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Research Article

Factors Associated with Cesarean Section Birth in Mexico from 2008 to 2017

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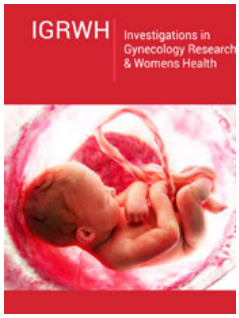

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Abstract

Introduction: Over the last thirty years, there has been a significant increase in the number of cesarean sections worldwide and in Mexico. The global recommendation is that the percentage of births by cesarean section should not exceed 15% of all births, as surpassing this threshold is associated with severe maternal morbidity and mortality.

Objective: The aim of this study is to find the institutional, clinical, and socioeconomic factors associated with the type of childbirth resolution in Mexico.

Methodology: The study analyzes births that occurred and were registered from 2008 to 2017 at the national level in Mexico, using birth certificates. Stratification was based on the region of the country, and a comprehensive analysis was conducted using univariate, bivariate, and multivariate approaches, employing logistic and multilevel regression techniques with a significance level set at 0.05.

Result: During the studied period, Mexico exceeded the World Health Organization's recommended percentage of births by cesarean section by 25.96 percentage points. The multilevel model analysis revealed that the institution managing the birth and the socioeconomic region of the pregnant woman's residence showed the strongest association with opting for a cesarean delivery.

Keywords: Birth; Type of delivery; Healthcare institutions; Mexico

Introduction

Cesarean section (C-section) stands as the most prevalent abdominal operation globally, with considerable variation in its prevalence both between and within countries [1]. In 1985, the World Health Organization (WHO) proposed a guideline that the rate of C-sections should not exceed 15% of all births, saying that no added health benefits were clear beyond this threshold [2]. In 2015, the WHO reiterated its stance on C-section rates [3], emphasizing that: (1) C-sections prove effective in saving lives when medically necessary; (2) at the population level, rates exceeding 10% show no correlation with reduced maternal and neonatal mortality rates; and (3) C-sections can result in significant, sometimes permanent, complications, disabilities, or even fatalities, particularly in settings lacking safe surgical facilities. Presently, Mexico ranks fourth globally, following China, Brazil, and the United States, for the highest number of unnecessary C-sections [4]. Data from the 2012 National Health and Nutrition Survey (ENSANUT) reveals a staggering 50.3% increase in C-sections in Mexico over the past 12 years, with the current nationwide percentage standing at 45.1% [5].

Research shows a direct association between maternal mortality and C-sections [6,7]. Maternal mortality increases up to seven times with C-sections compared to vaginal deliveries

[8], and morbidity rises to ten times higher [9]. Neonatal mortality also sees an increase with C-sections in low-risk women, reaching 1.77 per 1,000 live births compared to 0.62 for vaginal deliveries [10]. From an economic standpoint, surgical childbirth entails significantly higher costs compared to vaginal care, involving increased material usage, operating room expenses, and more costs related to medications and surgical tools. For instance, in England, it has been estimated that each 1% increase in the national C-section rate costs £5 million to the national health services, a financial burden that could be mitigated [11].

The mechanism to assess the conditions of labor and newborn care in a public context is through the Labor and Neonate Certificate of Birth [12]. This official and non-transferable document certifies the birth of a live individual at the moment of occurrence, offering the mother tangible proof of this event. The Birth Certificate is a mandatory, unique format for birth registration in the national territory. The procedure for obtaining the birth certificate involves health personnel responsible for issuing it within the first 24 hours after a live birth occurs. The primary aim of this study was to find institutional, clinical, and socioeconomic factors associated with the type of childbirth resolution in Mexico.

Materials and Methods

Study overview

An observational, longitudinal study was conducted, using the experiences of the population over time [13]. The study focused on the birth trajectories of individuals born and registered from 2008 to 2017 at the national level in Mexico. Data from each live birth's birth certificate was used, pooling information from ten years.

Data source

All birth certificate data is publicly accessible at http://www.dgis.salud.gob.mx/contenidos/basesdedatos/da_nacimientos_gobmx.html (Source: SS/DGIS, SINAIS). The data usage follows the "MX Terms of Free Use of Open Data of the Government of Mexico," available at https://datos.gob.mx/libreusomx

Data processing

Structured Query Language (SQL) database management system was employed to create the birth database for the years 2008-2017.

Socio-demographic variables

Socio-demographic variables were collected from the mother, encompassing state of residence, age in years, educational background, marital status, and work activity. Institutional variables included the health institution of entitlement, presence of prenatal care, and information on earlier pregnancies. For newborns, variables such as sex, age in weeks according to Capurro, type of birth (vaginal or cesarean section), weight in grams, height in centimetres, APGAR index score, Silverman-Andersen rating, birth shift, and birth institution were considered.

Inclusion and exclusion criteria

For the study, the inclusion criteria made up all births registered in Mexico from 2008 to 2017. Exclusions encompassed births with a recorded route of termination as "dystocic or unspecified," those occurring at home, on a public street, or with unspecified locations. Additionally, births resulting from multiple pregnancies (2 or more) were excluded. Variables lacking information from any case were not used for analysis and were treated as missing values.

Data Analysis

The states of residence for the mothers were grouped into four socioeconomic regions based on the 2018 report on regional economies published by the Bank of Mexico [14]:

A. Northern region: Baja California, Chihuahua, Coahuila, Nuevo León, Sonora, and Tamaulipas.

B. North central region: Aguascalientes, Baja California Sur, Colima, Durango, Jalisco, Michoacán, Nayarit, San Luis Potosí, Sinaloa, and Zacatecas.

C. Central region: Mexico City, Mexico, Guanajuato, Hidalgo, Morelos, Puebla, Querétaro, and Tlaxcala.

D. Southern region: Campeche, Guerrero, Chiapas, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatan.

Data analysis

Descriptive and inferential statistics were employed for data analysis using the Statistical Package for Social Sciences (SPSS). Univariate, bivariate, and multivariate analyses were conducted using logistic regression and multilevel techniques. Multivariate models were constructed based on the results of the bivariate analysis. The probability of committing a type I error was set at 0.05, and the statistical association between different study variables was assessed using the Odds Ratio (OR) and the 95% confidence interval [15].

Result

Behaviour of births over time

During the observed period (2008-2017), 21,146,302 births occurred in Mexico. After applying inclusion and exclusion criteria [16], the study encompassed 20,104,570 births analysed between 2008 and 2017, equivalent to 95% of the births during that period.

The annual distribution of births shows 1,863,008 births in 2008 (the year with the lowest number) and 2,099,995 births in 2012 (the year with the highest number). Subsequently, there was a decreasing trend in the number of births per year (Figure 1).

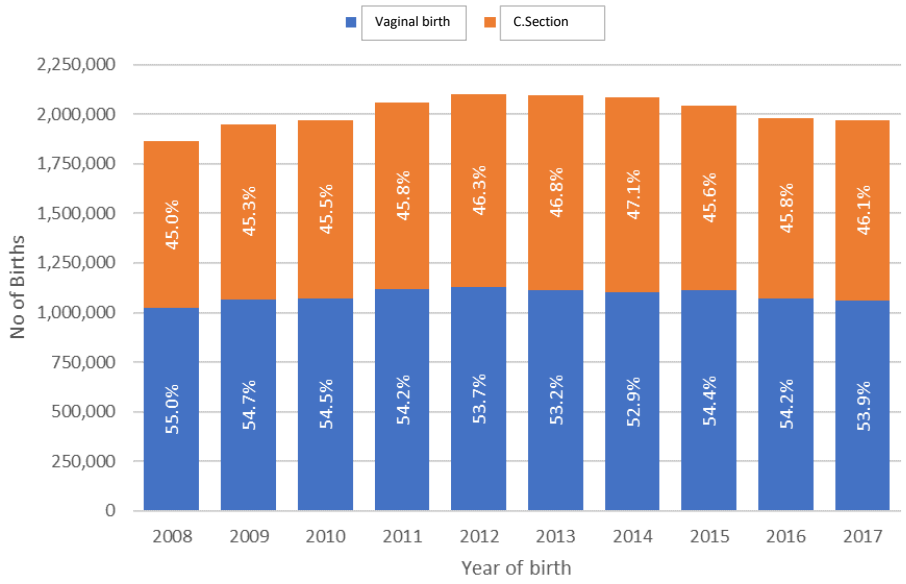

Figure 1: Frequency of births by type of delivery between 2008 and 2017 in Mexico.

Type of birth

Based on the type of birth, there were 10,864,533 (54.0%) vaginal births and 9,240,037 cesarean section births (46.0%) during the observed period [17]. The year 2012 recorded the highest number of vaginal births, while 2014 had the highest number of cesarean sections, displaying a consistent increase in cesarean section births from 2008 to 2014.

Relative percentage of cesarean sections

In relative terms, 2014 had the highest percentage of cesarean sections, accounting for 47.1% of births by this method. A $\chi 2$ hypothesis test comparing the proportions of vaginal and cesarean births per year yielded a $\chi 2$ value of 3262.480 with 9 degrees of freedom and a p-value <0.0001, showing statistically significant differences in these proportions per year of birth (Figure 1).

Demographic characteristics of the mother

Age: The mean age of the mother at the time of her child's birth was 25.8 years (SD = 6.3 years), staying stable over time with no statistically significant differences found between mean ages for each analysed year.

Educational attainment: The highest percentage of mothers had completed secondary education, constituting 37.9%, followed by those with a high school education at 26.9%. The categories of unschooled and primary school displayed a declining trend, with no statistically significant differences found between proportions of educational attainment per year [18].

Marital status: Approximately 89.5% of mothers lived with a partner, irrespective of their civil registry status. The remaining 10.5% did not have a partner at the time of their child's birth, with no statistically significant differences found in proportions of marital status per year.

Work activity: At the time of delivery, 83.2% of women were not engaged in any work activity, while 77.5% were entitled to a health institution in the country, including Seguro Popular. No statistically significant differences were seen in proportions per year for this variable. The trend of the mother's work activity increased over time, while marital status remained stable.

Parity: A total of 82.3% of women were primiparous, while 17.7% had multiple pregnancies, with no statistically significant differences found in proportions per year for this variable (Table 1).

Table 1: Frequency of maternal characteristics.

		Birth Year										
Characteristic	**Type of Measurement**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**P-value**
Mother's Age	Mean	25.79	25.73	25.73	25.71	25.67	25.67	25.75	25.83	25.92	25.96	>0.05 Ω
	Std. Dev.	6.25	6.29	6.3	6.31	6.3	6.3	6.3	6.27	6.26	6.29	
Maternal Education	No Education	3.35%	3.07%	2.88%	2.65%	2.37%	2.31%	2.05%	2.40%	2.31%	2.01%	>0.05 π
	Primary	25.12%	23.49%	22.06%	20.60%	19.21%	17.87%	16.58%	15.20%	13.69%	12.87%	>0.05 π
	Secondary	37.27%	37.67%	38.13%	38.11%	38.20%	38.09%	38.09%	37.63%	37.97%	38.10%	>0.05 π
	High School	22.76%	23.95%	24.63%	25.92%	27.01%	28.08%	28.88%	29.01%	28.78%	29.35%	>0.05 π
	Bachelor's	11.49%	11.83%	12.16%	12.22%	12.62%	12.97%	13.60%	14.85%	16.25%	16.62%	>0.05 π
	Postgrad	0.00%	0.00%	0.14%	0.50%	0.59%	0.69%	0.79%	0.91%	1.00%	1.05%	>0.05 π

Marital Status	In Union	89.64%	89.35%	89.37%	89.38%	89.46%	89.38%	89.47%	89.65%	89.95%	89.70%	>0.05 π
	Not In Union	10.36%	10.65%	10.63%	10.62%	10.54%	10.62%	10.53%	10.35%	10.05%	10.30%	>0.05 π
Mother's Employment	Employed	15.30%	15.20%	15.60%	15.80%	16.30%	17.00%	17.30%	17.90%	18.50%	18.40%	>0.05 π
	Unemployed	84.70%	84.80%	84.40%	84.20%	83.70%	83.00%	82.70%	82.10%	81.50%	81.60%	>0.05 π
Mother with Entitlement	No Entitlement	42.55%	32.06%	26.80%	22.03%	20.72%	19.15%	17.64%	16.11%	15.05%	14.71%	>0.05 π
	With Entitlement	57.45%	67.94%	73.20%	77.97%	79.28%	80.85%	82.36%	83.89%	84.95%	85.29%	>0.05 π
Previous Pregnancies	Primigravida	81.52%	81.87%	81.97%	82.15%	82.11%	82.49%	82.51%	82.46%	82.69%	82.48%	>0.05 π
	Multigravida	18.48%	18.13%	18.03%	17.85%	17.89%	17.51%	17.49%	17.54%	17.31%	17.52%	>0.05 π
Ω One-factor Anova π Chi Square												

Table 2 displays the characteristics of the newborns. Over the cumulative period, 51% of the newborns were male, 92.8% were born full-term, and 6.8% were preterm (before 37 weeks of gestation). Additionally, 93.7% had a normal height at birth, while 4.1% were classified as short. Regarding health assessments, 98.9% of the newborns achieved a normal APGAR score (between 8-10), and 89.6% received a Silverman-Andersen scale evaluation of 0. However, 1% had an evaluation showing severe respiratory failure or imminent respiratory failure (Scale of 10 to 7) [19].

Table 2: Neonatal characteristics in births that occurred 2008-2017 in Mexico.

Feature	Year of Birth	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	P-value
Sex of the Newborn	Man	50.90%	51.10%	51.00%	50.90%	51.00%	51.00%	51.00%	50.90%	50.80%	50.90%	>0.05 Ω
	Woman	48.90%	48.80%	48.80%	48.90%	48.90%	48.90%	48.90%	49.00%	49.10%	49.00%	
Gestational age	Preterm	6.60%	6.60%	6.70%	6.70%	6.70%	6.70%	6.90%	6.90%	7.10%	7.20%	>0.05 π
	Term	93.40%	93.40%	93.30%	93.30%	93.30%	93.30%	93.10%	93.00%	92.90%	92.80%	>0.05 π
	Post-term	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	>0.05 π
Low birth weight	Low weight	5.40%	5.50%	5.60%	5.70%	5.80%	5.90%	6.10%	6.10%	6.30%	6.40%	>0.05 π
	Average Weight	94.50%	94.40%	94.30%	94.20%	94.10%	94.00%	93.90%	93.80%	93.60%	93.50%	>0.05 π
	High Weight	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	>0.05 π
Newborn Size	Short stature	5.40%	5.50%	5.60%	3.60%	3.70%	3.70%	3.80%	3.90%	4.00%	4.10%	>0.05 π
	Normal size	90.00%	90.20%	90.40%	93.60%	93.60%	93.70%	93.70%	93.70%	93.70%	93.70%	>0.05 π
	Tall-stature	4.70%	4.30%	4.10%	2.90%	2.70%	2.60%	2.40%	2.40%	2.20%	2.10%	>0.05 π
APGAR at 5 minutes	from 0-3	1.00%	1.00%	0.90%	0.80%	0.80%	0.80%	0.80%	0.70%	0.60%	0.70%	>0.05 π
	4 to 7	0.60%	0.60%	0.50%	0.50%	0.50%	0.40%	0.50%	0.50%	0.50%	0.50%	>0.05 π
	8 to 10	98.40%	98.50%	98.60%	98.70%	98.80%	98.80%	98.80%	98.90%	98.90%	98.90%	>0.05 π
Silverman at 5 minutes	Severe respiratory failure (0)	0.20%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	>0.05 π
	Impending respiratory failure [1-4]	1.00%	0.70%	1.10%	1.00%	0.50%	0.50%	0.60%	0.80%	0.90%	0.90%	>0.05 π
	Potential respiratory failure [5-9]	9.90%	9.50%	9.80%	9.30%	9.00%	9.10%	9.30%	9.80%	9.60%	9.70%	>0.05 π
	No Respiratory Failure [10]	88.90%	89.70%	88.90%	89.60%	90.40%	90.30%	89.90%	89.30%	89.40%	89.40%	>0.05 π
π Chi Square												

Notably, none of these variables showed statistically significant differences across the study years. The mean gestational age for vaginally delivered infants was 39.26 weeks (SD=4.41), while for those born via cesarean section, the mean gestational age was 38.71 weeks (SD=3.96). This disparity was statistically significant, as showed by a p-value of less than 0.0001.

The analysis revealed an increase in low birth weight, preterm births, and short height at birth over the study period. Importantly, this trend did not translate into respiratory complications, as both the APGAR index and the Silverman assessment at five minutes remained stable over time.

The distribution of births by state reveals that eight states, namely the State of Mexico, Mexico City, Jalisco, Veracruz, Puebla, Guanajuato, Michoacán, and Nuevo León, collectively contribute to 52.3% of all births in Mexico during the studied period (Figure 2).

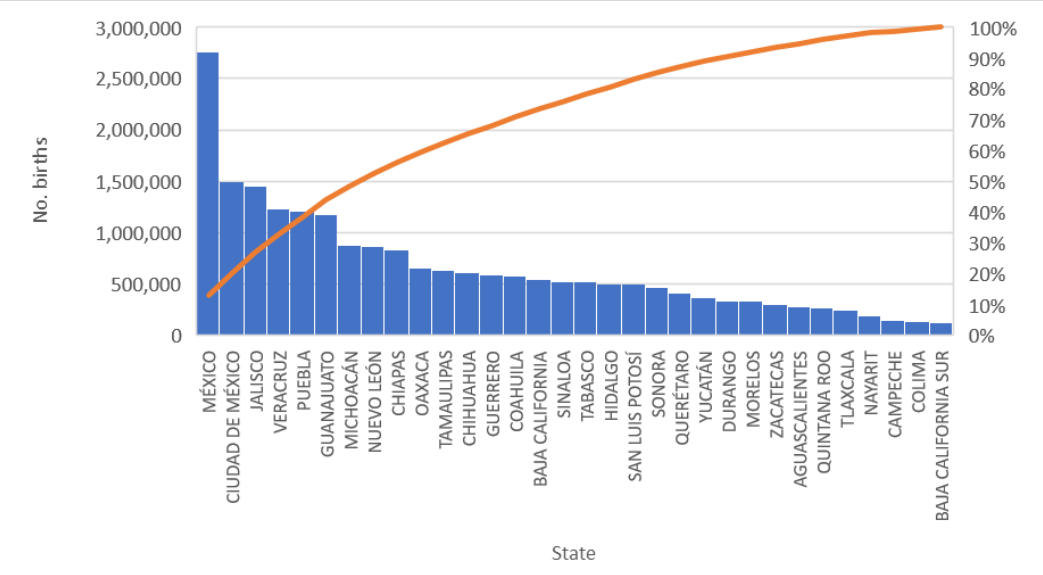

Figure 2: Number of births in Mexico by state, and state proportion of births 2008-2017.

The proportion of cesarean births shows regional variations across states cumulatively from 2008-2017. Nuevo León recorded a 58% proportion of cesarean section births, while San Luis Potosí reported a proportion of 32%. This shows a notable difference of 26 percentage points between the highest and lowest values (Figure 3).

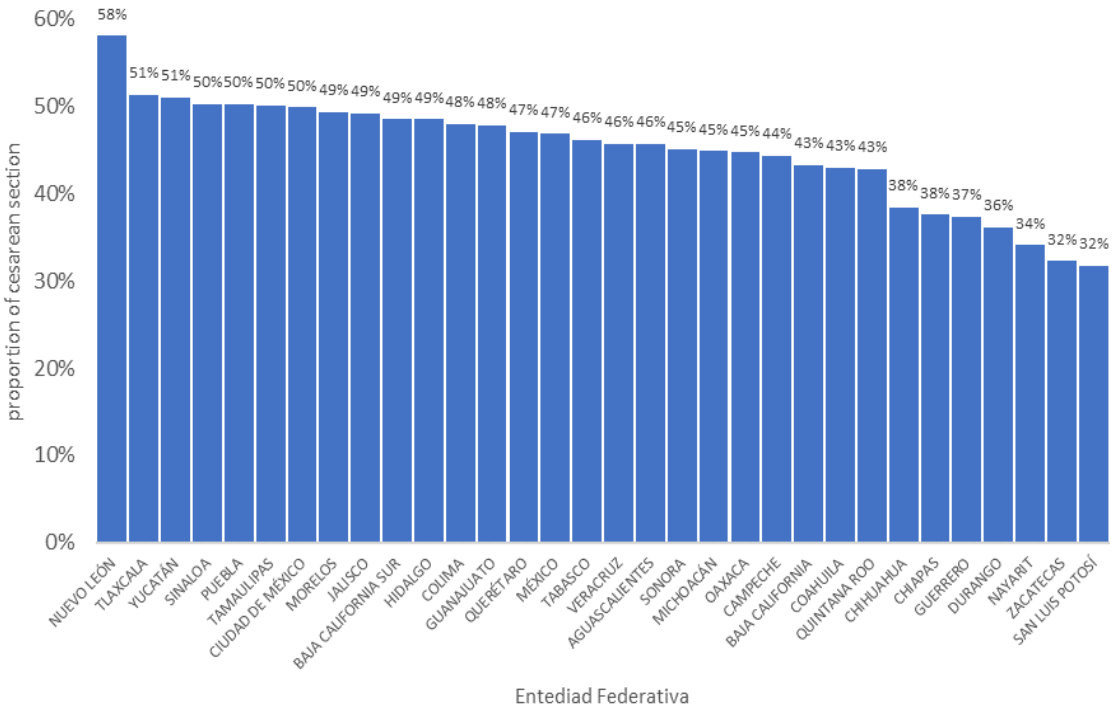

Figure 3: Proportion of cesarean section births by state 2008-2017 in Mexico.

In terms of births by institution and year, the data reveals that the Ministry of Health (SSA) attended the highest number of births, with private institutions following closely (Figure 4). Notably, both IMSS "Oportunidades" (now "Bienestar") and private institutions experienced an upward trend in the number of births over the observed period. Figure 4 illustrates the proportion of births by institution in Mexico from 2008 to 2017.

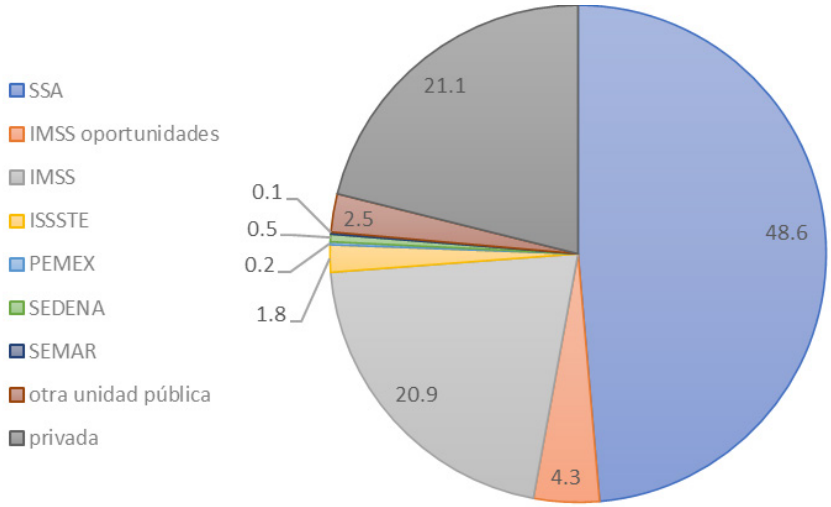

Figure 4: Proportion of births by institution in Mexico, 2008-2017.

When examining the trend over time, a noticeable increase in the proportion of cesarean births is clear in the private sector, as well as among the most vulnerable population served by IMSS "Oportunidades". In contrast, the primary social security institution in the country has shown a decrease in cesarean births. Nevertheless, it's important to highlight that both public and private institutions surpass the WHO reference value. Figure 5 illustrates the proportion of cesarean section births by institution in Mexico from 2008 to 2017.

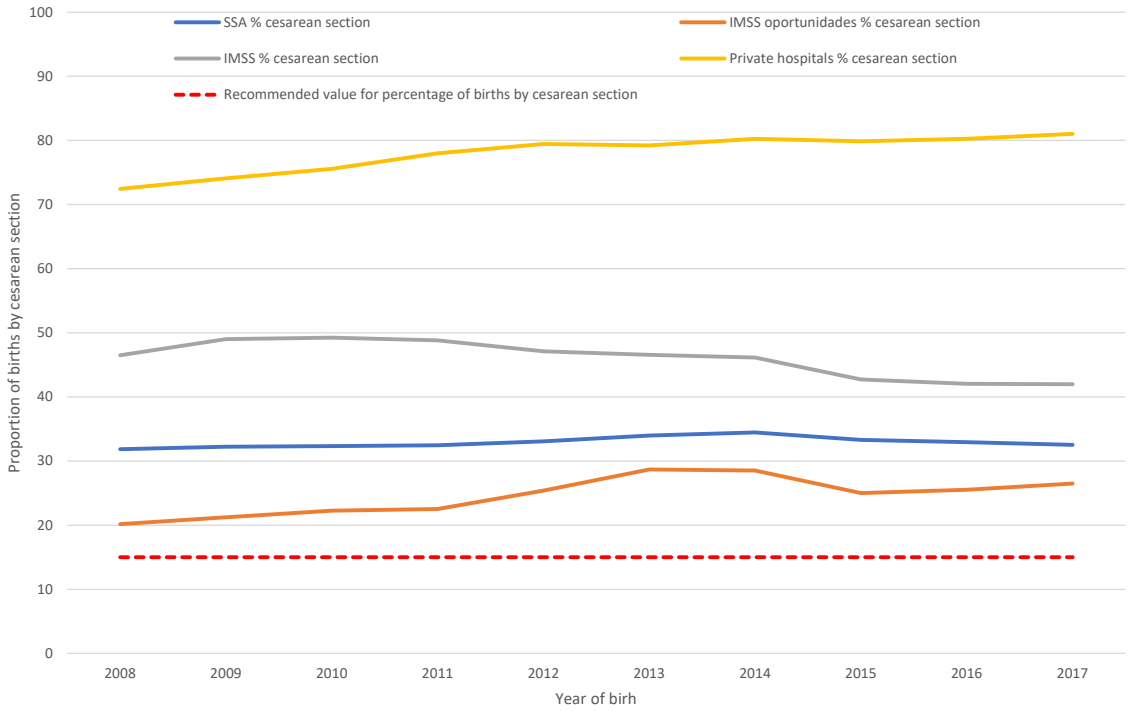

Figure 5: Proportion of cesarean section births by institution in Mexico 2008-2017.

Figure 5 depicts the percentage of births contributed by each institution per year in Mexico from 2008 to 2017. The Ministry of Health (SSA) consistently contributes between 46% and 50% of births, with a slight increase in the percentage of cesarean births from 31.9% to 32.5%. In 2017, IMSS accounted for 20.6% of births, experiencing a 2.7% decrease compared to 2008 [20], resulting in an overall 4.5% reduction in births over the period. Private institutions have seen a relative increase in the number of births, rising from 22.1% in 2008 to 22.7% in 2017. However, the percentage of cesarean births in private institutions surged by 8.6%, reaching 81.0%. Notably, there is a substantial 66% difference between the observed percentage and the WHO-recommended value for cesarean section births in private institutions.

A binomial logistic regression was conducted for multivariate analysis, with the type of delivery as the dependent variable (see Annex 1). The model is statistically significant, yielding a Nagelkerke R-square of 0.212 and an overall predictive accuracy of 65.1%, specifically 75.8% for vaginal delivery and 65.1% for cesarean section [21-24]. The analysis reveals that older maternal age, higher education level, employment status, entitlement to prenatal care, and primiparity increase the likelihood of cesarean section. Tlaxcala shows the strongest association with cesarean section, private institutions are 5.7 times more associated with cesarean delivery than public institutions, and the northern socioeconomic region is most strongly linked with cesarean section.

Annex 1: Results of binomial logistic regression, dependent variable resolution of pregnancy by cesarean section versus vaginal delivery, in Mexico 2008-2017.

Variables in the equation	Category	B	Sig.	Exp(B)	95% C.I. for EXP(B)	
					Lower	Upper
Grupo de edad de la Madre	Less than 20 years	1	0			
	20-34 years	0.092	0	1.096	1.082	1.111
	35 or more years	0.389	0	1.476	1.454	1.498
Mother's Educational Level	None	1	0			
	Primary	0.157	0	1.17	1.145	1.195
	Secondary	0.32	0	1.377	1.348	1.407
	High School	0.519	0	1.68	1.644	1.716
	Bachelor's	0.786	0	2.194	2.145	2.244
	Postgraduate	0.731	0	2.077	1.983	2.177
Marital Status	In union/With partner	1				
	Without union/Without partner	-0.028	0	0.972	0.961	0.984
Mother Works	Yes	0.116	0	1.123	1.113	1.133
	No	1				
Entitlement	Yes	0.039	0	1.04	1.031	1.049
	No	1				
Mother Received Prenatal Care	Yes	0.469	0	1.599	1.564	1.635
	No	1				
Primigravida or Multigravida	Primigravida	0.176	0	1.193	1.184	1.202
	Multigravida	1				
Birth Entity	AGUASCALIENTES	0.317	0	1.373	1.328	1.419
	BAJA CALIFORNIA	0.281	0	1.324	1.238	1.417
	BAJA CALIFORNIA SUR	0.638	0	1.892	1.81	1.978
	CAMPECHE	0.496	0	1.642	1.524	1.769
	COAHUILA	0.199	0	1.221	1.141	1.306
	COLIMA	0.562	0	1.753	1.684	1.825
	CHIAPAS	0.416	0	1.516	1.418	1.621
	CHIHUAHUA	-0.023	0.505	0.977	0.914	1.046
	CIUDAD DE MÉXICO	0.573	0	1.774	1.679	1.875
	DURANGO	0.071	0	1.073	1.04	1.108
	GUANAJUATO	0.583	0	1.792	1.697	1.893
	GUERRERO	0.302	0	1.353	1.265	1.447
	HIDALGO	0.69	0	1.993	1.881	2.111
	JALISCO	0.358	0	1.43	1.393	1.469
	MÉXICO	0.433	0	1.542	1.46	1.629
	MICHOACÁN	0.284	0	1.328	1.292	1.366
	MORELOS	0.683	0	1.979	1.865	2.1
	NAYARIT	0.017	0.425	1.017	0.976	1.059
	NUEVO LEÓN	0.558	0	1.748	1.634	1.87
	OAXACA	0.621	0	1.86	1.74	1.989

	PUEBLA	0.623	0	1.865	1.764	1.971
	QUERÉTARO	0.537	0	1.711	1.616	1.813
	QUINTANA ROO	0.297	0	1.346	1.256	1.444
	SAN LUIS POTOSÍ	-0.135	0	0.873	0.845	0.902
	SINALOA	0.55	0	1.733	1.682	1.786
	SONORA	0.389	0	1.476	1.378	1.58
	TABASCO	0.595	0	1.813	1.695	1.939
	TAMAULIPAS	0.534	0	1.706	1.597	1.823
	TLAXCALA	0.699	0	2.012	1.894	2.137
	VERACRUZ	0.496	0	1.642	1.537	1.753
	YUCATÁN	0.687	0	1.987	1.855	2.129
	ZACATECAS	1	0			
Birth Institution Public or Private	Public	1				
	Private	1.748	0	5.743	5.688	5.799
Birth Shift	Morning		0			
	Afternoon	-0.013	0	0.987	0.98	0.994
	Night	-0.525	0	0.592	0.588	0.596
Apgar at 5 minutes	Perinatal Asphyxia	1	0			
	Physiological Immaturity	0.397	0	1.487	1.405	1.573
	Normal	0.452	0	1.571	1.509	1.636
Gestational Age	Preterm	1	0			
	Term	-0.865	0	0.421	0.416	0.426
	Post-term	-0.252	0.168	0.777	0.543	1.112
Birth Institution	SSA	1	0			
	IMSS Oportunidades	-0.294	0	0.745	0.732	0.758
	IMSS	0.365	0	1.44	1.429	1.452
	ISSSTE	0.901	0	2.462	2.413	2.512
	PEMEX	0.949	0	2.583	2.452	2.722
	SEDENA	-0.081	0	0.922	0.891	0.955
	SEMAR	0.597	0	1.817	1.695	1.948
	Other Public Institution	0.516	0	1.675	1.644	1.706
	Private Institution	1.776	0	5.906	5.856	5.956
Socioeconomic Region of Mother's Residence	Northern Region	0.179	0.005	1.196	1.184	1.207
	North-Central Region	0.089	0.004	1.084	1.075	1.093
	Central Region	-0.079	0.005	0.924	0.916	0.933
	Southern Region	1				
	Constant	-1.304	0	0.272		

For multilevel analysis, mixed linear models were employed using binary logistic regression, where the type of delivery served as the dependent variable (vaginal or cesarean section). The model incorporated the mother's socioeconomic region of residence as the first variable, the institution of birth as the second level, and maternal factors (maternal age, number of births, and maternal level of education) as random effects. Statistical significance was set at p=0.05, and the intersection between socioeconomic status and institution of birth was assessed, considering two hierarchical levels (economic region of residence of the mother and the institution of birth) and featuring maternal age, number of births (first or multigest), and maternal level of education as independent variables.

The model achieved statistical significance with a p-value <0.0001 and an r-squared of 0.651. In the multilevel model, all categories of the socioeconomic region showed significance. The analysis revealed that the northern region is 1.3 times more associated with cesarean section delivery compared to the southern region, while the North Central and Central regions show a lower association with pregnancy termination compared to the South region.

Concerning the birth institution, private institutions showed a 6.1 times higher association with cesarean section births compared to the Ministry of Health. In contrast, IMSS Oportunidades exhibited a 30% lower association with cesarean section delivery compared

to the Ministry of Health. Notably, IMSS was the only institution that did not reach statistical significance in this model (see Table 3). Maternal variables included in the model as random effects did not show statistical significance.

Table 3: Results of the multilevel model of births in Mexico 2008-2017. Dependent variable: Type of delivery (vaginal or cesarean section).

Variables in the Equation	Category	B	Sig.	Exp(B)	95% I.C. for EXP(B)	
					Inferior	Superior
Socio-economic Region	Northern Region	-160	0.007	1.326	1.309	1.343
of maternal residence	North Central Region	-0.087	0	0.917	0.906	0.928
	Central Region	-0.063	0	0.939	0.929	0.949
	Southern Region			1		
Institution of Birth	SSA			1		
	IMSS Opportunities	-0.36	0	0.698	0.068	0.715
	IMSS	0.217	1	1.242	0	
	ISSSTE	0.986	0	2.68	2.573	2.792
	PEMEX	1.22	0	3.394	3.182	3.62
	SEDENA	0.062	0.099	1.064	0.988	1.146
	SEMAR	0.0481	0	1.618	1.464	1.789
	Other Public Institution	0.951	0	2.588	2.425	2.762
	Private	1.821	0	6.176	6.176	6.329

The average probability of being born by cesarean section according to the socioeconomic region of residence of the mother, the regions with the highest probability of being born by cesarean section were the north (0.599) and the southern region (0.611), the central region (0.558) and the central north region (0.547) had the lowest mean probability of being born by cesarean section.

The average probability of being born by cesarean section varies significantly depending on the institution of birth. The probabilities of cesarean section births across different institutions are as follows: Private institutions (0.817), State Health Units (0.580), SEMAR (0.633), SEDENA (0.459), PEMEX (0.667), ISSSTE (0.678), IMSS (0.529), IMSS Oportunidades (0.356), and Ministry of Health (0.430).

When examining the intersection between the socioeconomic region of maternal residence and the institution of birth, statistically significant variations in the probability of cesarean section births were seen only for State Health Units (other public units), PEMEX, ISSSTE, SEMAR, and SEDENA.

Discussion

This study supplies a comprehensive analysis of birth behavior in Mexico over a decade, considering organizational conditions, sociodemographic factors, and clinical conditions of the mother, as well as the health status of the newborn. One significant finding is the association between cesarean delivery and the institution supplying childbirth care, particularly in private facilities.

Despite international recommendations and efforts to reduce cesarean section rates, the study reveals persistently high rates in Mexico, with an overall increase of 46.0% between 2008 and 2017. This finding aligns with a WHO bulletin that reported a cesarean section rate of 45.3% during the same period in Mexico. Notably, the highest percentage occurred in 2014, coinciding with the publication of clinical practice guidelines by the Mexican Institute of Social Security (IMSS) aimed at reducing unnecessary cesarean deliveries.

Although there was a decline in cesarean rates in next years, especially in public and social security institutions, a resurgence occurred in 2017, primarily attributed to private hospitals where cesarean births reached 81.0%. This observation underscores the challenge of implementing sustained changes in a multisectoral health system.

The study emphasizes the stark contrast in cesarean rates between private and other institutions. In 2017, private hospitals had a 54.5 percentage point difference compared to IMSS Oportunidades, despite similar national birth percentages. Over the years, [25] private institutions have increased their relative frequency of births, showing a growing preference for private care.

The analysis of factors associated with cesarean delivery reveals that maternal age, level of education, and employment status influence the likelihood of cesarean section. Mothers aged 35 years and over were associated with 47% more cesarean sections compared to those under 20. Additionally, mothers with higher education levels and those employed had higher odds of cesarean delivery.

In the multilevel analysis, the institution of birth appeared as the variable with the strongest association with cesarean delivery. Private institutions were associated with 5.2 times higher odds of cesarean delivery compared to Ministry of Health hospitals,

irrespective of maternal characteristics. This highlights the pivotal role of the institution in influencing the mode of delivery.

The study concludes by emphasizing the need for targeted collective and multidisciplinary actions to reduce cesarean section rates in Mexico [26-28]. Addressing this issue requires a multifaceted approach, considering factors at the health system, professional, patient, and community levels. Reducing unnecessary cesarean sections is essential to mitigate associated risks and enhance overall maternal and newborn health.

Limitations and Strengths

Limitations of the study include the absence of pathological conditions as criteria for cesarean delivery and the lack of certain maternal conditions for a more detailed analysis. Strengths include the population-based nature of the study, encompassing 20,104,570 births over a decade, and standardized data collection across the entire country.

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