Why Low Birth Weight (LBW) is Still a Problem in Kerala: A preliminary exploration

V. Raman Kutty

Discussion Paper No. 57

Kerala Research Programme on Local Level Development
Centre for Development Studies
Thiruvananthapuram

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English
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First published 2004
Editorial Board: Prof. P. R. Gopinathan Nair, H. Shaji
Printed at:
Kerala Research Programme on Local Level Development
Published by:
Dr K. N. Nair, Programme Co-ordinator,
Kerala Research Programme on Local Level Development,
Centre for Development Studies,
Prasanth Nagar, Ulloor,
Thiruvananthapuram
Cover Design: Defacto Creations

ISBN No: 81-87621-60-5

Price: **Rs 40**
US$ 5

KRPLLD 2004 0500 ENG

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1. Introduction

Low Birth Weight (LBW) is defined as birth weight below 2500 gm, and is considered to be an important factor compromising healthy survival of infants. This is true all over the world, but in quantitative terms, LBW is a major health problem in most underdeveloped countries. Even in industrialised countries of the West, prevalence of LBW varies among population groups depending upon social and economic status, demography, race, ethnicity, smoking among mothers, bacterial infection, and other conditions such as hypertension, and low nutritional status. Thus it is well documented that in the US, prevalence of LBW is higher in the black population and among poorer socio-economic groups.

Recent reports on prevalence of LBW from around the world vary. It is recorded to be 6.2 percent in Taiwan, 5 percent among the White, 12.8 percent among the Black, and 7.5 percent among Hispanic Americans, and 5.3 percent in Norway. Proximate determinants of the risk for low birth weight may change from place to place. Thus, from Taiwan, low pregravid weight of mothers as well as low gestational weight gain has emerged as contributing factors. Maternal hypertension during pregnancy is well known to result in LBW, regardless of ethnic differences. Increase in multiple births may also contribute to increasing prevalence of LBW. Cigarette smoking among young women in the West has shown a tendency to increase, and one of its unpleasant consequences could be increase in the proportion of LBW babies. Asymptomatic bacteriuria (presence of bacteria in the urine without overt symptoms of disease) in the mother is another important risk factor. Paradoxically, teenage pregnancies resulting in LBW babies are emerging as a significant cause of LBW and infant mortality in the US. In India, prevalence of LBW as high as 23-30.3 percent has been reported. It is possible that some risk factors that have raised major concern in the West, such as smoking among mothers, may not be operative in India. However, several other factors, notably short stature and low pregravid weight of mothers, as well as their young age, may have contributed considerably to this high prevalence of low birth weight infants. Maternal infection during pregnancy, and inadequate coverage by antenatal services may be additional contributory factors. The latter may add substantially to the continuing prevalence of anaemia among pregnant women.

Among Indian States, Kerala is known for its high health achievement. This is true in maternal

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ACKNOWLEDGEMENTS: *We wish to acknowledge the contribution of the research associates, Ms Reshmi C.N and Ms Jasmin Mary Philip who helped us in collecting the birth weight data and interviewing the pregnant women.We are also grateful to the Superintendent, Sree Avittom Tirunal Hospital, Thiruvananthapuram for permission to do the study and to Dr Sheela Balakrishnan, Assistant Professor, Obstetrics and Gynaecology Department for her important role in the conduct of the study.*

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and child health as well as in other dimensions of health such as longevity. Kerala has the lowest fertility and infant mortality among all Indian States; in fact, its birth rate of 18/1000, and IMR of 12/1000 in 1997, would rank as perhaps the best in the underdeveloped world. The State is reputed to have the highest rate of hospital deliveries (above 95 percent), and excellent antenatal coverage. In spite of these achievements, prevalence of low birth weight in Kerala remains high, as shown in micro-studies done over the years. The National Fertility and Health Survey (NFHS) 1992-'93 reported 19 percent LBW babies in rural Kerala. The study done by the Kerala Sastra Sahitya Parishad (KSSP) in 1996 put the figure of LBW prevalence from across the State at 13.3 percent.

These figures may not appear too ominous in the light of the higher all-India figures. However, in other indices of maternal care, such as coverage of ante-natal protection and child birth under professional care, Kerala has achieved parity with most advanced nations: therefore, the State should be compared to these nations in indicators such as birth weight also. Moreover, both the above studies by NFHS and KSSP depended on birth weights reported by mothers. And they failed to probe the causes for low birth weight. In the present investigation, we attempt to find out the important reasons for the comparatively high prevalence of LBW in Kerala, in spite of adequate antenatal coverage and almost total institutional delivery.

2. Subjects and methods

For our study, we chose two large hospitals in Kerala, Sree Avittom Thirunal Hospital (SATH) in Thiruvananthapuram, the capital city, and the Malankara Orthodox Syrian Church Medical Mission Hospital (MMMH) in Kolenchery, a village in central Kerala near the city of Kochi. The first is a public hospital, being the teaching hospital of the Medical College Thiruvananthapuram. It serves a cross section of the people of the city of Thiruvananthapuram. However, being a public hospital, most of the services are free or highly subsidised; therefore, a large proportion of its clientele comprises poor and lower middle class people, who cannot afford to go to private hospitals. MMMH also serves a large community of rural people. It is the main hospital of an important Christian denomination in Kerala. It serves all sections of people living in the vicinity, and, being a specialist hospital also caters to referred cases from nearby areas. Thus the clientele consists of women from families, which may be classified in general, as belonging to the middle-income range, not to the affluent groups. The choice of the hospitals was dictated by the need for covering a wide spectrum of subjects under one institution, and the need to compare the private versus the public institution settings.

We selected consecutive subjects who were registered for antenatal check-up with a selected obstetric service unit in each hospital, and after getting satisfied that they fulfilled all our inclusion criteria, admitted them into the study. From each institution, we intended to study 1000 subjects; we selected women who were booked in the first and the second trimesters of pregnancy. We studied their initial characteristics, including the details of routine clinical and laboratory examination done in the hospital. These included personal and demographic details, menstrual, marital and obstetric history, haemoglobin, weight, height and blood pressure recording, and relevant family history. We also took note of the medications and other drugs prescribed. We made an effort to meet them during follow-up visits. When these subjects were booked in for delivery, we made a note of the type of delivery, the baby weight, placenta weight, and weight during the third post-natal day, and any other development during pregnancy. We lost some in follow-up; the most important reason for this was that a large number of women who had registered for antenatal check-up in these hospitals had their childbirth elsewhere. No attempt was made to follow them up, since we wanted a cohort of women on whom all information that we needed would be available. We supplied both the hospitals with electronic balances, which had a sensitivity of five gm, these were used to weigh the babies. The balances had been originally inspected and sealed by the Weights and Measures Department of the government, and were occasionally checked with standard weights.

By selecting only patients who had booked in the early months of pregnancy and who had full follow-up, we eliminated antenatal care as a variable that could affect birth weight. However, this might not have mattered in Kerala, where over 90 percent of all deliveries do receive antenatal care from some medical institution. Our intention has been to probe why, in spite of adequate antenatal cover, LBW remains as a problem in Kerala. Also, subjects chosen from these two major hospitals may not represent all the women of Kerala. Hence, the prevalence of LBW calculated from our data may not be a true reflection of the prevalence of LBW in the State. However, estimating the prevalence of LBW for the State was not one of our objectives; rather, we focussed on the possible causes of LBW.

We attempted a multivariate analysis of our data, to construct a predictive model for birth weight using the various variables discussed earlier. We constructed two models. The first, a linear regression model in which the dependent variable was birth weight, had all independent variables, as far as possible, entered as continuous (age of the mother, mother's weight on the third day after delivery, mother's height, systolic BP, diastolic BP, initial haemoglobin level), or ordinal [parity status, birth order (gravida)] variables. Prematurity was included as a categorical variable, defined as birth 15 or more days before the expected date of delivery. Step-wise forward regression was done for model selection. We found that only four variables, i.e., mother's weight on the third day after delivery, mother's height, prematurity and birth order were significantly predictive of birth weight. The second model was constructed by stepwise binary logistic regression, where all variables were converted into binary categories (presumed average risk and high risk categories), and the dependent variable was birth weight, coded into normal (2500 gm or above) and LBW (below 2500 gm). In this, the final model again threw up four significant predictors of LBW: mother's weight on the third day after delivery below the 25th centile, mother's height below the 25th centile, prematurity (being born 15 or more days before the expected date of delivery), and being the first-born child.

The same variables were selected in both the models. These variables are all well known predictors for LBW, in various studies from around the globe. Some other variables such as smoking among the mothers become irrelevant in a population of non-smoking women. The quality of antenatal care cannot be tested in these subjects, since they all uniformly received more or less standard antenatal care.

3. Results

See Tables 1-24.

Discussion

We had 986 subjects from SATH and 908 from MMMH in the study (Table 1), who gave birth in the respective hospitals. Our initial target was to study 2000 births from the two hospitals; however, we could not meet this target within the stipulated time. The religious break-up shows that Hindus predominate in the SATH, and Christians in MMMH (Table 2). This is along expected lines: SATH is a public hospital and reflects more or less the religious distribution in the community at large, whereas MMMH is run by a Christian denomination, and is frequented more by women of that community. Tables 3 and 4 show that in spite of differences in community distribution, the fertility behaviour of women in these two large hospitals in Kerala had several similarities. Proportions of women in parity categories 0,1, and 2 are remarkably similar. It is to be noted that childbirth of order parity 3 or above is extremely rare. There is a difference between parity and gravidity status, which indicates the extent of foetal wastage. Parity above 3 is rare, whereas there are women who are gravida 6. Since abortion (medical termination of pregnancy) is legal and easily available in the State, many women resort to this as a form of interval contraception. This could explain the difference between parity and gravidity status.

Table 1 Distribution of subjects according to place of delivery

Place of delivery	Frequency	Percent
SAT Hospital, Trivandrum	986	52.1
MMM Hospital, Kolenchery	908	47.9
Total	1894	100.0

Table 2 Subjects by place of delivery and religion

Place of delivery		Religion			Total
		Hindu	Christian	Muslim	
SAT Hospital, Trivandrum	N	630	166	184	980
	%	64.3%	16.9%	18.8%	100.0%
MMM Hospital, Kolenchery	N	259	424	93	776
	%	33.4%	54.6%	12.0%	100.0%
All	N	889	590	277	1756
	%	50.6%	33.6%	15.8%	100.0%

Table 3 Subjects by place of delivery and parity status

Place of delivery	Parity					Total
		0	1.00	2.00	3.00	
SAT Hospital, Trivandrum	N	499	401	81	5	986
	%	50.6%	40.7%	8.2%	.5%	100.0%
MMM Hospital, Kolenchery	N	446	396	59	2	903
	%	49.4%	43.9%	6.5%	.2%	100.0%
All	N	945	797	140	7	1889
	%	50.0%	42.2%	7.4%	.4%	100.0%

Table 4 Subjects by place of delivery and gravida status

Place of delivery	Gravida	1.00	2.00	3.00	4.00	5.00	6.00	Total
SAT Hospital, Trivandrum	N	459	340	153	27	6	1	986
	%	46.6%	34.5%	15.5%	2.7%	.6%	.1%	100.0%
MMM Hospital, Kolenchery	N	397	342	125	35	3	1	903
	%	44.0%	37.9%	13.8%	3.9%	.3%	.1%	100.0%
All	N	856	682	278	62	9	2	1889
	%	45.3%	36.1%	14.7%	3.3%	.5%	.1%	100.0%

Most subjects had their antenatal check-up from specialists (obstetricians) rather than general practitioners (Table 5). This is not surprising since the sample has been drawn exclusively from two large hospitals staffed by experienced obstetricians. Most of them (around 80 percent) first approached the health-care provider within three months of pregnancy (Table 7). This shows the high degree of utilisation of antenatal services. Caesarian rates in SATH are slightly higher than that at MMMH (Table 8). This may be attributed to the superior status of SATH in terms of staff strength and its reputation as a teaching hospital; hence, more complicated cases are likely to be referred to SATH.

Table 5 Subjects according to whether they approached a specialist or general practitioner for antenatal care, by place of delivery

		General practitioner	Specialist	Does not know	Total
SATH	N	1	983		984
	%	.1%	99.9%		100.0%
MMMH	N	25	878	1	904
	%	2.8%	97.1%	.1%	100.0%
All subjects	N	26	1861	1	1888
	%	1.4%	98.6%	.1%	100.0%

Table 6 Subjects according to the type of setting for antenatal care and place of delivery

Place of delivery	Type of setting	PHC	Government Hospital OPD	Private Hospital	Private consultant	Pri prac govt
SATH	N	47	498	141	41	2
	%	4.8%	50.5%	14.3%	4.2%	25.
MMMH	N	7	39	831	21	[illegible]
	%	.8%	4.3%	91.8%	2.3%	.4
All	N	54	537	972	62	2
	%	2.9%	28.4%	51.4%	3.3%	13.

Table 7 Time of first visit to health care practitioner during current pregnancy, by hospital attended

Hospital attended	Time of first visit	First month	Second month	Third month	Within the first three months	Total
SATH	N	166	224	386		984
	%	16.9%	22.8%	39.2%	**79%**	100.0%
MMMH	N	178	340	219		901
	%	19.8%	37.7%	24.3%	**82%**	100.0%
All subjects	N	344	564	605		1885
	%	18.2%	29.9%	32.1%	**80%**	100.0%

Table 8 Subjects by place of delivery and type of delivery

		Normal	Assisted	LSCS	Breech	Total
SATH	N	707	29	239	9	984
	%	71.8%	2.9%	24.3%	.9%	100.0%
MMMH	N	636	79	182	4	901
	%	70.6%	8.8%	20.2%	.4%	100.0%
All subjects	N	1343	108	421	13	1885
	%	71.2%	5.7%	22.3%	.7%	100.0%

The overall LSCS rate of around 22 percent is rather high. Surveys in Kerala in the general population also have reported a high LSCS rate of more than 20 percent. Is the high LSCS rate a reflection of the 'over-medicalisation' of pregnancy and childbirth? Or could this be due to increasing proportion of complicated pregnancies? We need to probe these important questions. The unwillingness of doctors and patients to take risks, in a State where the average number of children per family has fallen below two, could be another factor fuelling high LSCS rates.

From Table 9, it is clear that subjects from SATH and MMMH were very similar in their characteristics, such as mean parity, gravidity, height, and weight of the mothers. Mean birth-weight of last baby differs by about 70 gm, babies in MMMH being heavier. Mean haemoglobin level of the mother at first examination is lower in MMMH, only 10.86 gm percent against 11.05 gm in SATH; by the second examination, this gap has narrowed (11.08 gm percent and 11.12 gm percent respectively). This is indicative of the effect of antenatal interventions like iron and folic acid tablets. There is a difference of 1.9 years in mean age of mothers as between MMMH and SATH, with mothers in MMMH being older, though not differing in their parity or gravidity status. It is possible that this is due to differences in marital behaviour between the predominant communities in the two areas. Christian women marry later than their Hindu and Muslim counterparts; therefore, in MMMH, where the subject population is predominantly Christian, the mean age of the mothers is higher. Mean birth weight in MMMH is heavier by 64.32 gm than in SATH. The overall proportion of LBW is 15.1 percent (Table 10). It is higher among women who delivered at SATH (16.3 percent) than at MMMH (13.8 percent). The overall proportion of LBW is lower than that reported from some other studies from Kerala. This may be because of the selection bias of our subjects: we have only considered women who registered early and were available throughout their pregnancy for follow-up. Even in such women, LBW proportion is quite high. Thus our original proposition, that for a State that has such favourable maternal and child health indices, the proportion of LBW stands out as a problem crying out for attention, is supported by our data.

When we look at known risk factors for LBW, age of the mother does not seem to make a high contribution (Table 11). However, SATH, which has a higher proportion of younger mothers, does have a slightly higher share of LBW babies. Premature babies, or those born more than 15 days prior to the expected date of delivery, have a higher proportion of LBW, as do first-born babies (Tables 12,13, and 14). Coupled with around 50 percent of all babies being first-born, because of the decline in fertility, this factor could emerge as a major contributing element in the high LBW proportion among Kerala's infants. However, when the state policy aims to stabilise the low fertility status of its women, this is hardly amenable to correction. Short stature of the mother and low post-partum weight are factors associated with LBW in our data (Table 15, 16). Short stature of the mother could be an outcome of both genetic predisposition as well as nutritional deprivation during formative years. Whereas the first factor may not be amenable to corrective intervention, the second factor opens up the possibility of achieving better birth weight babies through nutritional programmes for young girls, in the long run. Mother's weight on the third day after delivery is taken as a proxy indicator for mothers' weight before pregnancy, as we have no direct measure of this. Our data show a clear association between low post-partum weight of the mother (below 25 centile) and LBW. This is supported by Table 17, which shows that in those subjects about whom we have data on weight during initial registration antenatal period, this relationship holds good. However, the mode of delivery - LSCS, assisted or normal - does not seem to make much difference in this proportion (Table 19).

Table 9 Distribution of subjects with respect to important parameters of the study, by place of delivery

Place of delivery		Age of mother	PARITY	GRAVIDA	BWei last l
SAT Hospital, Trivandrum	Mean	24.2	.59	1.77	280
	Std. Deviation	3.6	.66.	.86	556
	N	986	986	986	41
	Minimum	18.0	.00	1.00	106
	Maximum	39.0	3.00	6.00	500
MMM Hospital Kolenchery	Mean	26.1	.58	1.79	287
	Std. Deviation	3.7	.62	.86	488
	N	901	903	903	43
	Minimum	18.0.	.00	1.00	100
	Maximum	44.0.	3.00	6.00	410
All	Mean	25.1	.58	1.78	284
	Std. Deviation	3.8	.64	.86	523
	N	1887	1889	1889	84
	Minimum	18.0.	.00	1.00	100
	Maximum	44.0.	3.00	6.00	500

Table 10 Proportion of low birth weight (below 2500 grams) by place of delivery

		Low Birth Weight	Normal Birth Weight	Total
		1.00	2.00	
SATH	N	160	823	983
	%	16.3%	83.7%	100.0%
MMMH	N	124	776	900
	%	13.8%	86.2%	100.0%
All	N	284	1599	1883
	%	15.1%	84.9%	100.0%

Table 11 Age of mother and proportion of LBW

	Age of mother	20 and above	Below 20	All subjects
Normal birth weight	N	1519	75	1594
	%	85.0%	82.4%	84.9%
LBW	N	268	16	284
	%	15.0%	17.6%	15.1%
All subjects	N	1787	91	1878
	%	100.0%	100.0%	100.0%

Chi square= 0.27, p=NS

Table 12 Proportion of low birth weight (LBW: birth weight below 2500 gm) according to time of delivery

		Normal weight (above 2499 gm)	LBW (below 2500 gm)	Total
Full term	N	1437	199	1636
	%	87.8%	12.2%	100.0%
More than 14 days before expected	N	136	79	215
date of delivery	%	63.3%	36.7%	100.0%
All	N	1573	278	1851
	%	85.0%	15.0%	100.0%

Chi square=88.0,p<0.01

Table 13 Proportion of LBW according to parity

	Parity status	0	1	2	3	All subjects
Normal birth weight	N	775	695	120	6	1596
	%	82.5%	87.4%	86.3%	85.7%	84.9%
LBW	N	164	100	19	1	284
	%	17.5%	12.6%	13.7%	14.3%	15.1%
All	N	939	795	139	7	1880
	%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi square (trend)= 5.9, $p<0.05$

Table 14 Proportion of LBW according to gravida status

	Gravida status	1.00	2.00	3.00	4.00	5.00	6.00	All subjects
Normal birth weight	N	700	592	237	57	8	2	1596
	%	82.3%	87.1%	85.6%	93.4%	88.9%	100.0%	84.9%
LBW	N	151	88	40	4	1		284
	%	17.7%	12.9%	14.4%	6.6%	11.1%		15.1%
All subjects	N	851	680	277	61	9	2	1880
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi square (trend)=7.67,$p<0.01$

Table 15 Height of mother and proportion of LBW

		Height 25 centile and above	Height below 25 centile	All subjects
Normal birth weight	N	1262	304	1566
	%	87.0%	77.0%	84.9%
LBW	N	188	91	279
	%	13.0%	23.0%	15.1%
All subjects	N	1450	395	1845
	%	100.0%	100.0%	100.0%

Chi square=23.8,$p<0.01$

Table 16 Post delivery weight of mother and proportion of LBW

		Mother's weight 25 centile or above	Mother's weight below 25 centile	All subjects
Normal birth weight	N	1025	280	1305
	%	89.4%	75.7%	86.0%
LBW	N	122	90	212
	%	10.6%	24.3%	14.0%
All subjects	N	1147	370	1517
	%	100.0%	100.0%	100.0%

Chi square=42.5,p<0.01

Table 17 Weight of mother at first weighing during pregnancy and proportion of LBW

		Mother's weight equal to or more than 25 centile	Mother's weight less than 25 centile	All subjects
Normal birth weight	N	1181	283	1464
	%	87.9%	74.3%	84.9%
LBW	N	163	98	261
	%	12.1%	25.7%	15.1%
All subjects	N	1344	381	1725
	%	100.0%	100.0%	100.0%

Chi square=41.7,p<0.01

Table 18 Mother's weight gain during pregnancy and proportion of LBW

		Gain in weight equal to or more than 3 kg (25 centile)	Gain in weight less than (25 centile)	All subjects
Normal birth weight	N	686	215	901
	%	86.2%	83.7%	85.6%
LBW	N	110	42	152
	%	13.8%	16.3%	14.4%
All subjects	N	796	257	1053
	%	100.0%	100.0%	100.0%

Chi square=0.81, p=NS

Table 19 Type of delivery and proportion of LBW

		Normal	Assisted	LSCS	Breech	All sub jects
Normal birth weight	N	1129	101	358	10	1598
	%	84.1%	93.5%	85.9%	76.9%	85.0%
L BW	N	214	7	59	3	283
	%	15.9%	6.5%	14.1%	23.1%	15.0%
All sub jects	N	1343	108	417	13	1881
	%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi square=7.8,p<0.05

As stated earlier, all subjects had been registered during early pregnancy and were followed up to term. Therefore, we could not examine whether quality of antenatal care made a difference in birth weight, as they all received reasonable and uniform degree of care during pregnancy. However, their haemoglobin status at the time of first antenatal examination is another indicator of their nutritional and health status. We observed that 50 percent of women had a haemoglobin value below 11 gm, which is accepted as the cut-off level for anaemia during pregnancy. The fact that such a large proportion of women who avail of antenatal care in these two premier hospitals should be anaemic is a pointer to the large burden of morbidity underlying the generally rosy health statistics reported from Kerala. The 25th centile value for haemoglobin among these subjects, however, is 10.50 gm percent, indicating that though haemoglobin status is poor, there are very few women with very poor haemoglobin values. Low haemoglobin status, as shown by Hb below 25th centile, is also associated with LBW (Table 20). As these Hb values were taken early in pregnancy, we may presume that most of these women would have been administered corrective therapy in the form of iron and folic acid tablets. It would have been interesting to find out the average gain in haemoglobin during pregnancy, and whether this variable is associated with birth weight. Unfortunately, however, this could not be done because less than five percent of the women had a repeat haemoglobin value. This is also an indicator of the fact that though the antenatal coverage is good, quality of antenatal services leaves much to be desired even in the premier institutions in the State.

Table 20 Mother's haemoglobin status and proportion of LBW

		Mothers with Hb (Haemoglobin) equal to or above 10.5 gm percent (25 centile)	Mothers with Hb (Haemoglobin) below 10.5 gm percent (25 centile)	Total
Normal birth weight	N	1102	430	1532
	%	85.9%	83.3%	85.2%
LBW	N	181	86	267
	%	14.1%	16.7%	14.8%
All subjects	N	1283	516	1799
	%	100.0%	100.0%	100.0%

Chi square=1.71,p=NS

High blood pressure during pregnancy is another known predictor of high-risk pregnancies, and possibly, low birth weight babies. We categorised all women who were found to have high blood pressure (systolic BP >139 mm Hg/ diastolic BP >89 mm Hg) as high risk. We had five percent of our subjects who fell into this category. We found them also to have a higher risk for LBW, as shown in Table 21. Since the BP measurements were taken early in pregnancy, we presume that most of them would have received medical advice relating to their high blood pressure status. Hence what we saw was perhaps only the residual effect, after treatment for hypertension. Nevertheless, it is reassuring to know that high blood pressure in early pregnancy by itself does not contribute to the risk of LBW.

Table 21 Proportion of LBW among mothers recorded to have high blood pressure (systolic BP>139/ diastolic BP>89 mmHg)

		Normal blood pressure	High blood pressure	All subjects
Normal birth weight	N	1521	78	1599
	%	85.0%	83.0%	84.9%
LBW	N	268	16	284
	%	15.0%	17.0%	15.1%
All subjects	N	1789	94	1883
	%	100.0%	100.0%	100.0%

Chi Square=0.15,p=NS

Table 22 lists the most important variables associated with LBW and the risks that they carry. Among them, prematurity (gestational age <38 weeks), low height, and weight of the mother are the most important. Many of the others such as haemoglobin status during antenatal period and high blood pressure in the mother do not attain statistical significance in the Table. Both our regression models, though statistically significant, are poor predictors of outcome. The linear regression model (Table 23) has a modified R^2 of 0.137. In the logistic model, the prediction for LBW is as low as three percent. This tells us that we may not be capturing important factors that influence birth weight in our models. However, that both models come up with almost the same predictors of birth weight, gives us confidence that these are important, if not exclusively the most important, agents that can make a difference in the birth weight. Therefore, any intervention will have to focus on them. Of the two, the logistic model is preferable, since it gives us the risk estimates associated with the factors that may produce low birth weight. Table 24 shows that prematurity carries an almost four-fold increase in risk of LBW. Poor weight of the mother carries a risk of more than three times; short stature and parity both carry a two-fold risk for LBW according to the logistic model.

In the logistic model, we included as high-risk subjects, those mothers who were below the 25th centile in weight, and those who were below the 25th centile in weight. Thus, by definition, we had 25 percent of subjects in each of these risk categories. There were 35.4 percent of the subjects (670 out of 1892), who were in either one of these risk categories. If we add prematurity also to the list of risk factors, we had 805 out of 1892, or 42.5 percent of subjects, as falling in one of these three risk categories. This proportion increases to 72 percent, (1363/1892), if we were to include parity = 0 as yet another risk category. In other words, almost three out of four of our subjects fell into one or the other of the high-risk categories predicted by the logistic model. We can surmise that if we focus on the ones amenable to intervention, viz., improving the height and weight of the mother and preventing premature delivery, we can reduce this proportion of high-risk mothers to almost one in four. This may be a worthwhile goal to strive for.

Table 22 Univariate analysis of the influence of important risk factors

Risk category	Reference category	N
Age of mother <20 years	Age of mother>19	1878
Gestational age less than 38 completed weeks	Gestational age 38 completed weeks or more	1851
Height of mother less than 25 centile of distribution (149cms)	Height of mother 25 centile or above	1845
Weight of mother (post delivery) less than 25 centile (49kgs)	Weight of mother (post delivery) 25 centile or above	1517
Weight of mother at first weighing during pregnancy below 25 centile	Weight of mother at first weighing during pregnancy 25 centile or above	1725
Mother's weight gain during pregnancy below 25 centile	Mother's weight gain during pregnancy 25 centile or above	1053
Mother's hemoglobin below 25 centile (10.5 gm)	Mother's haemoglobin 25 centile (10.5 gm) or above	1799
Mother's blood pressure high	Mother's blood pressure not high	1883

Conclusions and policy implications

We started our study with two assumptions:

(i) In Kerala, in spite of many other health indices being very positive, the high prevalence of low birth weight stands out as an indicator of morbidity demanding correction, and

(ii) The State having achieved a demographic transition, the demographic causes of LBW, such as adolescent pregnancies, high birth order (beyond 3), very short birth interval, and pregnancy among elderly women have been eliminated as possible risk factors for LBW. Our investigation supports these two assumptions. There is a comparatively high proportion of LBW babies born, even in the best of circumstances. The principal risk factors for these relate to the mother's nutritional status before pregnancy: her weight and height. First-born children, having an inherent chance for LBW, also contribute to the risk. Premature birth, even 15 days before the expected date, seems to be an important contributing factor.

From the policy angle, the scope for intervention seems to be limited. When the State has already accepted a limited family size as desirable, the proportion of first-born children is likely to remain the same or even increase. Mother's weight and height are intimately related to her previous nutritional status; therefore, any intervention at this level should be targeted to the next generation of mothers, who are children or adolescents. It is possible that the present generation of young girls, who are likely to have an average calorie intake higher than that of their mothers, may give birth to heavier babies. Thus an improvement in the birth weight distribution in Kerala may, possibly, take place over a longer duration of time, giving rise to a 'generation' effect. Even in the present data set, we note that babies with birth weight below 2000 gm, the very low birth weight, are hardly 2 percent: these babies are at very high risk for survival. The very low prevalence of this group is encouraging.

We have to investigate the causes for premature delivery to see if any of these is avoidable. Delivery before 38 completed weeks is the single-most important reason for low birth weight, increasing the risk almost four-fold. We have not been able to pinpoint any medical or non-medical causes for prematurity in the sample.

This study also throws up an interesting insight. Statistics show that Kerala has already achieved an infant mortality level, which is quite low in comparison with its level of development. Reliable data from recent years suggest that it is as low as 12/1000 among rural and 15/1000 among urban births. If this low level of infant mortality is compatible with a low birth weight proportion in the region of 15-20 percent, perhaps we should not be too worried about LBW *per se* as an important indicator of infant morbidity.

Table 23 Variables in final model of linear regression for predictors of birth weight

	Unstandardied Coefficients	**SE**	**Standardized Coefficients**	**t**	**Sig.**
(Constant)	1154.54	293.9		3.93	.000
Mother's weight on 3rd day after delivery	11.87	1.41	0.24	8.45	.000
Prematurity	-257.43	40.1	-0.167	-6.434	.000
Mother's height	8.29	2.02	0.116	4.1	.000
GRAVIDA	69.68	13.11	0.139	5.314	.000

Dependent Variable: BIRTHWEIGHT Adjusted R2=0.137

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	31252945	4	7813236.26	52.07	.000
Residual	1.92E+08	1282	150051.70		
Total	2.24E+08	1286			

Predictors: (Constant), MOTWGT, PREMAT, GRAVIDA, HEIGHT
Dependent Variable: BIRTHWGT

Table 24 Variables in the final logistic regression model for prediction of LBW

Variable	Risk category	B	S.E.	Wald	df	Sig.	Risk ratio
Mother's weight on 3rd day after delivery	Below 25th centile (49kg)	1.18	0.22	27.85	1	.000	3.26
Mother's height in cm	Below 25th centile (149cms)	0.61	0.24	6.77	1	.009	1.85
Prematurity	Born more than 15 days before the expected date of delivery	1.41	0.32	19.82	1	.000	4.10
Parity	Parity=0	0.55	0.22	6.04	1	.000	1.73
Constant		-6.69	0.70	92.23	1	.000	

Chi-square for model=66.3,df=4,p<0.001 R2 (Cox and Snell)=0.076, prediction for LBW=3 percent

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