

Rate and direct medical costs of cesarean sections among supplementary health plan holders living in the state of São Paulo, Brazil: 2015-2021

Rildo Pinto da Silva (<https://orcid.org/0000-0001-5718-2747>)¹

Antonio Pazin-Filho (<https://orcid.org/0000-0001-5242-329X>)²

Abstract Brazil has the second largest cesarean section rate in the world. Differences in rates exist between the public and private health sectors. This study used data on admissions of supplementary health plan holders aged between 10 and 49 years living in the state of São Paulo admitted between 2015 and 2021 to determine cesarean section rates and costs in the private health sector. We conducted a partial economic analysis in health from a supplementary health perspective focusing on the direct medical costs of admissions. A total of 757,307 admissions were analyzed with total costs amounting to R\$7.701 billion. The cesarean section rate over the period was 80%. Rates were lowest in young women (69%) and highest in the oldest age group (86%), exceeding 67% across all groups. The rate was 71% higher than in public services. The proportion of admissions with use of the intensive care unit was higher among cesarian deliveries. The median cost of a cesarean was 15% higher than that of a normal delivery and twice as high in insurance companies than healthcare cooperatives. There is an opportunity to apply policies that are widely used in public services to the private sector with the aim of reducing cesarean rates in private services, direct costs of admission, and the cost of supplementary health plans.

Key words Cesarean section, Health cost analysis, Direct cost, Private sector, Supplementary health

¹ Programa de Mestrado Profissional em Gestão de Organizações de Saúde, Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo. R. Pedreira de Freitas, Casa 2, Campus Universitário. 14049-900 Ribeirão Preto SP Brasil. rildo.silva@alumni.usp.br

² Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo. Ribeirão Preto SP Brasil.

Introduction

Brazil has the second largest cesarean section rate in the world (55.7% of live births). The rate has increased steadily since 1995, when it stood at 40%. The global rate is one-fifth of live births, while in Latin America and the Caribbean it is 45.8%¹. The above rate is based on data from Brazil's live births information system (SINASC) for 2017 and includes deliveries on both the public and private health systems. The percentage of cesarean deliveries in Brazil is above the recommended rate.

The World Health Organization (WHO) states that maintaining a cesarean section rate of up to 16% reduces both maternal and fetal morbidity and mortality^{2,3}. In Brazil, following WHO recommendations, the National Committee for the Incorporation of Technologies into the Unified Health System (Conitec - SUS) adjusted this rate to up to 30% due to the high incidence of prior cesareans⁴ in the country. A cesarean section is by no means a risk-free procedure, with studies reporting an increased risk of adverse outcomes and maternal morbidity and mortality⁵⁻⁹.

Various factors influence the cesarean section rate: race (white women have a 44% greater chance of undergoing a cesarean¹⁰), economic status (the cesarean section rate is 27% in the last income tercile, compared to 11% in the first¹¹), maternal education level (the cesarean section rate is 31% in mothers with 12 or more years of schooling, compared to 10% in those with up to eight years), and choice of type of delivery. Various authors have raised concerns about the level of autonomy of pregnant women when choosing the type of delivery they would prefer. Findings show that, initially, most women prefer to have a natural birth but change their mind during pregnancy. The authors suggest that doctors are an important influence on this choice, especially in private health services¹²⁻¹⁷. Several of the factors influencing choice of delivery type are socioeconomic.

The type of service where the delivery is performed (public or private) is a factor that should be controlled in studies investigating cesarean section rates. Marmitt et al.¹⁸ reported that the cesarean section rate in private maternity services in Rio Grande in the state of Rio Grande do Sul was 95.7%, against only 39.8% in public services. Using SINASC data, Dias et al. found that the rate in private hospitals was 85%. Another study in Belo Horizonte reported that mothers who gave birth in private hospitals were 4

times more likely to have a cesarean than those in public hospitals¹⁹. The nationwide *Nascer no Brasil* (Born in Brazil) survey used a sample of hospitals that each performed over 500 deliveries²⁰. Population studies using data derived from private health operators, which best represent the private health sector, were not found.

One-quarter of the Brazilian population hold private health plans. Rates differ across regions, with 40% of the population of the state of São Paulo holding plans. Private health operators are the payers of supplementary health care and are regulated by the National Health Agency (ANS), which, among other functions, establishes policies for the supplementary health sector. In 2014, the ANS created the *Programa Parto Adequado*²¹, or Adequate Childbirth Program, to encourage normal childbirth in private maternity services and minimize the difference between private and public sector rates.

Cesarean sections imply additional costs^{22,23} to the alternative intervention – normal childbirth – with outcomes differing according to the type of delivery chosen. Economic evaluation in health (EEH) is used to discover the best resource allocation alternative based on cost-benefit and opportunity costs. Evaluations consist of “the comparative analysis of alternative courses of action in terms of both their health costs and consequences”²⁴. Such evaluations are incomplete when limited to cost analysis without a comparative assessment of the outcomes of each alternative course of action²⁵, including direct costs associated with resources used during treatment and medical costs associated with the resources used for treatment in health services (e.g., doctor fees, per-day hospital costs, medication, and materials and supplies)²⁴. Study designs are based either on primary data or modelling, using a range of integrated data sources to create a model that seeks to emulate the real world²⁶. There is a lack of large population based EEH studies of deliveries performed in the realm of supplementary health.

Population-based studies addressing these gaps in information on cesarean rates and costs can contribute to promoting the application of policies that have been widely tested in the SUS to supplementary health services, thereby helping improve imbalances and fostering better integration between the two systems.

The aim of this study was twofold: 1) to calculate cesarean section rates among supplementary health plan holders in the state of São Paulo between 2015 and 2021; and 2) to calculate the

direct medical costs of admissions for normal deliveries and cesarean sections among this population.

Methods

Data processing

This study used records of supplementary health admissions obtained from the Brazilian open data platform²⁷ (*Portal Brasileiro de Dados Abertos*) accessed on 29/11/2022). The records consist of two datasets: one containing the procedures performed during the admission of supplementary health plan holders – *detailed file* (DET) – and another with consolidated data on these admissions – *consolidated file* (CONS). The datasets are organized according to the state where the service provider is located. We downloaded files covering the period 2015-2021 for the state of São Paulo. The bind key between the two databases is the variable *id_evento_atencao_saude*.

We selected female plan holders aged between 10 and 49 years. Admissions were classified according to delivery type using the supplementary health unified terminology (TUSS) codes, as follows: **31309127** (vaginal delivery), **31309054** (cesarean section), and **31309208** (cesarean section with hysterectomy). Admissions in which these two types of delivery were charged simultaneously and where other delivery-related events were charged (e.g., care of the newborn in the delivery room) but the charge did not show the type of delivery were excluded.

Place of residence was obtained using the *relatório_dtb_brasil_distrito* file derived from the Brazilian Institute of Geography and Statistics²⁸ (IBGE, accessed on 06/12/2022) by crossing the first six digits of the variable “full municipality code” of the municipalities in the state of São Paulo with the variable *cd_munic_beneficiario* from the CONS dataset.

The variables in the dataset selected for analysis were age group, operator size, type of health operator, and type of admission (elective or urgent/emergency). These variables were not processed.

Admissions described using TUSS code 31309135 for multiple births (each subsequent birth) were considered multiple pregnancies. TUSS codes 10104020 (intensive medical care in a general or pediatric ICU – number of 12-hour shifts per patient) and 10104011 (intensive medical care by daytime physician – days per patient)

were considered intensive care unit (ICU) admissions.

Admissions in which the fields cancellation of admission and type of admission were not completed and where the amounts informed for procedures were identical to the amounts paid to providers – variables *vl_item_evento_informado* and *vl_item_pago_provider* – were excluded.

The cesarean section rate was calculated as the total number of admissions for cesarean delivery divided by the total number of live births multiplied by 100.

The results of the exploratory analysis showed inconsistencies for the outcome maternal death when compared to data from the hospital information system (SIH/SUS); supplementary health data have a low coverage rate. All admissions where the outcome was death (4,083) were excluded due to discrepancies in values caused by possible mis-reporting outliers, as proposed by Smiti et al.²⁹.

Potential outliers in recording amounts paid were also addressed. Outliers were identified by applying a two-step cluster unsupervised classification model using the log-likelihood distance measure and cluster formation criterion or Schwartz's Bayesian Criterion (BIC) to the standardized total admission cost variable. The analysis was performed using SPSS version 28.0. This model was used to avoid selection bias given the “a priori” removal of discrepancies and the impact analysis only at the end of the study³⁰.

Of 758,383 admissions selected in this phase, the model generated a group of 1,076 (0.1%) admissions where costs were over R\$133,392 per admission. These were considered potential outliers and therefore excluded from the analysis. This group accounted for 130 (12.1%) normal deliveries and 946 (87.9%) cesarean sections and a total of R\$309,310,695 (3.9%) in spending. Data processing resulted in a dataset of 757,307 admissions of supplementary health plan holders living in the state of São Paulo who gave birth and where the outcome was discharge, continued hospital stay, or transfer during admission (Figure 1).

Economic analysis

The study perspective was supplementary health. We conducted a partial economic analysis in health focusing on the direct medical costs of admissions according to type of delivery²⁴. The following costs of admission were considered: daily rates, including ICU; tests; service fees;

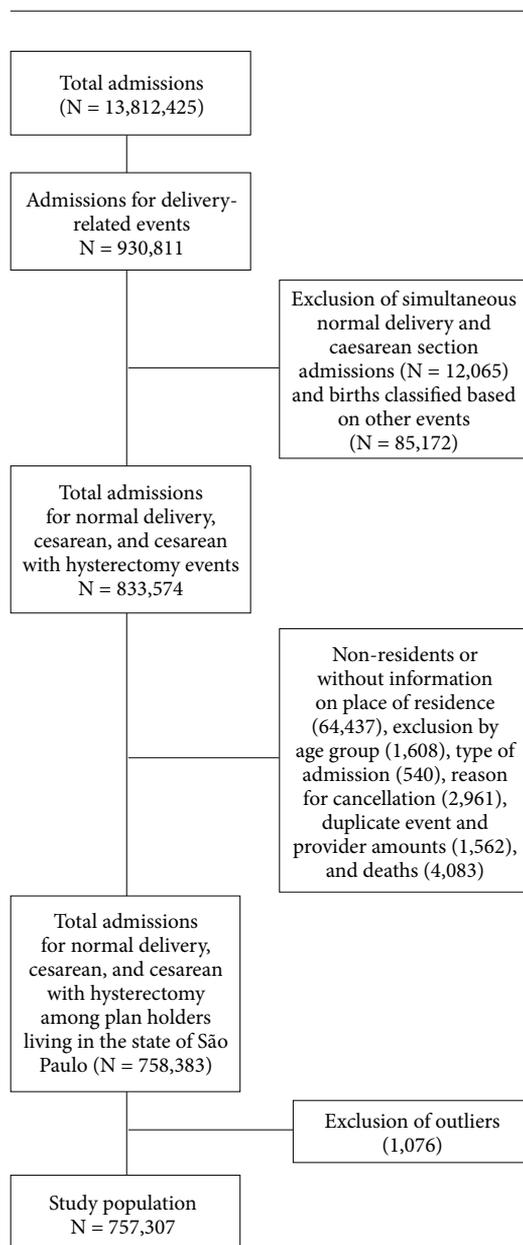


Figure 1. Flow diagram of the processing of data on admissions to private supplementary health services in the state of São Paulo during the period 2015-2021.

Source: Authors.

use of medical/hospital equipment; obstetrician and other specialist fees; therapies; gas therapy; hemotherapy; materials and supplies; medication; and handling fees paid by the operator to the service provider (*vl_item_evento_informado*) or provider (*vl_item_pago_fornecedor*). The unit

of analysis was admission for delivery up to discharge. Costs were calculated as the sum of all direct medical costs effectively charged to the health operator by the hospital for each admission.

Admission costs were inflation-adjusted to December 2021 using the National Consumer Price Index (IPCA).

The following cost analysis categories were used: type of delivery, size and type of operator, plan holder age group, type of admission (elective or urgent/emergency), type of birth (singleton or multiple), and use of the ICU during admission.

Calculation of number of live births

To calculate the number of live births a correction factor was applied to the total number of deliveries performed based on data from the SINASC for the period 2015-2020 for births in the state of São Paulo. This is because the data show the number of admissions without information on the number of live births. The following correction factors used by SINASC for the period were applied to the study dataset: 1.007 live births for each normal birth and 1.039 live births for each cesarean section.

The study protocol was approved by Ribeirão Preto Medical School's Clinical Hospital, University of São Paulo, which dispensed the need for Informed Consent Form (reference number 49725221.7.0000.5440).

Results

The cesarean section rate over the period was 79.7%, with the lowest and highest rates being recorded in 2021 (77.4%) and 2017 (80.7%), respectively. Total spending over the period 2015-2021 was R\$7.701 billion on 757,307 admissions. The median cost per admission was R\$7,620.46 (IQR 5,262 – 12,043). Median cost per admission increased from R\$6,883.35 in 2015 to R\$7,700.45 in 2021 (11.9%), with a 2.0% fall in median costs per admission between 2020 and 2021 (Table 1).

The cesarean section rate increased with age – from 68.6% in the youngest group to 85.8% in the oldest. Small private health operators (84.9%) had higher rates than large operators (78.8%). Concerning type of operator, philanthropic operators had the highest rates (84.3%), while self-managed operators showed the lowest (76.1%). Elective admissions (84.4%) and those where the ICU was used (85.5%) had the highest

cesarean section rate. Rates were similar between multiple and singleton pregnancies. Admissions were concentrated in the 20 to 39 year age group (91.8% of admissions and cesarean section rate of 79.7%), large private health operators (73.1%), and group medicine operators (45.1%). Most of the admissions (58.1%) were classified as urgent/emergency (Table 2).

The median cost of a cesarean section was R\$7,805.24 [IQR 5,408 – 12,153], which was 14.7% higher than the cost of a normal delivery (median cost R\$6,807.03 [IQR 4,661 – 11,476]). The increase in the median cost of a normal delivery was higher than that of a cesarean section (13.8% compared to 11.6%) (Supplementary Table 1, available from: <https://doi.org/10.48331/scielodata.G4SGG3>).

The median cost of a cesarean section increased with age, from R\$6,125.24 in the youngest age group to R\$8,754.89 in the oldest (a difference of 42.9%). Large private health operators (R\$9,065.12), insurance companies (R\$12,247.08), urgent/emergency admissions (R\$7,865.83), multiple pregnancies (R\$13,087.45), and admissions with use of the ICU (R\$23,959.61) had the highest costs across all categories (Table 3). The cost of a cesarean section in large operators was 85.2% higher than in small operators. The cost was lowest in philanthropic operators (R\$4,889.80), which account for only 2.7% of admissions. The cost of a cesarean section in health insurance companies, which account for 21.2% of admissions, was 90.4% higher than in healthcare cooperatives (27.2% of

admissions), 67.9% higher than in group medicine operators (45.1% of admissions), and 9.4% higher than in self-managed operators (Table 3).

The median cost of a cesarean section in group medicine operators, insurance companies, and healthcare cooperatives increased by 12.5%, 18.9%, and 19.0%, respectively, during the period, while costs in self-managed operators decreased by 9.3%.

The median cost of a cesarean section for urgent/emergency admissions was similar to that of elective admissions (difference of 2.1%), while the cost for admissions that used the ICU was three times higher than those that did not. Finally, the median cost of a multiple pregnancy cesarean section, which accounted for only 0.5% of cesareans, was 68.0% higher than for singleton pregnancies.

The median cost of a normal delivery increased from R\$5,303.16 in the youngest group up to R\$7,560.53 in the 30-39 year age group, followed by a decrease in the oldest age group (40-49 years, R\$7,357.20). The latter group accounted for the smallest number of deliveries (4,157). The median cost of a normal delivery was highest in large private health operators (R\$7,611.49). This cost was 79.5% higher than in small operators (R\$4,240.35) and 62.8% higher than in medium operators (R\$4,674.54) (Table 4).

The median cost of a normal delivery in self-managed operators was R\$14,190.98. This type of operator accounted for 3.8% of total admissions. Philanthropic operators showed the smallest cost for this type of delivery

Table 1. Median cost and rates according to delivery type by year of admission among private supplementary health plan holders living in the state of São Paulo admitted during the period 2015-2021.

Year	Delivery type						N	Median cost (R\$)
	Normal			Cesarean				
	N	Median cost (R\$)	Rate (%)	N	Median cost (R\$)	Rate (%)		
2015	15,548	6,244.03	17.4%	71,136	7,029.05	79.4%	86,684	6,883.35
2016	18,948	6,417.44	16.2%	93,889	7,607.47	80.5%	112,837	7,383.05
2017	21,811	6,932.86	16.0%	109,817	7,999.68	80.7%	131,628	7,804.41
2018	19,906	6,980.43	17.3%	91,380	7,978.48	79.5%	111,286	7,783.08
2019	18,387	6,844.22	16.3%	90,457	8,056.35	80.4%	108,844	7,834.75
2020	18,691	7,193.44	17.3%	86,140	7,986.99	79.5%	104,831	7,859.15
2021	20,345	7,108.14	19.5%	80,852	7,842.24	77.4%	101,197	7,700.45
Total	133,636	6,807.03	17.1%	623,671	7,805.24	79.7%	757,307	7,620.46

Annual rate per 100 live births = year of admission. Median amounts were inflation-adjusted to December 2021 using the National Consumer Price Index (IPCA).

Source: Authors.

Table 2. Cesarean section rates according to admission characteristics among private supplementary health plan holders living in the state of São Paulo admitted during the period 2015-2021.

Admission characteristics	Delivery type		Live births		Rate	
	Normal	Cesarean	Normal	Cesarean	Normal	Cesarean
Plan holder age group (years)						
10-14	173	417	174	433	28.5%	68.6%
15-19	6,383	17,528	6,428	18,212	25.9%	71.1%
20-29	57,795	230,158	58,200	239,134	19.4%	77.4%
30-39	65,128	342,374	65,584	355,727	15.5%	81.3%
40-49	4,157	33,194	4,186	34,489	10.7%	85.8%
Operator size						
Large	102,966	450,481	103,687	468,050	18.0%	78.8%
Medium	19,850	113,169	19,989	117,583	14.4%	82.3%
Small	4,052	29,266	4,080	30,407	11.7%	84.9%
No plan holders	6,768	30,755	6,815	31,954	17.5%	79.3%
Type of health operator						
Self-managed	6,195	22,692	6,238	23,577	20.8%	76.1%
Healthcare cooperative	29,770	176,399	29,978	183,279	14.0%	82.7%
Philanthropic	2,621	17,865	2,639	18,562	12.4%	84.3%
Medicine group	68,720	272,721	69,201	283,357	19.5%	77.4%
Insurance company	26,330	133,994	26,514	139,220	15.9%	80.8%
Type of admission						
Elective	40,118	277,175	40,399	287,985	12.2%	84.4%
Urgent/emergency	93,518	346,496	94,173	360,009	20.6%	76.3%
Multiple pregnancy						
No	132,943	620,708	133,874	644,916	17.1%	79.7%
Yes	693	2,963	698	3,079	18.4%	78.5%
Admission to ICU						
No	130,838	601,994	131,754	625,472	17.3%	79.5%
Yes	2,798	21,677	2,818	22,522	11.0%	85.5%

Annual rate per 100 live births.

Source: Authors.

(R\$4,323.53). The median cost of a normal delivery in insurance companies was R\$12,006.02, which is double that of healthcare cooperatives (R\$5,698.69) and 93.3% higher than medicine group operators. Costs for urgent/emergency admissions were 3.4% higher than elective admissions, while costs for multiple pregnancies were 11.7% higher than singletons. Costs for admissions with use of the ICU were 247.3% higher than those without (Table 4).

The median cost of a normal delivery in medicine group operators, insurance companies, and healthcare cooperatives increased by 9.4%, 30.3%, and 28.0%, respectively, while, contrary to cesarean sections, the cost in self-managed operators rose by 42.8%.

The findings show that the overall median cost of a cesarean section was higher across all

types of operators except self-managed operators, where it was 21.1% lower. In insurance companies, the cost of a cesarean section was only 2.0% higher than that of a normal delivery. The type of operator with the highest difference in cost between cesarean section and normal delivery (20.8%) was group medicine operators.

The difference in cost between cesarean section and normal delivery was small (2.7%) for admissions that use the ICU. For admissions without the use of the ICU, the difference in cost between type of delivery was 13.6%. A total of 2,798 admissions for normal deliveries (2.1% of normal births) used the ICU, compared to 21,677 (3.5%) of admissions for cesarean sections. A significant association was found between type of delivery and utilization of the ICU ($X^2(1, N = 757,307) = 672.1, p < 0.001$).

Table 3. Cesarean section costs by admission characteristics among private supplementary health plan holders living in the state of São Paulo admitted during the period 2015-2021.

Admission characteristics	Total admission costs (R\$)	Median admission costs (R\$)	25th percentile	Median	75th percentile
Plan holder age group (years)					
10-14	3,008,928	7,215.65	4,046.50	6,125.24	9,080.60
15-19	144,017,600	8,216.43	4,756.35	6,758.97	9,394.80
20-29	2,117,304,679	9,199.35	5,126.83	7,251.59	10,634.76
30-39	3,721,558,956	10,869.86	5,623.09	8,246.26	13,126.96
40-49	390,248,760	11,756.61	5,904.80	8,754.89	13,887.36
Operator size					
Large	5,291,057,633	11,745.35	6,534.85	9,065.12	13,703.07
Medium	736,400,861	6,507.09	4,106.00	5,500.18	7,257.55
Small	193,829,557	6,623.03	3,617.60	4,893.75	7,098.27
No plan holders	154,850,872	5,034.98	2,266.53	4,387.63	6,432.03
Type of health operator					
Self-managed	374,593,439	16,507.73	7,366.01	11,193.80	16,806.69
Healthcare cooperative	1,394,330,444	7,904.41	4,860.83	6,431.18	8,603.97
Philanthropic	99,945,557	5,594.49	3,409.14	4,889.80	6,625.35
Medicine group	2,607,738,358	9,561.93	5,033.78	7,505.75	11,354.30
Insurance company	1,899,531,125	14,176.24	8,448.82	12,247.08	15,476.24
Type of admission					
Elective	2,841,500,198	10,251.65	5,271.05	7,703.36	12,818.39
Urgent/emergency	3,534,638,725	10,201.10	5,526.80	7,865.83	11,611.29
Multiple pregnancy					
No	6,312,409,172	10,169.69	5,401.18	7,787.33	12,113.53
Yes	63,729,751	21,508.52	8,634.37	13,087.45	23,008.10
Admission to ICU					
No	5,721,397,874	9,504.08	5,331.54	7,630.08	11,619.47
Yes	654,741,049	30,204.41	14,878.13	23,959.61	37,238.03
Total	6,376,138,923	10,223.56	5,408.23	7,805.24	12,152.62

Amounts shown in R\$ inflation-adjusted to December 2021 using the National Consumer Price Index (IPCA).

Source: Authors.

When insurance companies and self-managed operators (Group 1) and medicine group operators and healthcare cooperatives (Group 2) were grouped together, it was found that the first group have older plan holders, are bigger, and account for the largest share of admissions with use of the ICU, elective admissions, and multiple births.

When multiple births and admissions that use the ICU are removed, median costs are higher in Group 1 across all age groups, operator sizes, types of admission, and types of delivery. The difference in cost between the two groups was 72.4% for cesareans and 98.8% for normal deliveries. Within Group 1, there was no difference in the median cost of the different types of delivery, unlike Group 02 where the cesarean section is 14.4% more expensive (Supplementary Table 2,

available from: <https://doi.org/10.48331/scielo-data.G4SGG3>).

Discussion

The cesarean section rate during the study period (80%) is similar to that reported by Dias et al. (83%) in private hospitals in the southeast of Brazil³¹ and other studies showing rates of over 80%^{18,32-34}. Actual rates may well be higher considering that we employed restrictive data-mining method (for example, the exclusion of admissions where the outcome was death). The rate in 2021 is 157% higher than the rate recommended by CONITEC and 71% higher than the rates observed in public services in the state, which range from 44.9% in 2019 and 46.5% in 2020 (prelim-

Table 4. Costs of normal deliveries according to admission characteristics among private supplementary health plan holders living in the state of São Paulo admitted during the period 2015-2021.

Admission characteristics	Total admission costs (R\$)	Median admission cost (R\$)	25th percentil	Median	75th percentil
Plan holder age group					
10-14	1,121,677	6,483.68	3,475.49	5,303,16	8,060.74
15-19	45,733,987	7,164.97	4,125.53	5,877,46	8,065.87
20-29	485,135,783	8,394.08	4,430.49	6,308,10	9,243.67
30-39	744,419,787	11,430.10	4,967.93	7,560,53	13,562.12
40-49	48,485,854	11,663.66	4,837.78	7,357,20	13,529.19
Operator size					
Large	1,153,570,092	11,203.41	5,456.93	7,611,49	12,964.38
Medium	115,689,261	5,828.17	3,259.66	4,674,54	6,570.87
Small	25,800,437	6,367.33	2,815.10	4,240,35	6,973.30
No plan holders	29,837,299	4,408.58	2,016.45	3,611,37	5,492.68
Type of health operator					
Self-managed	134,160,550	21,656.26	7,219.29	14,190,98	25,376.68
Healthcare cooperative	215,323,607	7,232.91	4,098.78	5,698,69	7,870.29
Philanthropic	13,556,193	5,172.15	2,535.94	4,323,53	6,781.34
Medicine group	574,644,773	8,362.12	4,363.52	6,211,65	9,258.06
Insurance company	387,211,966	14,706.11	7,639.39	12,006,02	16,168.58
Type of admission					
Elective	431,755,880	10,762.15	4,517.41	6,647,51	11,878.84
Urgent/emergency	893,141,208	9,550.47	4,733.86	6,875,25	11,316.23
Multiple pregnancy					
No	1,315,089,689	9,892.13	4,649.43	6,803,54	11,477.66
Yes	9,807,400	14,152.09	6,221.50	7,600,68	11,287.39
Admission to ICU					
No	1,245,466,040	9,519.15	4,616.54	6,718,55	11,076.45
Yes	79,431,049	28,388.51	14,915.40	23,333,67	35,026.09
Total	1,324,897,088	9,914.22	4,660.55	6,807.03	11,475.95

Amounts shown in R\$ inflation-adjusted to December 2021 using the National Consumer Price Index (IPCA).

Source: Authors.

inary data)³⁵. This level of difference shows that the private health sector makes a significant contribution to the elevated overall cesarean section rate in the state of São Paulo. The higher the population coverage of private health plans, the higher this contribution is likely to be, making this finding particularly relevant since policies applied solely to the SUS are unlikely to reduce the overall cesarean section rate in Brazil.

The cesarean section rate was higher than 77% across all categories analyzed by this study except admissions of patients aged up to 19 years. The cesarean section rate among this age group varied between 69% and 71%, which is also considered high. Gama³⁶ reported a cesarean section rate of 77% among adolescents who gave birth in private services. This is of serious concern, espe-

cially considering that it is quite likely that these patients will undergo cesareans again in the future, perpetuating the problem.

There appears to be no justification for these rates of cesarean sections. A considerable proportion of cesareans were classified as elective admissions. Domingues et al. found that approximately 80% of patients who underwent a cesarean did not go into labor¹⁶, while Potter et al. reported that 64% of cesareans in private services were scheduled³⁷ and Almeida et al. showed that the frequency of cesareans in a private hospital was greater on week days³².

Our dataset lacks key information for assessing whether cesarian sections were undertaken for medically indicated reasons – no Robson classification and high level of missing ICD data.

However, studies show that private health plan holders adopt more healthy habits³⁸, access preventive services more frequently³⁹, and receive better quality antenatal care⁴⁰. These factors tend to result in lower risk of complications during labor and delivery and should therefore technically favor normal childbirth.

Cesarean sections are associated with increased use of the ICU, with the costs of deliveries in admissions using this unit being three times higher than those that do not. In a systematic literature review of maternal complications associated with cesarean sections without medical indication, Mascarello et al. showed that the increased chance of admission to an ICU among this group of patients was associated with other complications⁴¹. Lansky et al. highlighted the importance of iatrogenic prematurity in relation to cesarean sections⁴². Thus, high cesarean section rates are accompanied by complications, evidenced in the present study by the increased use of the ICU.

Initiatives to reduce cesarean section rates have been implemented in Brazil^{43,44}, based on ANS's safe childbirth program. In their assessment of this program, Leal et al. observed a reduction in cesarean section rates accompanied by an increase in intrapartum cesarean sections, with rates 77.2% lower than in private hospitals investigated by the *Nascer no Brasil* survey (87.7%). The cesarean section rate reported by this survey was 42.9%. The authors draw attention to the fact that the cesarean section rate in the private sector is double that in public health services⁴⁵. The survey included 12 private hospitals selected using convenience sampling. The voluntary nature of the program may limit the reduction in cesarean section rates among private health plan holders in the state of São Paulo. Economic interests may also limit adherence to the program.

To reduce cesarean section rates, it may be necessary to provide financial incentives to the private health sector, which is a topic that has received little attention in the literature. A study by Borem et al. in a philanthropic hospital in the state of São Paulo highlighted the results of a shift from a per procedure childbirth care payment model to a per shift model and the establishment of minimum normal delivery targets with performance-based bonuses for on-call shift doctors. The findings revealed improvements in childbirth care, an increase in the rate of vaginal deliveries from 0% to 71%, and a 61% reduction in ICU costs, together with a 65% rise in the overall

remuneration of doctors⁴⁶ without a deterioration in care outcomes.

In addition to high cesarean section rates, our findings show that this procedure has a higher median cost. Market dynamics are evidenced by the difference in costs between insurance companies/self-managed companies and cooperatives/medicine group operators.

Insurance companies and self-managed companies outsource services using accredited service providers, while in healthcare cooperatives doctors are members of the cooperative and group medicine operators employ a vertical contracting model where the service provider is part of the same group of businesses as the operator. A report by the Administrative Council for Economic Defense highlights the advance of verticalization in health operators⁴⁷. Even when admissions with the utilization of the ICU and multiple births are removed, verticalized private health operators have much lower costs than non-verticalized operators. While this study did not analyze the outcomes of admissions, it is important to highlight this difference, which exceeds 36% across all categories analyzed by this study and is 43% in the 30-39 age group. Specific economic determinants of health have been discussed for some time⁴⁸. A large part of the cost problems of private healthcare are apportioned to the payment model. However, this discussion may not be productive for verticalized operators where the remuneration of their own service providers is not fee-for-service-based; thus there is no sense in discussing the remuneration model. To a certain extent, this work has captured the effect of the economic dynamics of private health operators and probable motives for the verticalization that is currently underway in the market, with hospital groups purchasing health operators. Borem et al.⁴⁶ highlight the powerful role payment models play in trends in care provision. This is an important discussion that should be addressed by care policies to preserve the best interests of patients.

It is also important to assess the quality of service provision in relation to service cost. Assuming that the quality of care is the same across all types of operators, insurance companies are wasting resources. On the other hand, supposing that differences in quality between operators may exist, the costs of group medicine operators and healthcare cooperatives would be better evaluated if admissions outcomes were considered. Unfortunately, the available data do not allow this type of evaluation, which is an important factor

in itself, given that the implementation of policies to improve quality presupposes the analysis of results, which is best done by conducting a population-based assessment of care outcomes.

A cost-effectiveness analysis conducted by Entringer et al.²³ with normal risk pregnant women showed that normal deliveries had a lower cost than cesarean sections. For primiparous women spontaneous vaginal delivery was more cost-effective than an elective cesarean across all the outcomes analyzed. For multiparous women with previous uterine scar, the cesarean was cost-effective for avoided maternal morbidity and avoided uterine rupture, and vaginal delivery remained cost-effective for avoided maternal death, admission to a neonatal ICU, and avoided neonatal death²³. This reinforces the importance of public policies to reduce the cesarean section rate and improve cost-effectiveness, especially considering the elevated cesarean section rate and higher costs associated with this type of delivery.

To the best of our knowledge, this is the first study of cesarean section rates and associated direct medical costs using supplementary health data. It is also the first time that differences in standardized procedure costs between types of operators are presented, opening up new perspectives for the discussion of care costs and the impact of prices on healthcare plans.

This study has some limitations. The data do not allow us to make a direct assessment of the medical indication of cesarean sections – lack of outcomes and the Robson classification. However, indication rates have received much research attention and it is unlikely that private health plan holders have worse health status than users of public services, where cesarean rates are almost half those observed here^{11,13,16,37,49}.

Collaborations

RP Silva: conception and study design, data acquisition, analysis and interpretation of data, drafting the manuscript Antonio Pazin-Filho: conception and study design, analysis and interpretation of data, revising the manuscript critically. Both authors have approved the version of the manuscript to be published.

Costs showed a right-skewed distribution, meaning that the treatment of outliers was a challenge. In this respect, the exclusion of high-cost admissions may partially explain the small cost differences found between types of delivery. The exclusion of admissions where the outcome was death is another study limitation, more from a care quality analysis point of view than in terms of cesarean rates and costs, given the small number of exclusions. An increase in rates would be expected if these admissions were included.

The analysis of care quality was adversely affected by the lack of information on the reason for cancellation of admissions. The differences in costs across operators should be evaluated considering care quality as perceived by patients, which was not done by the present study. To the best of our knowledge, this is first time that this database has been used in a scientific study. This poses data quality challenges, despite the fact that the data are official and used in different supplementary health information sources by the ANS and Brazilian health accounting system. Finally, despite the large sample size, the study was conducted at state level.

Directions for future research

Future research should investigate why there is such a big difference in costs across types of operators and if these differences persist in other types of procedures and other regions. It is also important to incorporate the analysis of outcomes into studies of supplementary health costs when this information becomes available. Finally, it would be interesting to assess the distribution of costs across different types of providers and what types of incentives, financial or otherwise, could increase the rate of normal deliveries.

References

- Betran AP, Ye J, Moller A-B, Souza JP, Zhang J. Trends and projections of caesarean section rates: global and regional estimates. *BMJ Glob Health* 2021; 6(6):e005671.
- World Health Organization (WHO). Appropriate technology for birth. *Lancet* 1985(8452); 326: 436-437.
- Betran AP, Torloni MR, Zhang J, Ye J, Mikolajczyk R, Deneux-Tharaux C, Oladapo OT, Souza JP, Tunçalp Ö, Vogel JP, Gülmezoglu AM. What is the optimal rate of caesarean section at population level? A systematic review of ecologic studies. *Reprod Health* 2015; 12:57.
- Brasil. Comissão Nacional de Incorporação de Tecnologias no SUS. Diretrizes de atenção à gestante: a operação cesariana – relatório de recomendação [Internet]. 2016. [acessado 2022 nov 18]. Disponível em: https://www.gov.br/conitec/pt-br/midias/relatorios/2016/relatorio_diretrizes-cesariana_final.pdf
- De la Cruz CZ, Thompson EL, O'Rourke K, Nemhahrd WN. Cesarean section and the risk of emergency peripartum hysterectomy in high-income countries: a systematic review. *Arch Gynecol Obstet* 2015; 292(6):1201-1215.
- Liu S, Liston RM, Joseph KS, Heaman M, Sauve R, Kramer MS. Maternal mortality and severe morbidity associated with low-risk planned cesarean delivery versus planned vaginal delivery at term. *CMAJ* 2007; 176(4):455-460.
- Leal MC, Esteves-Pereira AP, Nakamura-Pereira M, Torres JA, Theme-Filha M, Domingues RMSM, Dias MAB, Moreira ME, Gama SG. Prevalence and risk factors related to preterm birth in Brazil. *Reprod Health* 2016; 13(Suppl. 3):127.
- Dias MAB, Domingues RMSM, Schilithz AOC, Nakamura-Pereira M, Diniz CSG, Brum IR, Martins AL, Filha MMT, Gama SGN, Leal MC. Incidência do *near miss* materno no parto e pós-parto hospitalar: dados da pesquisa Nascer no Brasil. *Cad Saude Publica* 2014; 30(Supl.):S169-S181.
- Esteves-Pereira AP, Deneux-Tharaux C, Nakamura-Pereira M, Saucedo M, Bouvier-Colle MH, Leal MC. Cesarean delivery and postpartum maternal mortality: a population-based case control study in Brazil. *PLoS One* 2016; 11(4):e0153396.
- Berquó E, Di Lago TG. Atenção em saúde reprodutiva no Brasil: eventuais diferenciais étnico-raciais. *Saude Soc* 2016; 25(3):550-560.
- Carlotto K, Marmitt LP, Cesar JA. On-demand cesarean section: assessing trends and socioeconomic disparities. *Rev Saude Publica* 2020; 54:01.
- Weidle WG, Medeiros CRG, Grave MTQ, Dal Bosco SM. Escolha da via de parto pela mulher: autonomia ou indução? *Cad Saude Colet* 2014; 22(1):46-53.
- Hopkins K. Are Brazilian women really choosing to deliver by cesarean? *Soc Sci Med* 2000; 51(5):725-740.
- Hopkins K, Lima Amaral EF, Mourão ANM. The impact of payment source and hospital type on rising cesarean section rates in Brazil, 1998 to 2008. *Birth* 2014; 41(2):169-177.
- Dias MAB, Domingues RMSM, Pereira APE, Fonseca SC, Gama SGN, Theme Filha MM, Bittencourt SDA, Rocha PMM, Schilithz AOC, Leal MC. Trajetória das mulheres na definição pelo parto cesáreo: estudo de caso em duas unidades do sistema de saúde suplementar do estado do Rio de Janeiro. *Cien Saude Colet* 2008; 13(5):1521-1534.
- Domingues RMSM, Dias MAB, Nakamura-Pereira M, Torres JA, d'Orsi E, Pereira APE, Schilithz AOC, Leal MC. Processo de decisão pelo tipo de parto no Brasil: da preferência inicial das mulheres à via de parto final. *Cad Saude Publica* 2014; 30(Supl. 1):S1-S16.
- Panda S, Begley C, Daly D. Clinicians' views of factors influencing decision-making for caesarean section: a systematic review and metasynthesis of qualitative, quantitative and mixed methods studies. *PLoS One* 2018; 13(7):e0200941.
- Marmitt LP, Machado AKF, Cesar JA. Recent trends in cesarean section reduction in extreme south of Brazil: a reality only in the public sector? *Cien Saude Colet* 2022; 27(8): 3295-3307.
- Silva TPR, Dumont-Pena E, Moreira AD, Camargos BA, Meireles MQ, Souza KV, Matozinhos FP. Factors associated with normal and cesarean delivery in public and private maternity hospitals: a cross-sectional study. *Rev Bras Enferm* 2020; 73(Supl. 4):e20180996.
- Leal MC, Silva AAM, Dias MAB, Gama SGN, Rattner D, Moreira ME, Filha MMT, Domingues RMSM, Pereira APE, Torres JA, Bittencourt SDA, d'Orsi E, Cunha AJ, Leite AJM, Cavalcante RS, Lansky S, Diniz CSG, Szwarcwald CL. Birth in Brazil: national survey into labour and birth. *Reprod Health* 2012; 9:15.
- Agência Nacional de Saúde (ANS). Estímulo ao parto normal: organização da atenção ao pré-natal, parto e nascimento [Internet]. [acessado 2022 jul 5]. Disponível em: https://www.gov.br/ans/pt-br/arquivos/as-suntos/gestao-em-saude/parto-adequado/parto_adequado_final.pdf
- Entringer AP, Pinto M, Dias MAB, Gomes MASM. Análise de custo-efetividade do parto vaginal espontâneo e da cesariana eletiva para gestantes de risco habitual no Sistema Único de Saúde. *Cad Saude Publica* 2018; 34(5):e00022517.
- Entringer AP, Pinto M, Gomes MASM. Cost-effectiveness analysis of natural birth and elective C-section in supplemental health. *Rev Saude Publica* 2018; 52:91.
- Brasil. Ministério da Saúde (MS). Diretriz metodológica: estudos de microcusteio aplicados a avaliações econômicas em saúde [Internet]. 2021. [acessado 2022 dez 3]. Disponível em: https://rebrats.saude.gov.br/images/Documentos/2022/20220419_diretrizes_microcusteio_15062021.pdf
- Brasil. Ministério da Saúde (MS). Diretrizes metodológicas: diretriz de avaliação econômica [Internet]. 2014. [acessado 2022 dez 3]. Disponível em: <https://rebrats.saude.gov.br/diretrizes-metodologicas?download=4:diretrizes-metodologicas-diretriz-de-avaliacao-economica-2-edicao>

26. Ribeiro RA, Neyeloff JL, Itria A, Santos VCC, Viana CMM, Silva EN, Elias FTS, Wichmann RM, Souza KM, Cruz LN, Azeredo-da-Silva ALF. Diretriz metodológica para estudos de avaliação econômica de tecnologias em saúde no Brasil. *JBES* 2016; 8(3):174-184.
27. Portal Brasileiro de Dados Abertos. Procedimentos hospitalares por UF [Internet]. [acessado 2022 nov 29]. Disponível em: <https://dados.gov.br/dataset/procedimentos-hospitalares-por-uf>
28. Instituto Brasileiro de Geografia e Estatística (IBGE). DTB – Divisão Territorial Brasileira – Edição 2021: downloads ano [Internet]. [acessado 2022 dez 6]. Disponível em: <https://www.ibge.gov.br/geociencias/organizacao-do-territorio/estrutura-territorial/23701-divisao-territorial-brasileira.html?=&t=downloads>
29. Smiti A. A critical overview of outlier detection methods. *Computer Sci Rev* 2020; 38(1):100306.
30. Leys C, Klein O, Dominicy Y, Ley C. Detecting multivariate outliers: use a robust variant of the Mahalanobis distance. *J Experimental Soc Psychol* 2018; 74:150-156.
31. Dias BAS, Leal MC, Esteves-Pereira AP, Nakamura-Pereira M. Variações das taxas de cesariana e cesariana recorrente no Brasil segundo idade gestacional ao nascer e tipo de hospital. *Cad Saude Publica* 2022; 38(6):e00073621.
32. Almeida S, Bettiol H, Barbieri MA, Silva AAM, Ribeiro VS. Significant differences in cesarean section rates between a private and a public hospital in Brazil. *Cad Saude Publica* 2008; 24(12):2909-2918.
33. Barbosa JF, Toé TFD, Simões PW. Incidence of cesarean delivery among users of a private health plan. *Medicina (Ribeirao Preto)* 2015; 48(4):336.
34. Barros AJD, Santos IS, Matijasevich A, Domingues MR, Silveira M, Barros FC, Victora CG. Patterns of deliveries in a Brazilian birth cohort: almost universal cesarean sections for the better-off. *Rev Saude Publica* 2011; 45(4):635-643.
35. Secretaria de Estado da Saúde, Grupo Técnico de Avaliação e Informações de Saúde. Situação da taxa de cesáreas no estado de São Paulo: atualização 2020. [Internet]. 2021. [acessado 2022 dez 8]. Disponível em: https://portal.saude.sp.gov.br/resources/ses/perfil/gestor/homepage/gais-informa/gais_104_v3.pdf
36. Gama SGN, Viellas EF, Schilithz AOC, Theme Filha MM, Carvalho ML, Gomes KRO, Costa com, Leal MC. Factors associated with cesarean section among primiparous adolescents in Brazil, 2011-2012. *Cad Saude Publica* 2014; 30(Supl. 1):S1-S11.
37. Potter JE, Hopkins K, Faúndes A and Perpétuo I. Women's autonomy and scheduled cesarean sections in Brazil: a cautionary tale. *Birth* 2008; 35(1):33-40.
38. Lima-Costa MF. Estilos de vida e uso de serviços preventivos de saúde entre adultos filiados ou não a plano privado de saúde (inquérito de saúde de Belo Horizonte). *Cien Saude Colet* 2004; 9(4):857-864.
39. Silva SLA, Torres JL, Peixoto SV. Fatores associados à busca por serviços preventivos de saúde entre adultos brasileiros: Pesquisa Nacional de Saúde, 2013. *Cien Saude Colet* 2020; 25(3):783-792.
40. Mario DN, Rigo L, Boclin KdLS, Malvestio LMM, Anziliero D, Horta BL, Wehrmeister FC, Martínez-Mesa J. Qualidade do pré-natal no Brasil: Pesquisa Nacional de Saúde 2013. *Cien Saude Colet* 2019; 24(3):1223-1232.
41. Mascarello KC, Horta BL, Silveira MF. Maternal complications and cesarean section without indication: systematic review and meta-analysis. *Rev Saude Publica* 2017; 51:105.
42. Lansky S, Friche AAL, Silva AAM, Campos D, Bittencourt SDA, Carvalho ML, Frias PG, Cavalcante RS, Cunha AJLA. Birth in Brazil survey: neonatal mortality, pregnancy and childbirth quality of care. *Cad Saude Publica* 2014; 30(Supl. 1):S1-S15.
43. Borem P, Sanchez RC, Torres J, Delgado P, Petenate AJ, Peres D, Parry G, Betrán AP, Barker P. A quality improvement initiative to increase the frequency of vaginal delivery in Brazilian hospitals. *Obstet Gynecol* 2020; 135(2):415-425.
44. Marin DFD, Wernke AR, Dannehl D, Araujo D, Koch GF, Zanoni KM, Coral KBD, Guimarães NV, Feuerschuette O, Iser BPM. The Project Appropriate Birth and a reduction in caesarean section rates: an analysis using the Robson classification system. *BJOG* 2022; 129(1):72-80.
45. Leal MC, Bittencourt SA, Esteves-Pereira AP, Ayres BVS, Silva LBRAA, Thomaz EBAF, Lamy ZC, Nakamura-Pereira M, Torres JA, Gama SGN, Domingues RMSM, Vilela MEA. Avanços na assistência ao parto no Brasil: resultados preliminares de dois estudos avaliativos. *Cad Saude Publica* 2019; 35(7):e00223018.
46. Borem P, Ferreira JBB, Silva UJ, Valério Júnior J, Orlanda CMB. Aumento do percentual de partos vaginais no sistema privado de saúde por meio do redesenho do modelo de cuidado. *Rev Bras Ginecol Obstet* 2015; 37(10):446-454.
47. Conselho Administrativo de Defesa Econômica. Aplicação de modelos de disposição a pagar no estudo da competição na saúde suplementar: documento de trabalho [Internet]. 2020. [acessado 2022 dez 29]. Disponível em: <https://cdn.cade.gov.br/Portal/centrais-de-conteudo/publicacoes/estudos-economicos/documentos-de-trabalho/2020/documento-de-trabalho-n03-2020-aplicacao-de-modelos-de-disposicao-a-pagar-no-estudo-da-competicao-na-saude-suplementar.pdf>
48. Arrow KJ. Uncertainty and the welfare economics of medical care. *Am Economic Rev* 1963; 53(3):941-973.
49. Panda S, Begley C, Daly D. Influence of women's request and preference on the rising rate of cesarean section – a comparison of reviews. *Midwifery* 2020; 88:102765.

Article submitted 30/01/2023

Approved 06/04/2023

Final version submitted 08/04/2023

Chief editors: Romeu Gomes, Antônio Augusto Moura da Silva