Large for Gestational Age Births Among South Indian Women: Temporal Trend and Risk Factors from 1996 to 2010

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Publishing datasets The dataset will not be available for publishing online since further research has been planned.

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Abstract

Background/Purpose Mean birth weight is a good health indicator for any population. In the recent past, there have been many reports in the West indicating that there has been an increase in the proportion of large for gestational age (LGA) babies. The objective is to describe the change in the incidence of LGA babies from 1996 to 2010 in South India and the maternal risk factors.

Methods A rotational sampling scheme was used, i.e., the 12 months of the year were divided into 4 quarters and a month was from each quarter was selected rotationally. All deliveries for that month were considered. Only deliveries that occurred between 28 and 42 weeks of pregnancy were considered. The association between risk variables was studied using multivariable logistic regression.

Results There were 35,718 deliveries that occurred during these 15-year-study period in the gestational age 28–42 weeks were registered through the outpatient clinics. The incidence of LGA was 9.4 % that has mostly

remained at the same level. The incidence of LGA in mothers with gestational diabetes was 6.7, 3 and 17.6 % in overweight, obese and gestational 1 diabetes mothers. Overweight, obesity in pregnant women and cesarean section were significant risk factors.

Conclusion Unlike in Western countries, where the incidence of LGA babies has spiraled upward, has remained nearly at the same level over one and a half decades, in South India. The risk factors for giving birth to LGA babies in South India were similar to other studies.

Keywords Large for gestational age · Gestational diabetes · Overweight · Obesity · Cesarean section and trend

Background

Mean birth weight is a good health indicator for any population. If the mean birth weight was low, it suggested that the baby had not grown adequately. However, if the babies were large for gestational age (LGA) (mean + 2 SD) that meant more complications for the mother and the baby. In the recent past, there have been many reports from the West indicating that the mean birth weight of babies had increased considerably [1–5]. Not only has there been an increase in the birth weight of babies, but there has also been an increase in the proportion of LGA babies [6]. The proportion of LGA babies born increased from 8 % in 1978 to 11.5 % in 1995 in Canada. Similarly, in Sweden, from 1992 to 2001, newborn babies weighing over 4500 g increased from 3.7 to 4.6 %, respectively [7]. In China, the incidence of macrosomia, i.e., birth weight >4000 or 4500 g, has increased for the period from 1994 to 2000 [8]. Although babies with larger birth weights are preferred by the lay public, it has been shown that neurological sequelae and perinatal death increased as birth weight of the baby crossed 4000 g [9–11]. Thus, LGA babies were more likely to develop neonatal complications, as well as obesity, diabetes, and cardiovascular diseases later in life [12]. Although the increase in LGA babies seems to be one of the major concerns in the West, there has not been a single report on the magnitude of LGA from India in the recent past.

Some factors cited in the literature for the increased prevalence of LGA were the increase in pre-pregnancy maternal weight, pregestational diabetes, gestational diabetes, the increased gestational weight gain, and reduced smoking prevalence. A study from China reported that the incidence of LGA had partly leveled off due to the increasing use of cesarean deliveries and due to the moderation of gestational weight gain. A study from Sweden reported that prelabor intervention (induction of labor) if the expected birth weight was more than 4000 g was

prevalent [13]. As a result of complications due to LGA or the risk factors that lead to induction of labor for LGA babies, there was an increased risk of cesarean sections, of frequent use of episiotomy, or instrumental delivery and of the increased perineal rupture [10, 11, 14, 15]. Therefore, the objectives of this study were to describe the change in the rate of LGA from 1996 to 2010 in India and to study the association between specific maternal risk factors for LGA.

Methods

Ethical Approval

The study was approved by the Institutional Review Board of Christian Medical College, Vellore [IRB Min. No. 7109 dated 10. 03. 2010].

Study Site and Population

The Obstetrics and Gynecology Department of Christian Medical College and Hospital (CMCH), Vellore in the State of Tamil Nadu, India caters to 47,110 outpatients and 15,662 inpatients per year. The Department of Obstetrics and Gynecology had on an average delivered 20 babies per day in 1996 and 40 babies per day in 2010. Women of different socioeconomic status attend this institution for delivery. While the hospital predominantly caters to women patients belonging to the middle and lower socioeconomic strata, those from the higher socioeconomic groups seek care as private patients as well.

Sampling

To study the trends, for the incidence of LGA babies and the maternal risk factors for the same over a 15-year period, rotational sampling was used. Detailed description of the sampling is presented in an earlier publication [16].

Antenatal Assessment of Gestational Age

If menstrual cycles were regular and abdominal examination findings correlated, then the last menstrual period (LMP) was taken as the best estimate of gestational age. If menstrual cycles were irregular or the LMP was unknown, a scan at the first antenatal visit for women in their first and second trimesters was performed, and the gestational age by ultrasound scan was recorded. Hadlock's formula was used for the estimation of gestational age. CRL measurement was used up to 13 weeks of gestation. From 14 weeks gestation onward, the average of the biparietal diameter (BPD), head circumference (HC), femur length (FL), and abdominal circumference (AC) measurements was used

[17]. Some patients included in the cohort were treated with in vitro fertilization, and their gestation was calculated based on days since oocyte retrieval or co-incubation and adding 14 days [18].

Large for Gestational Age

For each gestational week of pregnancy, the 90th percentile of the birth weight was calculated. Babies whose birth weight was more than the 90th percentile of the cut-off values specific for gestational ages based on all deliveries that met inclusion criteria, were categorized as LGA. Only deliveries that occurred between 28 and 42 weeks of pregnancy were considered in this study [19].

Inclusion and Exclusion Criteria

The deliveries of all live births between 28 and 42 weeks of gestation were included, except those of babies with anomalies.

Definitions

Literacy

The standard of education was grouped separately for the women and their husbands as (a) nonliterate for those who were unable to read or write; (b) higher secondary for those who had a school education of 12 years; and (c) college and above for those with higher education.

Body Mass Index (BMI)

BMI was calculated from the weight at delivery using the standard formula: $[\text{weight (kg)}/\text{height (m)}^2]$. Women with a BMI below 18.5 kg/m^2 were classified as underweight, normal weight for BMI of $18.5\text{--}24.9 \text{ kg/m}^2$, overweight for $25\text{--}29.9 \text{ kg/m}^2$, and obese for $\text{BMI} \geq 30 \text{ kg/m}^2$ [20].

Diabetes

For women with diabetes predating their pregnancy and those with a positive 100 g 3-h oral glucose, tolerance test was conducted with plasma glucose cut-off values taken at baseline 1, 2, and 3 h following glucose ingestion. If there were two abnormal values in the oral glucose tolerance test, women were considered as gestational diabetics.

Polyhydramnios

Women whose ultrasound scan showed a four-quadrant amniotic fluid index of $>25 \text{ cm}$ or a single vertical liquor pocket of $>8 \text{ cm}$.

Birth Weight

All babies were weighed within an hour of delivery using 111 Braun electronic weighing scale. The scale is calibrated regularly by the engineering department to maintain the consistent accuracy of the scale. The accuracy of the scale being $\pm 0.5 \text{ g}$.

Pre and Postterm

Delivery at a gestational age between 28 and up to 37 weeks was classified as preterm and that after 42 weeks as postterm.

Statistical Methods

The association between risk variables and LGA were tested using Chi-square test with Yates correction. The variables which were significant at $p < 0.25$, were considered for multivariate logistic regression analysis. Results were presented with OR and 95 % CI. SPSS 16.0 software was used to analyze data.

Results

Based on rotational sampling method, in total, there were 39,618 deliveries that were sampled during this 15-year-study period. Of these, 35,718 deliveries in the gestational age 28–42 weeks were registered through the outpatient clinics, 4443 (12.4 %) of them were preterm deliveries. The mean (SD) age of all mothers who delivered between 28 weeks gestation and 42 weeks was 25.2 (4.2) years. The mean (SD) height, weight, and BMI were 155.4 cm (6.1), 62.9 kg (11.4), and 26 (4.3), respectively. The prevalence rates of hypertension and gestational diabetes were 3902 (10.9 %) and 2395 (6.7 %), respectively. The mean (SD), median (IQR) of birth weight, and gestation weeks were 2.9 kg (0.56), 2.9 (2.6, 3.2) kg, and 38 (2.1), 39 (38, 40) weeks, respectively.

A total of 3362 (9.4 %; 95 % CI 9.1, 9.7 %) LGA babies were observed in this group. There were 18,321 (51 %) male babies and 17,339 (49 %) female babies in the sample. Information on gender was not available for 58 babies. The incidence of LGA in each year for male and female babies with different risk variables is presented in Table 1. The incidence rates of LGA between male and female babies were similar over these years. The incidence rates of LGA were 8.6 % in 1996, 8.8 % in 2010, and nearly 10.5 % during the period 2000–2005. The diagrammatic display of the incidence of LGA and its association with the risk factors are presented in Figs. 1 and 2. The gestational diabetic and obese mothers had higher

Table 1 Incidence of large for gestational age from year 1996 to 2010 according to gender and risk factors

Birth year	Large for gestational age												
	Total delivery studied	Overall		Male		Female		Teenage (≤19)		Obesity		Diabetes	
		<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
1996	1610	138	8.6	66	8.2	72	9.0	4	3.8	21	16.7	14	18.7
1997	1682	167	9.9	87	10.1	80	9.9	10	8.3	37	22.6	18	20.7
1998	1801	135	7.5	75	8.0	60	7.0	9	8.0	22	13.3	27	17.1
1999	2000	174	8.7	85	8.3	89	9.1	6	4.5	21	12.8	21	12.3
2000	1893	197	10.4	102	10.1	95	10.8	7	4.6	43	19.7	36	18.9
2001	1829	203	11.1	114	12.4	89	9.7	7	5.7	48	17.5	31	20.7
2002	2345	239	10.2	131	10.7	108	9.6	5	3.1	64	19.0	47	22.8
2003	2588	236	9.1	116	8.5	120	9.8	8	3.9	48	15.0	23	20.2
2004	2695	298	11.1	167	12.0	131	10.1	10	5.3	80	19.6	25	21.0
2005	2313	250	10.8	121	10.4	129	11.2	6	3.9	63	17.5	27	19.0
2006	2449	207	8.5	102	8.3	105	8.7	4	3.2	59	11.7	15	14.0
2007	2826	252	8.9	134	9.4	118	8.5	11	8.5	85	15.8	37	24.0
2008	2766	261	9.4	128	9.3	133	9.6	6	4.9	77	13.8	46	23.0
2009	3165	275	8.7	151	9.2	124	8.2	4	2.7	93	14.4	39	17.0
2010	3755	330	8.8	163	8.4	167	9.2	10	7.9	110	14.1	49	16.7
Total	35,717	3362		1742		1620		107		871		455	

incidence of LGA compared to nongestational diabetic and non-obese mothers.

Demographic Risk Factors

The distribution of risk variables for LGA babies and the results of multivariable analysis are presented in Table 2. Teenaged mothers had 0.70 (0.56–0.88) lower odds for giving birth to LGA babies and those mothers aged 25–29 years had 1.15 (1.05–1.27) higher odds of giving birth to LGA babies, compared to mothers in the age group of 20–24 years ($p < 0.001$). As the age increased, the incidence of LGA increased significantly ($p < .001$).

When considering the relationship of the husband's occupation with their wives giving birth to LGA babies, women whose husbands were involved in business or owned agricultural lands had a significantly higher odds (OR 1.21, 1.09–1.35) of having LGA babies compared to those whose husbands were professionals ($p < 0.001$). With regard to the occupational status of the husbands, 7.9 % were unskilled workers and 10 % were professionals. The risk of delivering LGA babies was 1.2 times higher (1.1–1.4) among those women whose husbands owned agricultural land or were businessmen compared to women whose husbands were professionals ($p < 0.001$).

Regarding literacy of the mothers, 11.7, 9.2, and 9.6 % were professionals, housewives, and unskilled, respectively. A total of 11.2 % mothers had completed a college

degree or more compared to 7.6 % of mothers who were nonliterate. As regards their educational levels of husbands, 11 % had completed a college degree or more and 7.2 % were nonliterate.

Obstetric Risk Factors

The incidence of giving birth to LGA babies among mothers who had gestational diabetes was 8.7 %. Women who had gestational diabetes were (OR 2.0; 1.64–2.12) significantly at a higher risk for giving birth to LGA babies compared to women who did not have gestational diabetes ($p < 0.001$). These diabetic mothers had a higher chance of presenting with polyhydramnios, especially those who had suboptimal control of glucose levels. Mothers diagnosed with polyhydramnios during their pregnancies suffered a threefold higher risk of LGA (OR 3.0; 1.15–6.49) compared to women not diagnosed with polyhydramnios ($p = 0.02$). There was a higher odds of delivering an LGA baby by LSCS compared to normal delivery (OR 1.21; 1.10–1.33) ($p < 0.001$).

The incidence rates of giving birth to LGA babies in mothers who were overweight and obese were 38.2 and 17.6 %, respectively. Overweight and obese women too were 1.96 (1.77–2.17) and 2.72 (2.42–3.04) times, respectively, at higher risk for delivering LGA babies compared to women with normal weight ($p < 0.001$).

Fig. 1 a Incidence of large for gestational Age (LGA) by infant's gender and maternal age from 1996 to 2010.
b Incidence of large for gestational age (LGA) based on maternal age groups from 1996 to 2010

Discussion

Our study has found that the incidence of LGA babies was 8.6 % in 1996 and remained almost the same at 8.8 % in 2010. However, the period prevalence was about 10 % for the period from 2000 to 2005. The reason for this change could be attributed to the policy regarding screening for gestational diabetes. Earlier, the policy for screening for gestational diabetes was based on the presence of risk factors alone, but subsequently the policy was changed to universal screening. It is probable that this practice of universal screening helped to effectively diagnose and treat gestational diabetes thereby resulting in the prevalence of LGA babies remaining static. Our data contradict the findings from other hospital-based studies from the West which have highlighted a rise in the proportion of LGA babies over time [1–4]. However, prevalence of LGA babies in obese mothers and gestational diabetics did not show any specific trend.

Maternal factors that could contribute to an increase in LGA babies were maternal weight, gestational weight gain,

gestational diabetes, and maternal age. However, Ørskou et al. [13] have reported that the trend of LGA babies in China had leveled off due to an increase in cesarean sections. The CMC hospital where this study was carried out has also shown an increasing trend in the proportion of cesarean sections over the years. The risk of LSCS was 1.2 (1.1–1.3) times significantly higher for women who had LGA babies. The department fairly strictly adheres to the Cochrane recommendation of not inducing early for macrosomia [21].

As has happened in the case of China, this could mean that the rising trend in LGA babies is one of the reasons for the increased cesarean sections. More research in this area is certainly called for.

Diabetes and LGA

The association of diabetes and large birth weight has been demonstrated in previous cohort studies [6, 12, 22, 23]. Moreover, it has been shown that weight gain during

Fig. 2 a Incidence of large for gestational age (LGA) in mothers by gestational diabetes status from 1996 to 2010.
b Incidence of large for gestational age (LGA) in mothers by BMI categories from 1996 to 2010

pregnancy is also related to the increased birth weights [24, 25]. Although this study has shown significant association between diabetes and LGA, the data were not based on cohort design, and therefore, this should not be interpreted as causation.

Overweight and Obese Mothers

Our study found out that overweight and obese pregnant women were at 2–3 times at higher risk for giving birth to LGA babies. Other studies too have reported similar findings. Obesity has long been associated with chronic hypertension and diabetes prior to and during pregnancy. These in turn cause preeclampsia, and gestational diabetes, which can result in cesarean deliveries and prolonged hospital stay [26–32].

Data gathered from the Swedish birth registry have shown that obesity was significantly associated with fetal death and adverse pregnancy outcomes as well [33, 34].

Strengths and Limitations of the Study

The data for this study were obtained from the labor-room registry of a large referral hospital. The findings are thus the largest observations so far from Asia. Further, we have used international definitions to classify LGA, thereby enabling comparisons with other studies. However, our limited ability to extrapolate the findings of this study to other hospital settings is a drawback. Furthermore, not all women had a dating scan in the first trimester; therefore, very accurate gestational age assignment was not possible. This being a retrospective study, the exact numbers of pregnant women who had a dating scan could not be ascertained. Also, the ideal time to record the baseline height and weight of a pregnant woman is before she has started gaining weight due to gestation. As this is seldom available on a routine database, most researchers have relied on the woman's recall of her prepregnancy height, and weight, the reliability and standardization of which is very doubtful [35].

Table 2 Risk factors for large for gestational age based on bivariate (unadjusted) and multivariate (adjusted) analyses

Risk factor variables	Unadjusted analysis (35,718)				<i>p</i> value	Adjusted analysis		
	LGA					OR	95 % CI	<i>p</i> value
	No		Yes					
	<i>n</i>	%	<i>N</i>	%				
Sex								
Male	16,579	90.5	1742	9.5	0.59			
Female	15,719	90.7	1620	9.3				
Age								
20–24	13,374	92.0	1159	8.0		1.00		
≤19	1999	94.9	107	5.1		0.70	0.56–0.88	0.003
25–29	11,919	89.3	1428	10.7	<0.001	1.15	1.05–1.27	0.003
30–34	4012	88.1	543	11.9		1.11	0.97–1.26	0.13
≥35	942	89.1	115	10.9		0.90	0.70–1.16	0.41
Husband occupation								
Professional	15,311	90.0	1709	10.0		1.00		
Agriculture/business	5437	89.2	658	10.8	<0.001	1.21	1.09–1.35	<0.001
Unskilled/others	10,686	92.1	912	7.9		0.96	0.85–1.07	0.47
Husband education								
Degree and above	11,893	89.0	1477	11.0		1.00		
Higher secondary	16,462	91.5	1522	8.5	<0.001	0.92	0.83–1.03	0.17
Illiterate	1293	92.8	101	7.2		0.95	0.72–1.26	0.73
Mother occupation								
Professional	2578	88.3	340	11.7		1.00		
Housewife	29,119	90.8	2960	9.2	<0.001	0.95	0.82–1.10	0.49
Unskilled/others	253	90.4	27	9.6		1.10	0.67–1.28	0.71
Mother education								
Degree and above	10,221	88.8	1288	11.2		1.00		
Higher secondary	18,299	91.4	1735	8.6	<0.001	1.01	0.90–1.12	0.97
Illiterate	1244	92.4	103	7.6		0.86	0.65–1.15	0.32
Gestational diabetes								
No	30,416	91.3	2907	8.7	<0.001	1.00		
Yes	1940	81.0	455	19.0		1.87	1.65–2.12	<0.001
Induction								
Spontaneous	22,913	90.5	2409	9.5	0.31			
Induction	9443	90.8	953	9.2				
Polyhydramnios								
No	32,321	90.6	3351	9.4	0.01	1.00		
Yes	35	76.1	11	23.9		2.74	1.15–6.49	0.02
N preterm delivery								
No	28,276	90.4	2999	9.6	0.002	1.00		
Yes	4080	91.8	363	8.2		0.88	0.77–1.01	0.06
Type of delivery								
Normal	19,772	91.5	1840	8.5		1.00		
LSCS	8017	88.3	1060	11.7	<0.001	1.21	1.10–1.34	<0.001
Instrumental	4143	90.2	450	9.9		1.07	0.95–1.21	0.28
BMI								
Normal weight	12,595	94.4	752	5.6		1.00		
Underweight	572	95.8	25	4.2	<0.001	0.67	0.41–1.07	0.09

Table 2 continued

Risk factor variables	Unadjusted analysis (35,718)				Adjusted analysis		
	LGA				<i>p</i> value		
	No		Yes		OR	95 % CI	<i>p</i> value
	<i>n</i>	%	<i>N</i>	%			
Overweight	10,701	88.9	1333	11.1	1.96	1.77–2.17	<0.001
Obesity	4692	84.3	871	15.7	2.72	2.42–3.04	<0.001

Bold value indicates reference category

Despite the fact that the CMC hospital is a major referral hospital, its clientele predominantly comprise people belonging to the low and middle socioeconomic strata. Women from the very poor sections of the society may not be represented here.

In this study, BMI at the time of delivery was used. Being a retrospective study, the prepregnancy BMI and the gestational weight gain could not be accessed for further comments.

Conclusion

This study has concluded that, unlike in Western countries, the incidence of LGA babies has remained nearly the same for over a decade and a half in spite of economic advancement. The risk factors for LGA babies in South India were similar to other studies. Therefore, a good screening program has to be developed based on the risk factors to contain the consequences of for LGA babies.

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Authors' contributions LJ was involved in phrasing the research questions. He was involved in the verification of analytic results, which were done by BY and SV. He was involved in drafting the methods section. He also participated in the interpretation of results section along with RJ. BY was Involved in data abstraction supervision, and quality control assurance. He was also involved in data analyses and interpretation. He was further involved in the literature review and drafting the Background section. VS was involved in developing data entry system in EPIINFO and involved in Data Validation part. He was also involved in data analyses and verified the analytic codes. RV was involved in drafting the Background section along with BY. She was involved in the literature review and guiding the Biostatisticians in analyses. She was also involved in writing the Discussion section. RJ has provided leadership in phrasing the research question, was involved in designing the methods of data

abstraction and verified the results, and drafted the Discussion section, reviewed, and approved the overall manuscript.

Compliance with Ethical Standards

Conflict of Interest Dr. Lakshmanan Jeyaseelan (LJ), Bijesh Yadav (BY), Veerasamy Silambarasan (VS), Dr. Reeta Vijayaaselvi (RV) and Dr. Ruby Jose (RJ) declare that they have no conflict of interests.

Ethical Standards The study was approved by the Institutional Review Board of Christian Medical College, Vellore [IRB Min. No. 7109 dated 10.03.2010].

Informed Consent The Institutional Review Board of Christian Medical College Vellore provided consent for this research paper as recorded in the following minutes (IRB Min. No. 7109 dated 10.03.2010).

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