected using a standard approach / protocol / measurement tool are strengths of the analysis.

CONCLUSION

Robson Group 1 women have been identified as an important population for studying how vaginal birth can be increased, and cesarean birth reduced. Based on this

analysis, we suggest an increased focus on maintaining a healthy pre-pregnancy and pregnancy weight, tighter management of women with medical problems, and more specific referral standards that transfer at-risk women earlier in the labor course, if appropriate. Interventions or policies that remove financial incentives to perform a caesarean section could possibly reduce this practice though more research is needed to evaluate this.

Author Contributions: MSH conceived of the analytic plan with feedback and input from APB, JPV, RLG, and AMG. MSH performed the analysis with feedback and oversight from APB and JPV. MSH wrote the manuscript with input from all authors.

CONFLICT OF INTEREST

The authors have no relationships to disclose that may be deemed to influence the objectivity of this paper and its review. The authors report no commercial associations, either directly or through immediate family, in areas such as expert testimony, consulting, honoraria, stock holdings, equity interest, ownership, patent-licensing situations or employment that might pose a conflict of interest to this analysis. Additionally, the authors have no conflicts such as personal relationships or academic competition to disclose. The findings presented in this paper represent the views of the named authors only, and not the views of their institutions or organizations.

KEY MESSAGE

Certain woman-level, obstetric-level, and available facility-level risk factors are associated with greater likelihood of cesarean birth, even in low-risk women. The modifiable factors could be targeted for interventions to reduce cesarean birth in this population.

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REFERENCES

- ACOG Committee Opinion Weight Gain During Pregnancy 2018.
- ACOG Committee Opinion. Obesity in Pregnancy 2013.
- ACOG Practice Bulletin 184, 2017. Vaginal Birth After Cesarean. *Ob & Gyn* 130 (5): e217 – e233.
- ACOG Practice Bulletin. Anemia in Pregnancy. ACOG 2008.
- ACOG Practice Bulletin. Hypertension in Pregnancy. ACOG 2013.
- ACOG SMFM Safe Prevention of Primary Cesarean Delivery. Obstetric care consensus No. 1, 2016
- Betrán AP, Temmerman M, Kingdon C, Mohiddin A, Opiyo N, Torloni MR, Zhang J, Musana O, Wanyonyi SZ, Gülmezoglu AM, Downe S. Interventions to reduce unnecessary caesarean sections in healthy women and babies. *Lancet*. 2018 Oct 13;392(10155):1358-1368.
- Betrán AP, Temmerman M, Kingdon C, Mohiddin A, Opiyo N, Torloni MR, Zhang J, Musana O, Wanyonyi SZ, Gülmezoglu AM, Downe S. Interventions to reduce unnecessary caesarean sections in healthy women and babies. *Lancet*. 2018 Oct 13;392(10155):1358-1368.
- Betran AP, Torloni MR, Zhang JJ, Gülmezoglu AM; WHO Working Group on Caesarean Section. WHO Statement on Caesarean Section Rates: a commentary. *BJOG*. 2016;123(5):667-70. WHO Robson classification implementation manual.
- Betran AP, Vindevoghel, Souza JP, Torloni MR. A systematic review of the Robson classification for cesarean section: what works, doesn't work and how to improve it. *PLoS One* 2014, 9(6): e97769
- Betran AP, Ye J, Moller AB, Zhang J, Gulmezoglu AM, Torloni MR. The increasing trend in cesarean section rates: global, regional and national estimates: 1990 – 2014. *PlosOne* 2016 <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0148343>
- Boatin AA, Cullinane F, Torloni MR, Betran AP. Audit and feedback using the Robson classification to reduce cesarean section rates: a systematic review. *BJOG* 2018, 125 (1): 36 – 42.
- Chen I, Opiyo N, Tavender E, Mortazhejri S, Rader T PJ, Yogasingam S, Taljaard M, Agarwal S, LaopaiboonM, Wasiak J, Khunpradit S, Lumbiganon P GR, Betran AP. Non-clinical interventions for reducing unnecessary caesarean section. *Cochrane Database of Systematic Reviews*. 2018 Sep 28;9:CD005528. doi: 10.1002/14651858.CD005528.pub3.
- Cormick G, Betrán AP, Harbron J, DannemannPurnat T, Parker C, Hall D, Seuc AH, Roberts JM, Belizán JM, Hofmeyr GJ; Calcium and Pre-eclampsia Study Group. Are women with history of pre-eclampsia starting a new pregnancy in good nutritional status in South Africa and Zimbabwe? *BMC Pregnancy Childbirth*. 2018 Jun 15;18(1):236. doi: 10.1186/s12884-018-1885-z.
- Dietz P, Callaghan W, Morrow B, Cogswell M. Population-

- based assessment of the risk of primary cesarean delivery due to excess prepregnancy weight among nulliparous women delivering term infants. *Matern Child Health J.* 2005; 9(3):237–244. [PubMed: 16078011]
- Grimes DA, Peipert JF. Electronic fetal monitoring as a public health screening program: the arithmetic of failure. *ObstetGynecol*2010;116:1397–1400).
- Grobman WA, Rice MM, Reddy UM, Tita ATN, Silver RM, Mallett G et al. Labor induction versus expectant management in low-risk nulliparous women. *NEJM* 2018, 379: 513 – 523.
- Hoxha I, Syrogiannoulis L, Luta X, Tal K, Goodman DC, da Costa BR, Jüni P. Caesarean sections and for-profit status of hospitals: systematic review and meta-analysis. *BMJ Open* 2017;7:e013670. doi:10.1136/bmjopen-2016-013670
- International Weight Management in Pregnancy (i-WIP) Collaborative Group. Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: meta-analysis of individual participant data from randomised trials. *BMJ.* 2017 Jul 19;358:j3119. doi: 10.1136/bmj.j3119. Review.
- International Weight Management in Pregnancy (i-WIP) Collaborative Group. Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: meta-analysis of individual participant data from randomised trials. *BMJ.* 2017 Jul 19;358:j3119. doi: 10.1136/bmj.j3119. Review. Erratum in: *BMJ.* 2017 Aug 23;358:j3991.
- Kingdon C et al. Interventions targeted at health professionals to reduce unnecessary caesarean sections: A qualitative evidence synthesis. *BMJ Open.* 2018 (in press).
- Kingdon C et al. Non-clinical interventions to reduce unnecessary caesarean section targeted at organisations, facilities and systems: a qualitative evidence synthesis of stakeholders' views. *PLoS ONE.* 2018, 4;13(9):e0203274.
- Lavender T, Cuthbert A, Smyth RMD. Effect of partograph use on outcomes for women in spontaneous labour at term and their babies. *Cochrane Database of Systematic Reviews* 2018, Issue 8. Art. No.: CD005461. DOI: 10.1002/14651858.CD005461.pub5.
- Lindsay KL, Gibney ER, McAuliffe FM. Maternal nutrition among women from sub-Saharan Africa, with a focus on Nigeria, and potential implications for pregnancy outcomes among immigrant populations in developed countries. *J Hum Nutr Die.* 2012;25(6):534–46.
- Middleton P, Shepherd E, Crowther CA. Induction of labour for improving birth outcomes for women at or beyond term. *Cochrane Database Syst Rev* 2018; 5: CD004945
- NCD Risk Factor Collaboration. Trends in adult body mass index in 200 countries from 1975 – 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants. *Lancet* 2016; 387: 1377–96
- Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the global burden of disease study 2013. *Lancet.* 2014;384:766 –81.
- Oladapo OT, Diaz V, Bonet M, Abalos E, Thwin SS, Souza H, Perdoná G, Souza JP, Gülmezoglu AM. Cervical dilatation patterns of 'low-risk' women with spontaneous labour and normal perinatal outcomes: a systematic review. *BJOG.* 2018 Jul;125(8):944-954. doi: 10.1111/1471-0528.14930. Epub 2017 Nov 3. Review.
- Patel AB, Prakash AA, Raynes-Greenow C, Pusdekar YV, Hibberd PL. Description of inter-institutional referrals after admission for labor and delivery: a prospective population based cohort study in rural Maharashtra, India. *BMC Health Services Research* (2017) 17:360 DOI 10.1186/s12913-017-2302-4
- Roman H, Goffinet F, Hulsey TF, et al. Maternal body mass index at delivery and risk of caesarean due to dystocia in low risk pregnancies. *Acta ObstetGynecol Scand.* 2008; 87(2):163–170. [PubMed: 18231883]
- Shah A, Faundes A, Machoki M, Bataglia V, Amokrane F, Donner A et al. Methodological considerations in implementing the WHO global survey for monitoring maternal and perinatal health. *Bulletin of the WHO* 2008, 86: 126 – 131.
- Souza JP, Oladapo OT, Fawole B, Mugerwa K, Reis R, Barbosa-Junior F, Oliveira-Ciabati L, Alves D, Gülmezoglu AM. Cervical dilatation over time is a poor predictor of severe adverse birth outcomes: a diagnostic accuracy study. *BJOG.* 2018 Jul;125(8):991-1000. doi: 10.1111/1471-0528.15205. Epub 2018 Apr 17.
- United Nations Human Development Index, 2008. Accessed 11.15.18 (http://hdr.undp.org/sites/default/files/reports/268/hdr_2007_2008_en_complete.pdf)
- Vogel JP, Betran AP, Vindevoghel N, Souza JP, Torloni MR, Zhang J et al. Use of the Robson classification to assess cesarean section trends in 21 countries: a secondary analysis of two WHO multicountry surveys. *Lancet Glob Health* 2015, 3:e260 – 70.
- Weiss JL, Malone FD, Emig D, et al. Obesity, obstetric complications and cesarean delivery rate— a population-based screening study. *Am J Obstet Gynecol.* 2004; 190(4):1091–1097. [PubMed: 15118648]
- WHO Obesity and Overweight Fact Sheet. Accessed 10/9/18. (<http://www.who.int/news-room/factsheets/detail/obesity-and-overweight>)
- WHO Recommendations: Intrapartum Care for a Positive Childbirth Experience. Accessed 11.30.18 (<http://apps.who.int/iris/bitstream/handle/10665/260178/9789241550215-eng.pdf?sequence=1>)
- WHO Recommendations: Non-Clinical Interventions to Reduce Unnecessary Cesarean Sections. Accessed 11.30.18 (<http://apps.who.int/iris/bitstream/handle/10665/275377/9789241550338-eng.pdf?ua=1>).

