

Research Article

Reducing Caesarean Deliveries: Trends and Analysis of Risk Factors over a Decade

¹Tunny Sebastian, Visalakshi Jeyaseelan², Jeyaseelan Lakshmanan³, Reeta Vijayaselvi⁴, Ruby Jose⁵

¹Lecturer, Department of Biostatistics, Christian Medical College & Hospital, Vellore, India

²Lecturer, Department of Biostatistics, Christian Medical College & Hospital, Vellore, India

³Professor, Department of Biostatistics, Christian Medical College & Hospital, Vellore, India

⁴Assistant Professor, Department of Obstetrics and Gynaecology(Unit 4), Christian Medical College & Hospital, Vellore, India

⁵Professor and Head Department of Obstetrics and Gynaecology(Unit 4), Christian Medical College & Hospital, Vellore, India

Summary

This paper a retrospective analysis of Caesarean deliveries (CD) between 28 and 42 weeks of gestation over 11 years' revealed strategies that reduced the rate of Caesarian deliveries. The trend and risk factor analysis was done for singleton and twin gestations. Segmented regression analysis was performed for trend analysis between the two time periods. Multiple Logistic regression analysis and Generalized Estimating Equations regression analysis was done for the risk factor analysis of singleton and twin deliveries respectively. The increasing and decreasing trend of CDs were presented here. A significant change in trend for CD: a steady rise (10.2%) from 20.9% in 2000 to 31.2% in 2006, followed by a slow rise(2.8%) to 33% from 31.2% between 2006 and 2010, was observed when simple interventions to reduce CD rate was instituted. The trend analysis of successful trial of labour after CD was also done. This study concludes that the simple interventions can be instituted to decrease caesarean delivery rates. Multifaceted strategies will be effective in reducing CD rates. Preterm births constitute a majority of CD; hence measures to decrease preterm birth should be a priority.

Abstract

Objective

To analyse the increasing and decreasing trend and risk factors of Caesarean Delivery (CD) over 11 years.

Methods

A retrospective analysis of CDs between 2000 and 2010, with gestational age between 28 and 42 weeks was done. The overall CD trend as well as the risk factors for singletons and twin pregnancies were analysed.

Results

A significant change in trend for CD: a steady rise (10.2%) from 20.9% in 2000 to 31.2% in 2006, followed by a slow rise (2.8%) to 33% from 31.2% between 2006 and 2010, was observed when simple interventions to reduce CD rate was instituted. Weekly audits, evaluation and identification of maternal risk factors, re-evaluation and analysis of the indications for induction of labor, counselling for Trial of Labor after Caesarean section (TOLAC) and

external cephalic version for non complicated breech presentation and other mal presentations were important ways to lower the CD rates. CDs among twin pregnancies did not show the same trend.

Among singleton deliveries, demographic factors of increased age, height less than 150cms, higher body mass index, poorer levels of education of women and presence of obstetric factors of hypertensive disease, antepartum hemorrhage, abnormal Doppler indices, preterm premature rupture of membrane, decreased amniotic fluid index, clinical and sub clinical oligoamnios, Chorionamnionitis, breech or transverse lie at delivery, Preterm delivery, small and large for gestational age babies and male babies revealed a significantly higher risk for CD. Infertility and Previous CD also showed a higher risk for CD.

Among twin pregnancies, a higher body mass index and non vertex presentation at delivery were significant risk factors. Teenaged women and preterm delivery also had a higher risk of CD among twins.

Conclusion

Simple interventions can be instituted to decrease CD rates. Multifaceted strategies will be effective in reducing CD rates. Preterm births constitute a majority of CD; hence measures to decrease preterm birth should be a priority.

Keywords: Reducing Caesarian Delivery; Risk Factors; Segmented Regression Analysis.

***Corresponding author:** Tunny Sebastian, Department of Biostatistics Christian Medical College & Hospital Vellore India-632002, **Email:** tunnysebastian@cmcvellore.ac.in

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Introduction

Caesarean delivery (CD) is a life saving procedure and 18.5 millions CDs are performed yearly worldwide [1]. Rates between 5% and 10% have been recommended by WHO for better neonatal outcomes [2-3]. The CD rate in the United States was 20.7% in 1996 and rose to 32.7% in 2010 [4]. In Australia, it had increased from 21.8% in 1999 to 32.3% in 2013 [5]. China showed a steep increase of CD from 19% to 58% [6]. Increasing trends were noted in low income countries such as Tanzania, Latin America and in Africa as well [7-8]. CD rates were more than 40% in many Indian states (9). CD rates have skyrocketed all over the world even though; a higher CD rate was not associated with reduction in maternal and newborn mortality rates [10-11].

The risk of CD increases with increasing maternal age, extreme neonatal birth weights and high risk pregnancy [12-13]. The increasing safety of anesthesia, surgical skills, suture material, makes women accept elective CD easily [14-15]. Complications inherent with CD are noted to be close to 12% [16-17].

A prior CD has a 1% risk of uterine rupture as well, that contributes up to 10% of maternal deaths [18]. The whole world is looking at ways to contain this exploding of CDs (keeping the minimum CD rate at 15% as recommended by the WHO) (1).

Materials and Methods

Data Source

Data was collected from the Labour room register of the Department of Obstetrics and Gynecology, Christian Medical College Vellore. These records are maintained by the Senior Staff Nurse in charge of Labour Room and counterchecked every month by the Senior Doctor in charge of the Obstetric Audit. The data of all women who had CD between 28 and 42 weeks of gestation, from January 2000 to December 2010 were collected by rotational sampling.

IRB and Ethics Committee Approval

The Institutional Review Board of Christian Medical College Vellore waived the informed consent. (IRB Min No. 7109 dated 10.03.2010).

Statistical Methods

The records were entered in EPI INFO data sheet (Epiinfo3.5.1, CDC, USA) and analyzed using SPSS (SPSS Statistics for Windows, Version 17.0. Chicago: SPSSInc.) and STATA (StataCorp.2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorpLP). Frequencies and percentages were calculated for the categorical variables and mean and standard deviation were calculated estimated for the continuous variables. The trend analysis of CD rate was performed using the time series plot of yearly CD proportions. Segmented regression analysis was used to find the significant difference in the trend of two time periods. Unadjusted and adjusted logistic regression analyses were done to find the risks for CD among singleton deliveries. Generalized Estimating Equation (GEE) analyses were performed to find the risk factors for CD among twin deliveries, considering mother as a cluster. For

singleton delivery data analysis, the variables that were significant at 5% level of significance from the univariate analysis were included for multivariate analyses and 20% level of significance for the twin delivery data analyses. Single and multiple line plots were used to present the trend of CD based on the various factors.

Definitions

Literacy

Standard of education was grouped separately for the woman and for her husband into: illiterate, including those who were unable to read or write; Primary and Secondary, included those who had a school education of 7 years or less; High school and Higher Secondary, included those who had a school education of 8 years to 12 years; and Degree and above, for those with higher education.

Parity

The number of pregnancies carried to viable gestational age. The women who delivered for the first time were defined as nulliparous women and others as multiparous women.

Infertility

Women who were infertile for more than 1 year.

Hypertensive Disease of Pregnancy

Gestational hypertension included women who had blood pressure greater than or equal to 140/90 mmHg on 2 occasions, 6 hours apart after 20 weeks gestation. *Chronic hypertension*: If the diagnosis of hypertension predated the pregnancy, or had hypertension diagnosed prior to 20 weeks of gestation. *Eclampsia*: Hypertension and proteinuria associated with seizures. *Pre-Eclampsia*: Hypertension associated with proteinuria.

Cardiac Disease

Cardiac disease included all pregnant women with rheumatic or congenital heart disease diagnosed by the Cardiologist, based on echocardiogram and /or other relevant tests.

Body Mass Index (BMI)

BMI was calculated from maternal weight at delivery using the standard formula: $[\text{weight (kg)}/\text{height (m)}^2]$ formula. Women with a BMI below $18.5\text{kg}/\text{m}^2$ were classified as underweight, BMI of $18.5\text{--}24.9\text{kg}/\text{m}^2$, was considered normal, those with $25\text{--}29.9\text{kg}/\text{m}^2$ over weight and $\text{BMI} \geq 30\text{kg}/\text{m}^2$, obese. Pre pregnancy weight was not available in most of the patients who were booked at various gestational ages for antenatal care and therefore could not be used in the analysis. Gestational weight gain could not be used in the analysis for the same reasons.

Anemia

Included women with a Hemoglobin (Hb) $< 11\text{g}/\text{dL}$ based on WHO definition of anemia.

Diabetes

Diabetes included women with diabetes predating their pregnancy and those with a positive 100 gm 3 hour oral glucose tolerance test with cut-offs at baseline, one, two and three hours following

glucose ingestion.

Oligoamnios

An amniotic fluid index of less than 5cms.

Birth Weight

All babies were weighed within an hour of delivery using 111 Braun electronic weighing scale. The scale is calibrated regularly to maintain accuracy to $\pm 0.5g$.

Pre Term

Delivery at a gestational age of less than 37 weeks.

Small for Gestational Age (SGA)

SGA was assigned when a newborn had a birth weight lower than the 10th centile for the gestational age in weeks.

Large for Gestational Age (LGA)

LGA was assigned when a newborn had a birth weight higher than the 90th centile for gestational age in weeks.

Results

Descriptive Analyses

There were a total of 30,335 deliveries during the study period, out of which, 8411(27.7%) had CD. Of this, 7943(26.18%) were done on singletons, 459(1.51%) were done on twin gestation and the rest 9(0.03%) on triplets. Among 9 of the CD for twin gestations, the delivery of the second of twin was by CD following vaginal delivery of the first twin.

Singleton deliveries accounted for 29,368 deliveries and 7943 (27.1%) were CDs. There were 5396 (18.4%) primary CDs and 2547 (8.7%) repeat CDs. Successful TOLAC was noted in 763 (23.1%) of the singleton pregnancies. CDs among nulliparous and multiparous women constituted 4186 (25.9%) and 3757 (28.4%) respectively. The CD rate for singleton preterm births was 37.3% and the term CD rate was 25.6%.

Among the total of 946 twin deliveries, 459 (48.5%) had CDs, which was nearly double that of singletons. Among the CDs, 404 (42.7%) were primary CDs and 55 (5.8%) were repeat CDs. Successful TOLAC were conducted on 22 (28.6%) twin deliveries. Among twin pregnancies nulliparous women too had more CDs than multiparas 310 (50.7%) versus 149 (44.6%). Preterm CDs among twins was 292 (50.5%), whereas CDs among term twin pregnancy was 167 (45.4%), almost double that of singleton pregnancies.

Trend Analysis

The overall trend of CD was seen to increase steadily from 20.9% in 2000 to 31.2% in 2006, followed by a slower rise to 33.0% in 2010 Table 1. The segmented regression analysis showed a significance change in trends between the two time periods, 2000-2006 and 2007-2010 ($P < 0.05$).

Among singletons, the trend of CD rate was similar to the overall trend. The CD percentage increased during the period 2000-2006

(1.9% per year, 95% CI: 1.4%-2.3%, $P < 0.001$) but there was no such change between 2007 -2010 ($P = 0.224$). These CD percentage trends were statistically significant between the two time periods ($P < 0.05$).

For twin pregnancies, the CD rate rose from 33.3% in 2000 to 65.7% in 2006 and then dropped to 52.5% in 2010 (Fig1). The CD percentage was seen to increase between 2000-2006(5.1% per year, 95%CI: 3.1%-7.0%, $P < 0.001$) and decreased over the period between 2007-2010(7.6% per year, 95%CI: 2.7%-12.6%, $P < 0.01$), however the CD percentage trends was not statistically significantly

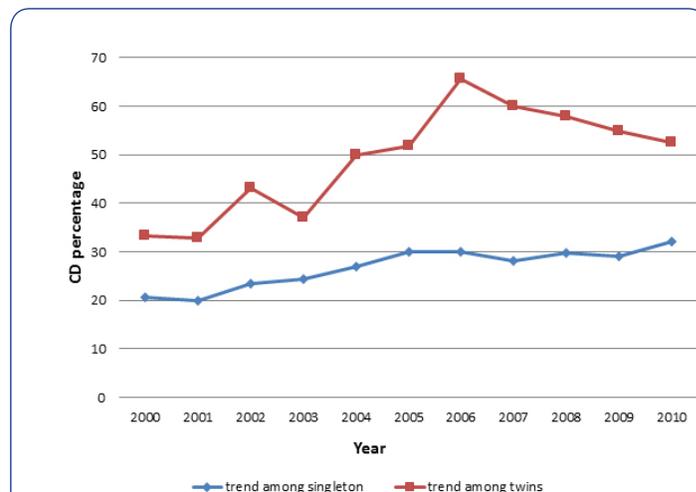


Figure 1: Trend of CD deliveries among singleton and twin deliveries from 2000 to 2010.

different between the two time periods ($P = 0.671$).

Both nulliparas and multiparas followed the overall trend of CDs. Among the singleton pregnancies, most of the increase in CD rate was contributed to by primary CD which increased from 14.9% to 22.1%, while repeat CD contributed minimal (5.7% to 10.1%) over the same period of time.

The percentages of successful TOLAC were noted to be significantly

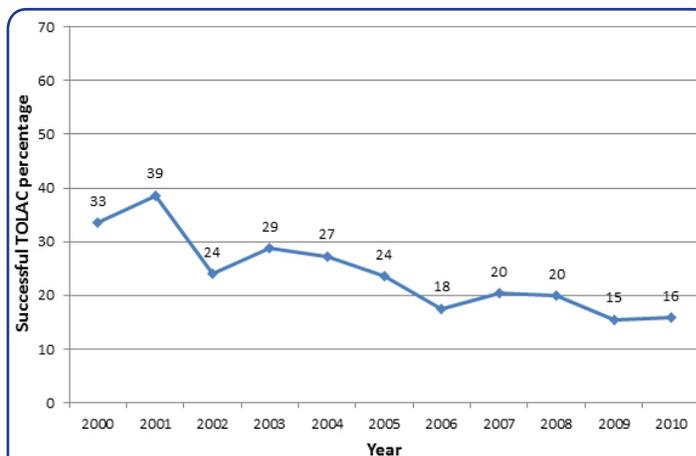


Figure 2: Trend of successful TOLAC.

Table 1: Incidence of Caesarean deliveries (CDs) from 2000 to 2010(N=30335).

Year	Total deliveries (N)	Overall CDs n(%)	Singleton deliveries		Twin deliveries	
			Total	CDs n(%)	Total	CDs n(%)
2000	2571	538(20.9)	2493	512(20.5)	78	26(33.3)
2001	2514	514(20.5)	2432	487(20.0)	82	27(32.9)
2002	2466	591(24.0)	2394	560(23.4)	72	32(44.4)
2003	2597	649(25.0)	2478	603(24.3)	116	43(37.1)
2004	2712	747(27.6)	2625	705(26.9)	84	42(50.0)
2005	2324	711(30.6)	2270	683(30.1)	54	28(51.9)
2006	2469	769(31.2)	2396	719(30.0)	67	44(65.7)
2007	2866	822(28.7)	2806	786(28.0)	60	36(60.0)
2008	2827	860(30.4)	2742	816(29.8)	76	44(57.9)
2009	3187	954(29.9)	3092	902(29.2)	95	52(54.7)
2010	3802	1255(33.0)	3640	1170(32.1)	162	85(52.5)
Total	30335	8410(27.7)	29368	7943(27.0)	946	459(48.5)

decreasing over the years, from 33% in 2000 to 16% in 2010 (Fig 2).

Risk Factors for Caesarean Deliveries among Singleton Pregnancies

Demographic Risk Factors

There were a total of 29,368 singleton women included in the study, the CD rate was 27.0 (7943). When different age groups were considered, i.e. teenaged, 20-29 years and ≥ 30 years, there were 300 (17%), 5800 (25%) and 1819 (39%) CDs respectively. The adjusted analysis (Table 2) show that mothers who were ≥ 30 years had a 1.6 (1.5-1.8) times higher risk of CD ($P < 0.001$) and teenage mothers had lower odds of 0.6 (0.5-0.7) of CD as compared to mothers who were 20-29 years ($P < 0.001$).

Underweight mothers had 0.6 (0.5, 0.9) times lower odds of having CD ($P < 0.05$), whereas overweight and obese mothers had nearly twice higher odds for CD as compared to normal weight mothers (1.4 (1.3-1.6); 1.8 (1.7-2.0) respectively and $P < 0.001$ each). Shorter women (height less than 150cm) had a higher odds 1.9(1.7-2.1), of CD ($P < 0.001$).

The parents' education/occupation was significant in the unadjusted analysis, but only mother's education was significant in the adjusted analysis. Women with primary or secondary school education had a 1.2(1.1-1.4) times higher odds of CD as compared to the higher educated women (Degree or above), $p < 0.01$.

Obstetric Risk Factors

Hypertensive mothers had 1.7 (1.5–2.0) higher odds of CD after adjusting for other risk factors ($P < 0.001$). Women who had ante partum hemorrhage had the maximum odds of CD (OR=6.3, 95%CI: 4.0-9.9; $p < 0.001$), followed by those who had abnormal umbilical artery Doppler waveform analysis (OR=3.9, 95% CI: 1.7–9.3; $P < 0.01$). Presence of preterm premature rupture of

membrane and decreased Amniotic fluid index, had significant higher odds of having CD; OR: 1.5 (1.2–1.8); $p < 0.001$, 1.5 (1.2-2.0), $p < 0.01$ respectively. Women who had chorioamnionitis and oligohydramnios had significantly higher odds for CD (OR: 2.5 (1.1-5.5), $p < 0.05$; OR:1.8 (1.2-2.6), $p < 0.01$ respectively) after adjusting for other factors. Mal presentations showed significantly higher odds of CD as compared to vertex presentation ($p < 0.001$). Women with infertility had 1.7 (1.4–1.9) times higher odds for CD ($P < 0.001$). There were 946 (38%) SGA neonates and 1213 (33%) LGA neonates who had CDs. Infants with SGA had significantly 1.8 (1.6-2.0) times higher odds of CD ($P < 0.001$) and infants with LGA had 1.4 (1.3-1.6; $P < 0.001$) times higher odds of CD as compared to normal birth weight babies. Male infants had 1.1 (1.05-1.2) times higher odds of CD as compared to female infants after adjusting for other factors ($p < 0.01$).

Multiparous women who had a previous CD had a higher odds for CD (OR: 23.4, 95%CI: 21.1-25.9) $P < 0.001$) in the unadjusted analysis.

Risk Factor Analysis of Cesarean Deliveries among Women With Twin Pregnancies

There were 946 pairs of twin deliveries, of which 459(48.5%) had CD. Most of the women belonged to the 20-29 year age group (74%) as in the singleton groups. Teenage pregnancies constituted 5%; 21% of the women were > 30 years of age. It is noteworthy that 63.6% of CD among twin pregnancies was preterm CDs (thrice that of singletons).

Teenaged women with twin gestations had nearly 3 times higher risk of CD as compared to the 20-29 age group women ($P = 0.134$) (Table 3). Overweight mothers had 1.9(1.2-2.9) times higher risk for CD and obese mothers had 1.6(1.03–2.5) times higher risk of CD as compared with those mothers with normal BMI after

Table 2: Risk factors for Cesarean delivery in singleton gestations (N=29368).

Variable	Multivariate analysis			Variable	Multivariate analysis		
	OR	95%CI	p value		OR	95%CI	p value
Year of delivery				Father Education			
2000-2006	1.00			Degree and above	1.00		
2007-2010	1.24	1.16-1.32	< .001	HS & HSS	0.99	.91-1.08	.790
Religion				Primary & Sec	1.09	.95-1.24	.209
Hindu	1.00			Illiterate	1.10	.90-1.33	.368
Muslim	0.99	0.89-1.10	.825	Abortion	0.99	0.92-1.08	.927
Christian	1.06	0.94-1.19	.361	Infertility of 2 or more years	1.65	1.42-1.91	<.001
Age of mother(years)				Hypertensive Diseases	1.70	1.45-2.00	<.001
20-29	1.00			Diabetes	1.09	0.97-1.23	.159
≤ 19	0.60	0.51-0.70	< .001	Preterm premature rupture of membrane	1.50	1.23-1.84	<.001
≥ 30	1.63	1.50-1.77	< .001	Antepartum hemorrhage	6.30	4.03-9.86	<.001
Mother Height				Chorionamnionitis	2.45	1.08-5.54	.031
<150 cm	1.89	1.74-2.05	<.001	Polyhydramnios	1.54	0.73-3.22	.254
≥ 150 cm	1.00			Oligohydramnios	1.76	1.20-2.58	.004
Body Mass Index				Abnormal Doppler	3.92	1.65-9.32	.002
Normal	1.00			Amniotic Fluid Index	1.54	1.17-2.02	.002
Underweight	0.63	0.47-0.85	.002	APL	2.05	.33-12.88	.444
Overweight	1.44	1.34-1.55	<.001	Presentation			
Obese	1.83	1.67-2.00	<.001	Vertex	1.00		
Mother Occupation				Breech	6.91	5.83-8.20	<0.001
House Wife	1.00			Transverse lie	31.91	9.61-105.97	<0.001
Unskilled and others	1.28	0.97-1.68	.078	Foot	1.61	0.14-18.99	.707
Professional and skilled	0.97	0.86-1.10	.677	Face	1.65	0.32-8.56	.551
Mother Education				Gestational Age			
Degree and above	1.00			Preterm (< 37 weeks)	1.44	1.31-1.59	<.001
HS & HSS	1.06	0.97-1.15	.238	Term(≥ 37 weeks)	1.00		
Primary & Sec	1.23	1.09-1.40	.001	Infant gender			
Illiterate	1.13	0.92-1.38	.240	Male	1.12	1.05-1.19	.001
Father Occupation				Female	1.00		
Agriculture & Business	1.00			Infant Weight			
Unskilled & others	1.07	0.97-1.18	.179	SGA	1.76	1.59-1.96	<.001
Professional & Skilled	1.01	0.93-1.11	.754	LGA	1.44	1.31-1.57	<.001

Table 3: Risk factors for Cesarean delivery in twin gestations(N=946).

Variable	Multivariate analysis			
	OR	95% CI		P- value
Delivery year				
2000-2006	1.00			
2007-2010	1.39	0.96	2.02	0.085
Mother's occupation				
Professional or Skilled	1.00			
Housewife	0.72	0.41	1.26	0.244
Unskilled or Others				
Age in years				
20-29	1.00			
< =19	2.57	0.75	8.81	0.134
> =30	1.21	0.79	1.85	0.373
Mother's BMI				
Normal	1.00			
Underweight	0.69	0.39	1.25	0.225
Overweight	1.85	1.20	2.86	0.005
Obese	1.61	1.03	2.51	0.037
Anemia	0.69	0.37	1.29	0.248
Preterm delivery	1.39	0.91	2.12	0.129
Presentation				
Vertex	1.00			
Breech	1.28	1.09	1.50	0.003

adjusting for other risk factors(P<0.01 and P<0.05 respectively).

Discussion

Principal Findings

This is the largest study from South East Asia that dealt with 30,335 deliveries over an 11 year period. The CD rate increased by around 10% from 2000 to 2006 after which it increased by only 2%, from 2006 to 2010. The increase in CD rate is similar to the patterns reported in other countries [19-20].

Simple interventions can be instituted to decrease CD rates as suggested by Chaillet et al(2015) [21]. When CD rates were noticed to be alarmingly increasing in 2004, certain simple interventions were introduced in order to stem the rise [10]. The evaluation and identification of maternal risk factors, re-evaluation and analysis of the indications for induction of labor, counselling for TOLAC after detailed evaluation of indication of previous caesarean section, and external cephalic version for non complicated breech presentation and other malpresentations were important ways to lower the CD rates. The interventions involved audits of indications for CD, provision of feedback to concerned Doctors, and implementation of best practices by introducing common protocols for labour room management as well. Weekly audits were introduced in each obstetric unit along with training to read cardiocotographs

for labour room personnel. The audit and feedback is an effective strategy, known to reduce CD by 13% when used alone and when used along with multifaceted strategy, can be reduced to 27%. Multifaceted strategies were effective and strong in reducing CD rates. The patient's desire for elective CD without an indication was not encouraged and the demand was minimal. Each of the above strategies contributed to reducing CD rate successfully [21].

When CD risks were analysed, increasing maternal age was found to be independently associated with increasing odds of CD that is in keeping with other study findings [13]. Other studies have found that CD was associated with social class and nature of employment (22). However, in the present study the proxy variables such as education and occupation were not significantly associated with CD. High CD rate was strongly associated with previous CD (OR= 23; 95%CI: 21-26), similar to other studies as well [13-14, 23].

SGA neonates had higher risk for CD as has been reported in the literature [12-13]. In the present study, overweight and obese women had significantly higher risk for CD, as was reported from France. In France, 20% of the increase in CD was due to increase in the age and weight of the women [10, 14]. Presence of Diabetes and hypertensive diseases were shown to be significantly associated with CD in many studies, however, in our study hypertension increases the risk for CD significantly, while diabetic status failed to show the significance [13-14, 24-25].

Limitations

Though this is a large scale study representing 11 years of deliveries from a private referral and teaching hospital, this may not represent the deliveries which are taking place at the Primary Health Centres in the rural area.

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