Inter-hospital variations in caesarean sections. A risk adjusted comparison in the Valencia public hospitals

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Abstract

***Background*—The aim of this study was to describe the variability in caesarean rates in the public hospitals in the Valencia Region, Spain, and to analyse the association between caesarean sections and clinical and extra-clinical factors.**

***Methods*—Analysis of data contained in the Minimum Basic Data Set (MBDS) compiled for all births in 11 public hospitals in Valencia during 1994–1995 (n=36 819). Bivariate and multivariate analyses were used to evaluate the association between caesarean section rates and specific risk factors. The multivariate model was used to construct predictions about caesarean rates for each hospital, for comparison with rates observed.**

***Results*—Caesarean rates were 17.6% (inter-hospital range: 14.7% to 25.0%), with ample variability between hospitals in the diagnosis of maternal-fetal risk factors (particularly dystocia and fetal distress), and the indication for caesarean in the presence of these factors. Multivariate analysis showed that maternal-fetal risk factors correlated strongly with caesarean section, although extra-clinical factors, such as the day of the week, also correlated positively. After adjusting for the risk factors, the inter-hospital variation in caesarean rates persisted.**

***Conclusions*—Although certain limitations (imprecision of some diagnoses and information biases in the MBDS) make it impossible to establish unequivocal conclusions, results show a high degree of variability among hospitals when opting for caesarean section. This variability cannot be justified by differences in obstetric risks.**

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The incidence of births that end in caesarean section is rising throughout the industrialised world, although there are considerable variations in rates and practices between countries, geographical areas and hospitals.[1–5] Over the past 10 years, numerous studies have monitored this "epidemic",[6] concluding almost unanimously that differences in maternal-fetal risk justify neither the incidence of caesareans, nor the differences in rates observed.

Three lines of research have undertaken to clarify the variations observed in caesarean section rates. The aim of the first has been to uncover a generalised overuse of surgery, and the corresponding overexposure to the risks involved. Most of these studies argue that a large percentage of caesarean sections are unnecessary, and place optimum rates for positive effects on maternal and perinatal mortality at around 7–12% of births.[7 8] The second line has attempted to identify non-clinical factors associated with caesarean sections, and establish their relative importance. Finally, the third group has concentrated on evaluating the effects of measures taken to reverse the upward trend in caesareans.

In Spain little has been published on the subject, and until the release of the Survey of Health Establishments for 1984–1988, no data were available on the incidence of caesareans.[9] During the period covered by the survey, caesareans rose from 9.4% to 12.9% of births (9.7% to 13.6% in the Valencia Region), with private hospitals reaching 2–3 points above the average. More recent data indicate that the trend continues to rise.[10] Figures, however, present only general rates, with no breakdown of the motives behind the decision to operate. This makes it impossible to determine to what extent, if at all, the variability observed is justified by varying risks within the populations treated. The aim of this study was to describe the variability in caesarean rates in the public hospitals of Valencia in 1994–1995, taking into account differences in obstetric risks in the populations treated, and to analyse the association between caesarean section rates and specific clinical and non-clinical factors.

Methods

SETTING

The study was conducted in the hospitals administered by the Valencia Health Service (VHS), the health system managed by the Valencia Regional Government. This network provides health care for the 3.9 million inhabitants of the Region, and comprises over 8000 beds (80% of those available in the region). Among the noteworthy features of the VHS are universal coverage, the cost free status of care, hospital funding through a general budget and payment by salary of the doctors, who have semi-civil servant status and receive no further monetary incentives.

SOURCE OF DATA AND SAMPLE

The Minimum Basic Data Set (MBDS), is an exhaustive database of all hospitalisation episodes in the VHS. It contains 30 variables, five corresponding to diagnostics (nine since 1995), and four to procedures (nine since

Table 1 Obstetric risk factors. Hierarchical classification of indications for caesarean

Category	*Description*	*ICD-9-CM*
Breech	Breech presentation	652.2
Dystocia	Materno-fetal disproportion	653
	Obstructed birth	660
	Abnormal uterine contractions	661 (except 661.3)
	Prolonged labour	662
	Abnormal presentation	652 (except 652.1, 652.5)
	Failure in induction of labour	659.0/659.1
Fetal distress	Fetal distress	656.3
	Prolapsed cord	663.0
Other	Antepartum haemorrhage, abruptio placenta and previa placenta	641
	Insufficient or excessive fetal growth	656.5/656.6
	Genital herpes	647.6/54
	Diabetes mellitus/abnormal glucose tolerance	648.0/648.8
	Arterial hypertension	642
	Oligohydramnios	658.0
	Infection of amniotic cavity	658.4
	Malformation of fetal SNC	655.0
	Congenital/acquired abnormality of cervix or vagina	654.6/654.7
	Iso-immunisation with Rh antigen	656.1
	Cerebral occlusion-haemorrhage	430,431,432,433,434
Remainder abnormal births	Remainder of births not coded under code 650 (completely normal birth) or coded under V27.0 (newborns), 670 to 676 (complications during puerperium) or 654.2 (previous caesarean)	

1995), all coded according to the International Classification of Diseases Review 9 Clinical Modification (ICD9CM). In the 18 hospitals using the MBDS in 1994–95, 50 550 hospitalisations ended in birth (Diagnosis Related Groups (DRG): 370 to 375; ICD9CM: 650 to 669). Of these, 13 239 cases, corresponding to six hospitals, were excluded to minimise biases attributable to poor quality information on the MBDS, as 20% lacked information or contained errors in relevant variables (birth date, admission date and delivery date and newborn's weight); another 492 cases corresponding to a seventh hospital were eliminated because of an unreasonable percentage of multiple deliveries, leaving for analysis 36 819 hospitalisations ending in birth in 11 hospitals.

Table 2 Obstetric risk factors. Valencia hospitals, years 1994–95

Condition	*Number*	*% of total*	*% caesareans*
Antecedent of caesarean	1 522	4.1	72.7
Breech presentation	1 090	3.0	70.3
Dystocia	2 985	8.1	85.9
Fetal distress	3 086	8.4	35.2
Other or maternal factors* (all)	1 639	4.4	41.1
Antepartum haemorrhaging,abruptio and others (641)	190	0.5	85.6
Delayed intrauterine growth (656.5)	96	0.3	46.9
Macrosomatia (656.6)	54	0.1	37.0
Diabetes mellitus (648.0, 648.8)	191	0.5	25.6
Hypertension disease (642)	364	1.0	47.0
Oligohydramnios (658.0)	74	0.2	28.7
Abnormal uterine neck (654.6)	138	0.4	99.3
Rh iso-immunisation (656.1)	481	1.3	8.9
Abnormal rests after birth (diagnosis 650)	7 472	20.3	14.4
Multiple birth (g)	521	1.4	52.2
Weight at birth			
less than 2500	5 925	16.1	22.6
between 2500 and 4000	28 143	76.4	15.3
greater than 4000	1 580	4.3	26.6
not provided or invalid	1 171	3.2	34.7
Maternal age (y)			
less than 25	5 372	14.6	14.9
under 25 and 34	26 246	71.3	17.1
more than 34	5 027	13.6	23.1
not provided or invalid	174	0.5	16.1
Charlson Comorbidity Index854			
0 (no chronic comorbidity)	36 566	99.3	17.4
1 or more	253	0.7	41.5
Circumstances of admission			
Emergency	36 330	98.7	17.5
Programmed	487	1.3	27.3
Not provided or invalid	2	0.0	100.0
Length of prepartal stay (days)			
0	21 465	58.3	12.7
1	8 937	24.3	18.5
2	1 757	4.8	26.5
3	1 095	3.0	28.4
4 or more	2 951	8.0	42.2
not provided or invalid	614	1.7	12.4
Day of the week			
Weekend	9 428	25.6	14.7
Monday–Friday	26 878	73.0	18.7
Not provided or invalid	513	1.4	12.3
Total	36 819	100.0	17.6

*In the group "Other maternal or fetal factors", no breakdown is provided for groups with an incidence lower than 1 per 1000 births, such as malformation of the SNC or genital herpes, although these are computed in the total.

DEFINITIONS AND VARIABLES

The following variables and definitions were used: (a) clinical factors not necessarily indicative of cesarean section: age (below 14 and over 50 were considered erroneous); weight at birth in grams (for the firstborn in multiple deliveries, erroneous <600 g); comorbidity, measured as presence or absence of any comorbidity included in an adaptation of the Charlson Index for administrative databases[11]; previous caesarean section, identified with the ICD9CM code 654.2 or indicated on previous births; multiple pregnancy, identified in the variables sex or weight of the second born or the ICD9CM code 651. (b) Clinical factors suggesting maternal-fetal risk: we used a modified version of the classification proposed by Anderson and Lomas,[12] validated for databases,[13] to construct the variable maternal-fetal risk. It included five hierarchical categories (table 1): presentation in breech position, dystocia, fetal distress, other maternal or fetal risk factors, and other abnormal deliveries. (c) Ambiguous clinical factors: length of stay before delivery; emergency or programmed admission. (d) Non-clinical factors: day of birth, grouped as weekday or weekend; and hospital.

MAIN OUTCOME MEASURED

Performance of any type of caesarean section: classic, lower cervical or extraperitoneal (DRG: 370–371; ICD9CM: 74).

ANALYSIS

Firstly, a bivariate analysis was conducted to describe the incidence of caesarean sections in relation to various circumstances. The distribution of the risk factors and the probability of caesarean section were analysed on a hospital

Table 3 Percentage of births and risk births by hospital and percentage of caesareans by type of risk

	Total		*Breech*		*Dystocia*		*Fetal distress*		*Antec. caesarean*	
Hospital	*Births*	*% c-section*	*% Breech*	*% c-section*	*% Dystocia*	*% c-section*	*% Distress*	*% c-section*	*% Antec.*	*% c-section*
A	3 407	21.31	2.23	76.32	11.62	93.18	2.88	82.65	2.26	97.40
B	3 206	14.69	1.62	61.54	6.67	91.59	2.28	86.30	2.78	92.13
C	1 920	17.55	2.03	87.18	6.41	90.24	1.88	69.44	2.19	97.62
D	13 539	19.31	4.53	65.91	7.78	97.53	14.98	27.86	6.71	62.33
E	1 607	16.49	3.05	89.80	6.41	96.12	2.55	87.80	1.93	100.00
F	2 422	15.15	2.97	87.50	7.72	60.96	6.69	66.05	3.43	61.45
G	565	24.96	1.77	90.00	18.76	47.17	10.97	95.16	2.65	93.33
H	2 698	16.05	2.37	70.31	7.64	97.09	16.05	7.39	4.78	93.02
I	1 550	15.16	2.45	84.21	13.10	43.35	4.97	66.23	2.97	89.13
J	4 214	14.67	1.47	62.90	6.34	69.66	0.93	79.49	1.26	71.70
K	1 691	16.20	0.89	40.00	7.45	96.83	2.19	97.30	2.90	97.96
All	36 819	17.61	2.96	70.28	8.11	85.86	8.38	35.19	4.13	72.73

c-section = caesarean section.

by hospitals basis. Next, a non-conditional logistical regression model was used to isolate the effects of the various variables on the incidence of caesarean sections, analysing the statistical association with the odds ratio (OR), accompanied with the corresponding confidence intervals of 95% (95%CI). We used a model with the principal effects of the variables and two way interactions, forcing (enter method) the inclusion of a first block with the principal effects of all the independent variables considered of interest, independently of their statistical significance. Then, the interactions were included with the forward stepwise method, retaining only those which were statistically significant. If two variables interacted significantly, the influence of one on the probability of a caesarean section was modified in function of the other's value, or vice versa. The model's performance was evaluated on the basis of how closely it predicted the results actually observed, following criteria for discrimination (C statistics) and calibration (Hosmer-Lemeshow test).

The above model was used to analyse the hypothetical differences in caesarean rates between hospitals that cannot be explained by differences in obstetric risks. This approach synthesises all of the factors into a single index that represents the expected probability of a caesarean delivery for each mother. This value was used to calculate the expected caesarean

Table 4 Factors associated with caesarean section. Logistics regression

Variable	*Values*	*OR*	*p*	*95% CI OR*	
Day of the week	Weekend (ref)	1			
	Mon-Fri	1.4	0.000	1.2	1.5
Previous caesarean	no (ref)	1			
	yes	29.8	0.000	25.1	35.4
Admission	Emergency (ref)	1			
	Programmed	3.0	0.000	2.2	4.2
Prepartal stay in days		1.0	0.001	1.0	1.1
Charlson Index	0 (ref)	1			
	1 or more	1.7	0.008	1.2	2.6
Multiple birth	no (ref)	1			
	yes	3.1	0.000	2.4	4.0
Weight at birth	2.5–4.0 kg. (ref)	1			
	<2500 g	2.3	0.000	1.7	3.1
	>4000 g	1.3	0.150	0.9	2.0
Maternal-fetal risk	None (ref)	1			
	Breech presentation	744.5	0.000	452.6	1224.9
	Dystocia	962.5	0.000	611.9	1514.0
	Fetal distress	119.1	0.000	80.4	176.6
	Other complications	59.5	0.000	36.3	97.6
	Remainder abnormal births	16.1	0.000	12.0	21.5
Age*	26–34*breech	0.3	0.000	0.2	0.6
Maternal-fetal risk	26–34*dystocia	0.4	0.000	0.2	0.6
	26–34*fetal distress	0.4	0.000	0.3	0.6
	26–34*other complications	0.4	0.000	0.2	0.7
	26–34*r. ab. births	0.7	0.009	0.5	0.9
	>34*breech	0.2	0.000	0.1	0.3
	>34*dystocia	0.3	0.000	0.2	0.4
	>34*fetal distress	0.3	0.000	0.2	0.5
	>34*other complications	0.5	0.003	0.3	0.8
Maternal-fetal risk fetal*days prepartum	breech*days	1.1	0.159	1.0	1.2
	dystocia*days	1.9	0.000	1.7	2.2
	fetal distress*days	1.1	0.009	1.0	1.2
	others*days	1.4	0.000	1.2	1.5
	rest*days	1.1	0.002	1.0	1.2
Maternal-fetal risk*birth weight	breech*<2500	0.3	0.000	0.2	0.4
	breech*>4000	2.0	0.251	0.6	6.2
	dystocia*<2500	0.6	0.056	0.4	1.0
	dystocia*>4000	0.7	0.252	0.4	1.2
	fetal distress*<2500	0.6	0.014	0.4	1.0
	fetal distress*>4000	0.6	0.059	0.3	1.0
	others*<2500	1.5	0.060	1.0	2.2
	rest*<2500	0.6	0.002	0.4	0.9
	r. ab. births*>4000	1.4	0.222	0.8	2.3

n=35 024; $\chi^2(38)=16664.00$; $p(\chi^2)<0.0001$; log likelihood=−7688.62; $r^2=0.52$; C statistics=0.94; ref: reference category; OR: odds ratio; 95% CI: confidence intervals of 95%. 1795 cases excluded because of missing data in some of the variables used in the model.

rate for each hospital, based on the distribution in the different hospitals of the known risks. To evaluate the behaviour of the different hospitals, the rates expected were compared with the rates actually observed and contrasted, giving a measurement similar to the relative risk (RR), equal to 1 when there are no differences. To quantify the random error of this RR and establish its confidence intervals, a normal approximation to a binomial distribution[14] was assumed.

Results

The rate of caesarean sections for all the hospitals was 17.6% (table 2). Surgery was the preferred treatment when specific risk factors or circumstances were present during labour (abnormalities in uterine neck, haemorrhaging before birth, dystocia, breech presentation or previous caesarean). In some situations, such as slow uterine growth, chronic or severe maternal hypertension disease, or when the pre-delivery stay had exceeded four days, the probability of caesarean was greater than 40%. Breech presentation accounted for 3% of births. The incidence of dystocia, without taking into consideration the previous cases, was 8.1%. In the remainder of the deliveries, 8.4% corresponded to signs of fetal distress. These figures vary considerably from one hospital to another (table 3), particularly in cases of dystocia and fetal distress. The decision to practice a caesarean section in the presence of these risk factors also varied considerably from one hospital to another.

The multivariate analysis showed that maternal-fetal risk factors were strongly associated with the caesarean section (table 4). The diagnosis of breech presentation, dystocia or fetal distress considerably increased the probability of caesarean (OR of 744, 962 and 119, respectively). When non-clinical variables were analysed, the day of the week maintained statistical significance (OR: 1.38, 95%CI: 1.25, 1.52), and almost all of the other variables contributed to explaining behaviour during delivery. The interactions between maternal-fetal risk factors and age, fetal weight and length of pre-delivery stay were also significant to a similar degree. The interactions between maternal-fetal risk and the first two variables had the effect of lowering the risk of caesarean, while the interaction between maternal-fetal risk and the length of the pre-birth stay had the opposite effect. A woman presenting these two factors would have a higher than expected risk based on the product of the ORs. The multivariate model was 90.6% correct in its predictions (cut off point > 0.5), with a sensitivity of 62.6%, specificity of 96.3%, positive prediction value of 77.8% and negative prediction value of 92.6%. The discrimination capacity was very high (C statistics: 0.95), but the Hosmer-Lemeshow test showed deficient calibration, as the model in fact predicted fewer caesareans than those actually performed in the deciles with the lowest probability.

Table 5 shows the number and percentage of births in each of the 11 hospitals, compared with those expected on the basis of the previous model, and the relative risk (RR) of caesarean associated with the hospital. Hospital E, for example, performed caesareans in 17.0% of the births, compared with the 10.9% expected according to the logistical model (RR: 1.56; 95%CI: 1.47, 1.65). In Hospital H, however, 15.5% of deliveries ended in cesareans, when the expected rate based on the structure of the risk factors in its population was 21.4% (RR: 0.72; 0.66, 0.78).

KEY POINTS

- Caesarean section rates in the Valencia Health Service—a public hospital network without economic incentives—has risen from 9.7% in 1984 to 17.6% in 1994–95.
- Caesarean section rates, and the indications that lead to caesarean sections, differ considerably from one hospital to another. This variability cannot be explained by differences in obstetric risks in the different centres or by other clinical factors
- The study does not suggest an appropriate rate for caesarean sections, but the wide variability observed, including within each risk category, suggests that caesarean section is often inappropriately used.
- Imprecise diagnosis of dystocia and fetal distress and information biases, limits drawing broad spectrum conclusions from hospital discharge administrative databases.

Table 5 Percentage of caesareans observed and expected by hospitals

Hospital	*Births*	*Caesareans observed (%)*	*Caesareans expected (%)*	*Relative risk*	*95% CI RR*
A	2 928	469 (16.01)	456 (15.56)	1.03	0.97,1.08
B	3 131	456 (14.56)	346 (11.05)	1.32	1.26,1.38
C	1 817	317 (17.44)	226 (12.45)	1.40	1.31,1.49
D	13 424	2593 (19.31)	2992 (22.28)	0.87	0.84,0.89
E	1 502	255 (16.97)	163 (10.86)	1.56	1.47,1.65
F	2 348	359 (15.28)	315 (13.40)	1.14	1.07,1.21
G	533	130 (24.39)	116 (21.77)	1.12	1.01,1.23
H	2 391	371 (15.51)	512 (21.42)	0.72	0.66,0.78
I	1 457	223 (15.30)	244 (16.76)	0.91	0.84,0.98
J	4 161	613 (14.73)	456 (10.96)	1.34	1.28,1.40
K	1 332	202 (15.16)	162 (12.12)	1.25	1.16,1.34
Total	35 024	5988 (17.09)	5988 (17.09)	—	—

The registry number corresponds to the cases with complete information for all the variables of interest; RR: relative risk; 95% CI: confidence intervals of 95%. 1795 cases excluded because of missing data in some of the variables used in the model.

Discussion

This study shows that caesarean section rates continue to rise in Valencia (17.6% in 1994–95), and that rates, and the indications that lead to caesarean sections differ considerably from one hospital to another. This variability cannot be explained by differences in obstetric risks in the different centres or by other clinical factors, confirming—in a public hospital network without economical incentives—findings published elsewhere in the international literature.

The non-clinical determinants that influence the decision to perform a caesarean include the woman's socioeconomic status,[15] her expectations and preferences when giving birth,[16] the

source of financing,[17] election of defensive medical practices under the threat of legal action,[18 19] the hospitals' practice style[3 20] and whether or not it is a teaching hospital.[21] Other factors include financial and other incentives[22] and the availability of technology. Some of the variables contemplated in this study attempted to take these factors into account, although most of them have not been explored in the Spanish context. Elucidating these areas, however, would help us understand the variability in rates detected, and explain the factors underlying the cesarean "epidemic", to which the Spanish National Health System has not been immune.

Today the risks associated with surgery are lower than before. However, as the risk of not performing surgery must be weighed by the healthcare provider who may face complaints or lawsuits if the delivery is unsatisfactory, the true implications in the rise in caesarean section rates need to be clarified. Despite safer surgery, mortality is still much higher after abdominal than vaginal delivery, and given the volume of births, the accumulation of many small risks can result in a significant increase in avoidable maternal deaths. Another factor that cannot be overlooked is maternal morbidity and discomfort post-caesarean.[23 24]

In obstetrics, the need for surgery is often assessed through the ongoing evaluation of risks, and the high caesarean rates seen today may indicate that the methods used to gauge these risks are the wrong ones. In some hospitals, deliveries are managed in the same way for all women, independently of previous risks, with the routine use of techniques with low specificity, such as fetal monitoring. This can lead to the over-identification of signs of fetal distress (false positives), and to unnecessary surgical interventions.[25]

In contrast with previous Spanish studies,[9 26] in this study access to clinical information about each patient made it possible to calculate specific rates for the various risk factors. However, two limitations should be pointed out: the imprecise diagnosis of dystocia and fetal distress, and information biases in the MBDS. In the first instance, because there are no precise criteria to identify dystocia and fetal distress, these risk factors are diagnosed inconsistently, causing the caesarean section rates associated with them to vary considerably. The hospitals examined showed a tendency towards an inverse relation between the incidence of dystocia and fetal distress and the percentage of caesareans. However, exceptions suggest that some hospitals tend to use specific diagnostic categories, and to proceed to surgery after the diagnosis has been established. The second limitation of the study, possible biases in the MBDSs, poses one of the main problems in drawing broad spectrum conclusions from our data. To limit these biases, we opted to exclude seven hospitals furnishing poor quality information, although that made it impossible to extrapolate results to the whole Valencia healthcare system. None the less, it is unlikely that the inclusion of these hospitals would have changed the trends detected, as they showed greater variability than the hospitals included (variation coefficient 0.49, compared with 0.32 in the hospitals included). However, the estimate of caesarean rates for each hospital based on the average behaviour observed can be biased by the quality of the information in the MBDS. Hence, fewer cases would be expected than those observed in hospitals where risk factors were under-declared.

When assessing the quality of the information on which the study was based, of particular interest is the history of previous caesarean, a highly controversial indication.[15 27] Studying the cases of the 172 women who, during 1993–95, were known to have given birth for the first time with caesarean section, and who had another child in 1994–95, suggests that this antecedent is under-declared in a systematic and biased manner. The antecedent was recorded for only 53.5% of the women, and 59.3% of these patients subsequently had a second caesarean section. However, it is telling to observe that if the antecedent was not available only 46.2% of these mothers had a second caesarean; if the information was provided the rate of subsequent cesarean was 78.7%.

Although our study does not suggest an appropriate rate for caesarean sections, the wide variability observed, including within each risk category, suggests that surgery is often inappropriately used. The data suggest, above all, that the caesarean is often practised when it is not clearly indicated, although there are probably also instances where surgery should be performed, but is not. These circumstances make it necessary to devise interventions for the selective reduction of caesareans, safeguarding situations where the benefits of surgery outweigh the risks involved. In other countries, intervention has concentrated on three different areas that account for about 75% of caesareans: previous caesarean delivery, dystocia and fetal hypoxia. Work in this area includes the systematic review of all available evidence and the development of guidelines based on scientific evidence, research to increase the body of available evidence and medical audits or utilisation reviews with feedback to obstetricians. Many of these strategies have proved to be viable and useful in containing and reducing the percentage of caesarean sections, while protecting mother and infant from increases in risks. In the Spanish—and European—context there remains much to be done in many areas: we must continue monitoring the trend, and analyse the factors underlying the variability observed. More importantly, however, we must apply the scientific results available to us to design interventions to improve the use of the caesarean section.

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