A Multi-Hospital-Based Study of the Prevalence of and Factors associated with Low Birth Weight in Nepal

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Executive summary

Birth weight is an important determinant of an infant's survival and future development. It also reflects a mother's health and nutrition and the care she receives during pregnancy. Low birth weight (LBW) predisposes a baby to early death, illnesses in infancy and childhood and impediments to normal development. Estimates of the prevalence of LBW in Nepal have ranged from 14% in community-based studies to 32% in hospital-based ones. The present study was undertaken in four major hospitals – one in each of four of the country's five development regions – in order to provide estimates that would reflect the true prevalence of LBW in Nepal. The study also identified major risk factors associated with LBW and possible intervention strategies to improve the country situation.

The prevalence of LBW ranged from 20.4% at the Maternity Hospital, Kathmandu, to 34.7% at Koshi Zonal Hospital, Biratnagar, with a weighted mean of 27.2% for all four sites. The prevalences at Western Regional Hospital, Pokhara and Bheri Zonal Hospital, Nepalgunj were 22.3% and 26.0% respectively. The majority of LBW infants were born at term, indicating that intrauterine growth retardation makes a major contribution. The ratio of preterm to term LBW ranged from 18:82 at the Maternity Hospital, Kathmandu, to 39:61 at Koshi Zonal Hospital, Biratnagar, with a weighted mean of 31:69 for all four sites.

Bivariate analysis revealed low maternal weight, height and body mass index, birth of a previous preterm infant and a birth interval of less than two years as the top five factors associated with LBW. Primiparity, adolescent motherhood, maternal illiteracy, rural residence and minimal antenatal care were also implicated. In multivariate analysis, the effects of some factors such as adolescent pregnancy and maternal illiteracy were substantially reduced. Overall, the strongest effects on LBW were seen for maternal weight, previous preterm delivery, short birth interval and paternal employment in agriculture.

The overall prevalence of LBW at 27% is high and deserves urgent attention and reduction. For some risk factors such as ethnic group, place of residence, paternal work, primiparity and previous preterm birth, very little can be done. Others – such as maternal stunting – are difficult to address in the short term but would be amenable to change over a longer period. Short term intervention strategies should target risk factors such as maternal anaemia, adolescent pregnancy, lack of antenatal care, low weight, illiteracy and birth spacing.

Another important issue is the care of LBW babies. As over a quarter of all infants are born LBW, and as 75% of neonatal deaths occur in this group, appropriate care for LBW infants becomes important if Nepal's present high neonatal and infant mortality rates are to be reduced. Training of medical and paramedical staff and provision of low cost special care facilities for babies should be commenced as soon as possible, particularly in zonal and regional hospitals. Since over 90% of babies are born at home, it is also important to help primary care providers including mothers and their relatives with knowledge about the care of LBW babies, and to stimulate use of referral facilities when they are needed.

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1 Introduction.

1.1 Low birth weight: nature and definition.

Concerns about low birth weight (LBW) are becoming increasingly prominent in discussions of public health in low income settings. This is partly because of the decline in postneonatal mortality that has been seen in many countries, which has meant that neonatal death has come to dominate the picture [1]. It may also be because the role of LBW in early death and later disease has only recently been addressed. There have been many studies over the last two decades to strengthen the conviction that LBW is a key aetiological factor in neonatal mortality [2-4], but there has also been a steady accumulation of evidence that it plays a part in later illness and death [5]. The duration of its effects is almost certainly lifelong: LBW infants probably go on to be at increased risk of infectious disease illness in childhood [6-8] and their potential for growth is limited all the way into adulthood [9-11]. Their cognitive development may be restricted, making them less able to function in society as children and adults [12-17]. What is more, it seems likely that LBW infants are at higher risk of dying in adulthood from cardiovascular disease such as hypertensive stroke and myocardial infarction. These findings have arisen from work on fetal programming, which has escalated in recent times and which suggests that babies who experience intrauterine growth retardation (IUGR) progress through life at higher risk of hypertension, suboptimal glucose tolerance and hyperlipidaemia [18-34].

LBW is currently defined as a weight of less than 2500g within the first 24 hours after birth. There are two important aspects of this definition that should be borne in mind. First, an infant who weighs 2500g is not LBW, while one who weighs 2499g is. Second, the definition takes no account of gestation. Clearly, a preterm baby is more likely to be LBW than a term baby because of growth in utero, and the relative contributions of preterm and term to the total burden of LBW have been much discussed. It seems that, in developing countries, the majority of LBW infants are born at term, while in industrialised countries the majority are preterm [35 36]. What this means in general terms is that the tendency to IUGR (and thus a baby who is born on time but small) is much greater in the developing world.

The background to IUGR is only partially clear, but what is clear is that most of the predispositions to it are bound up with mothers and their wellbeing over the whole life cycle. Some of these issues will be discussed in the section on risk factor analysis. Similarly, while preterm birth accounts for the minority of LBW in developing countries, it is still more common than in the industrialised world and there is likely to be crossover of at least some of the risk factors for IUGR with those for early labour and delivery.

1.2 Low birth weight in South Asia.

Since LBW is intimately related to the wellbeing of mothers and the communities in which they live, its prevalence in populations has been used as an index of public health and socioeconomic development. Several published studies have looked at the information available on LBW prevalence in various countries. What is clear is that the burden of the problem falls on southern Asia. Of over 21 million LBW infants born every year in the world, around 12 million are born in South-central Asia (Table 1.1). The reasons for this must lie in the general health, reproductive health, nutrition and workload of women on the subcontinent, and strategies for reducing the burden are currently being assessed. The figures quoted in Table 1.1 are a general guide, but they have been produced after weighting a limited amount of information from a limited number of sources. Only 33 of the 47 Asian countries actually contribute to the estimates, Nepal being one of those omitted.

Table 1.1 Prevalence of LBW worldwide, with an emphasis on Asia.

Region	LBW prevalence (%)		Number of LBW infants per year (thousands)	
	1990	*1995*	*1990*	*1995*
World	17	15	24 717	21 313
Developing	19	16	23 600	20423
Developed	7	6	1 117	890
Africa	15	*	4 167	*
Asia	22	18	18 031	14 911
Eastern	7	6	2 292	1 339
South-eastern	18	10	1 924	1 308
South-central	34	28	13 306	11 833
Western	12	8	508	431
Latin America	13	12	1 363	1 370

1990 figures based on WHO 1992 [37].
1995 figures based on WHO 1998 [38].
* coverage of births was not sufficient to derive figures.

Statistics, however, can only tell part of the story. Indeed, since the ability to collect information at community level parallels other aspects of development, it may be that the quality of such information is lowest in those areas with the biggest LBW problem. In order to quantify LBW, it is necessary to know when women are pregnant, know when they are due to give birth, succeed in reaching them within 24 hours of the births of their babies, weigh the babies accurately and reliably, record the results in a reproducible form, communicate these results to a collection point and then make them available at national and international level. This would be no small achievement in any society, but in countries such as Bangladesh and Nepal where over 90% of women deliver at home, most after minimal antenatal care, the process becomes forbidding.

1.3 Sources of information on low birth weight.

In practical terms, the available information on LBW comes from one of three sources:

1. Large surveys or censuses where birth weight is recorded by:
   - Direct measurement.
   - A proxy such as chest circumference.
   - A proxy such as mother's recollection of size at birth.

2. Smaller studies in sample communities where birth weight is recorded by direct measurement.

3. Hospital-based studies where birth weight is recorded by direct measurement. This may or may not be part of the routine collection of statistics.

Examples of data collected by each of the above methods are available: the figures in Table 1.2 have been derived using just such a mosaic of studies. The estimates of LBW prevalence show wide variation. This does not mean that they are incorrect, merely that generalisation is difficult.

Table 1.2 LBW prevalence in South Asia.

Country	Range in published studies (%)	Cited estimate of LBW prevalence* (%)
Bangladesh	23 – 60 [39]	50
Bhutan	35 – 44	
India	24 – 40 [40 41]	33
Maldives		25
Nepal	14 – 32 (see Table 1.3)	
Pakistan	18 – 34 [42 43]	25
Sri Lanka		25

* Figures in the cited estimates column are from the UNICEF database, quoted in serial publications [44]. Table adapted from a previous review of LBW in South Asia [45].

The immediate question that arises from the convenience-based nature of the information is that of representation. How far are the available data representative of the true situation in a country? Less developed communities are likely to show higher levels of LBW, but data collection within them is likely to be more difficult. Even small studies which attempt to seek out high risk areas are likely to be more expensive in terms of finance, transport and personnel than studies in more accessible areas.

There is also the question of reliability and validity. How reliable are proxies for LBW – such as chest circumference or mothers' recall of baby size - as identifiers of the problem [46]? What of the fact that any adjustments that need to be made to the results of proxy measurements may be different in different settings? These hindrances to extrapolation are not necessarily avoided by technology. The measurement of infant weight is not a simple task: interviewers need to be able to standardise their technique and recording. The difference between a LBW infant and one who is not LBW is – as already mentioned – the difference between 2499g and

2500g. How many decimal places will the available scale present and how many will be recorded? How accurate are figures when they have been rounded up or down by different interviewers? Problems such as these have been encountered in many data collection systems.

It is easy, however, to become entangled in these issues and to lose sight of primary motives. These may be framed as follows:

1. LBW in South Asia is a major health problem.

2. Quantification of LBW prevalence is important as a guide for policy and intervention.

3. It is necessary to estimate the size of the problem in different places with a *reasonable* level of accuracy.

4. The cut-off point for LBW (2500g) is to some extent a matter of convenience.

1.4 Low birth weight in Nepal.

Despite steady improvements, Nepal's children face major obstacles to a healthy life. The Infant Mortality Rate (IMR) is 79 per thousand live births, the Neonatal Mortality Rate (NMR) is 50 and the Under-Five Mortality Rate (U5MR) is 118 per thousand. Only 9% of the population live in urban areas [47]. Women marry at a mean age of about 17 years and 51% have begun childbearing by 19 years: 12% of 19 year olds have already had two children, for whom NMR is higher than others. 48% of married urban women have no education, a figure which reaches 83% in rural areas (all figures from Nepal Family Health Survey, 1996 [48] unless otherwise noted).

While it has been assumed that the prevalence of LBW in Nepal to some extent echoes that in adjacent countries – an assumption borne out by subjective experiences – data remain scanty. There is no estimate of LBW prevalence in major UNICEF serial publications. For the local information that does exist, two methods of estimation have been employed: survey data based on maternal recall of infant size at birth, and isolated estimates based on hospital data. Details of these studies are presented in the subsequent discussion.

Collection of data at household level would be optimal. Only 7.6% of Nepal's deliveries occur in institutions, and only about 10% are attended by medical staff [48]. The realities of home birth monitoring in the present situation, however, make studies time-consuming and expensive. It was for these reasons that the present study was conceived by UNICEF Nepal and MIRA. The aim was to establish birth weight for four groups of infants born simultaneously in different centres throughout Nepal. The resulting information would stimulate recommendations for intervention and further studies.

2 The study.

2.1 Objectives of the study.

The study protocol specified the following objectives:

1. To assess the prevalence of LBW in four major hospitals representing four of Nepal's five development regions.

2. To study factors associated with LBW in the context of these four Nepalese sites.

The specific questions to be addressed were:

1. What is the mean birth weight at each site and on aggregate?

2. What is the prevalence of LBW at each site and on aggregate?

3. What are the relative contributions of preterm and term to total LBW prevalence?

4. Is there variation in LBW prevalence between the sites?

5. What associations are there between LBW and maternal anthropometric, socioeconomic, healthcare, cultural and demographic factors?

6. Do these factors vary in importance between the sites?

7. What are the policy implications of the findings?

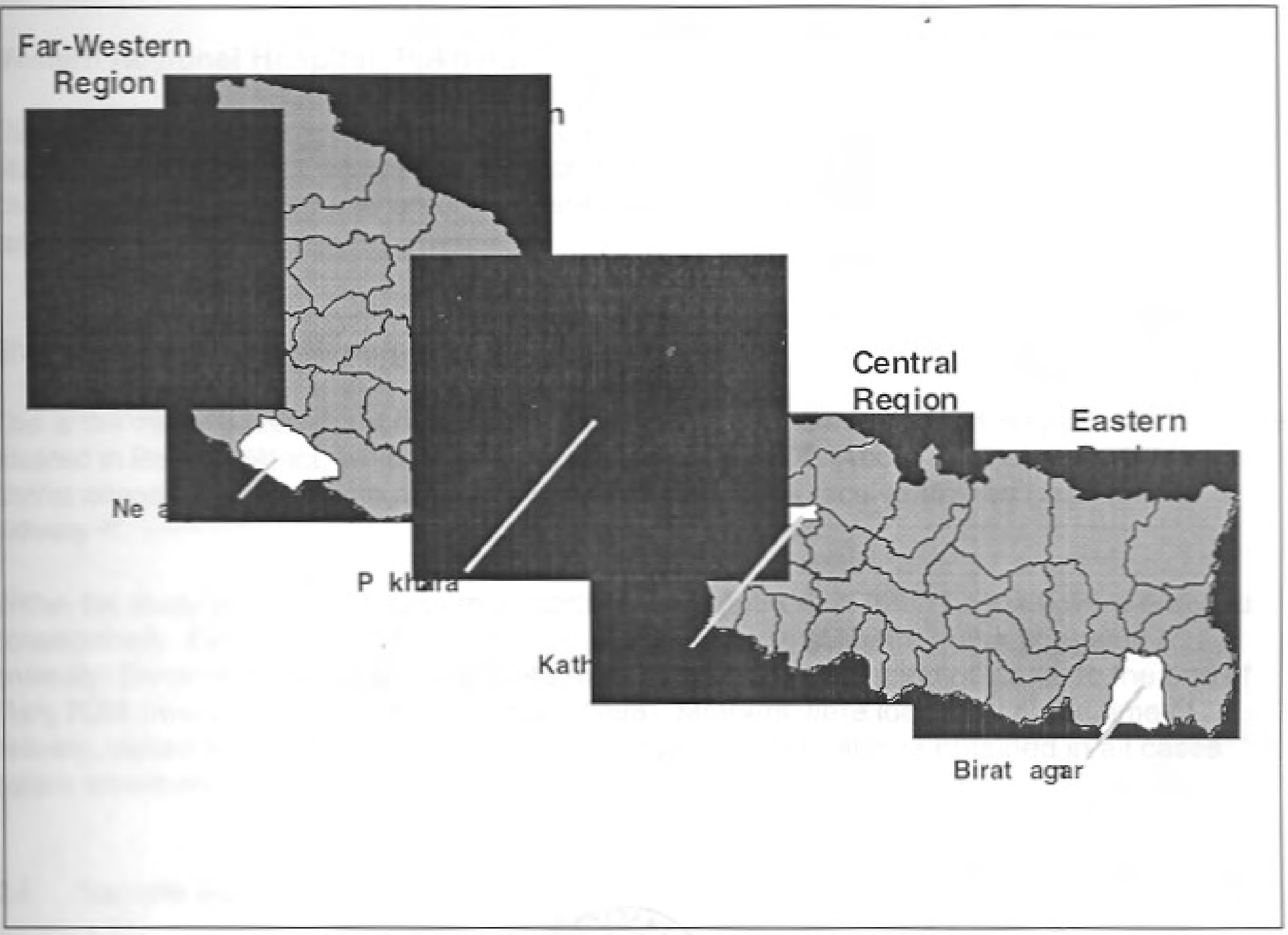
2.2 Study design.

The protocol specified the prospective recruitment of cohorts of infants as they were born at four sites, measurement of birth weights and collection of responses to a maternal questionnaire. Maternal anthropometry would also be documented at enrolment.

2.3 Sites and participants.

Data were collected at the four sites shown in Figure 2.1, for two consecutive months in 2055 (1998).

Figure 2.1 Sites of data collection.



Paropakar Shree Panch Indra Rajya Laxmi Devi Prasuti Griha Maternity Hospital, Kathmandu ("Prasuti Griha").

This is the largest maternity hospital in Nepal and is located in Kathmandu in the Central Development Region. The hospital draws its users from three districts in the Kathmandu Valley: Kathmandu, Lalitpur and Bhaktapur. Kathmandu district itself has a population of 675 000. Adding to this the totals for the other two districts, the catchment population is of the order of 1.1 million. About 12% of women in Kathmandu district attend for at least one antenatal care visit, and 7.5% receive trained help during delivery [48]. In the hospital itself, about half of the women attending for delivery have received antenatal care.

Koshi Zonal Hospital, Biratnagar.

This is the major government hospital for the Eastern Development Region. Biratnagar is situated in Morang district, which has a population of 675 000. About 17% of women in Morang district attend for at least one antenatal care visit and 1.5% receive trained help during delivery [49].

Western Regional Hospital, Pokhara.

This is the major government hospital for the Western Development Region. Pokhara is situated in Kaski district, which has a population of 293 000. About 39% of women in Kaski district attend for at least one antenatal care visit and 3.5% receive trained help during delivery [49].

Bheri Zonal Hospital, Nepalgunj.

This is the major government hospital for the Mid-Western Development Region. Nepalgunj is situated in Banke district, which has a population of 286 000. About 19% of women in Banke district attend for at least one antenatal care visit and 3.8% receive trained help during delivery [49].

Within the study period, infants born to participating mothers in each hospital were enrolled consecutively. Exclusion criteria were: multiple pregnancy; stillbirth; major congenital anomaly. Enrolment ran for two complete months from the beginning of Kartik to the end of Marg 2055 (mid-October – mid-December 1998). Mothers were identified at the time of delivery, visited within 24 hours in all cases and verbal consent was obtained in all cases before enrolment.

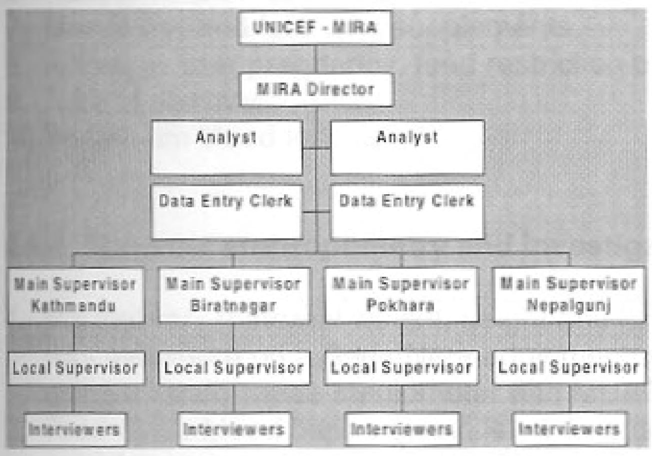
2.4 Sample size.

Sample size was estimated in advance with two objectives. Firstly, the projected sample size required to estimate mean birth weights and LBW prevalences. Secondly, the projected sample size required to ensure an adequate frequency of observations in each cell of an analytical famework containing four potential risk factor variables. The projections suggested a sample size of about 2700 infants. The necessary time to reach this figure was calculated on the basis of documented hospital birth rates and a period of two months was agreed upon. In practice, the study period was sufficient to meet this aim and exceed it.

2.5 Data collection.

At each site, data were collected by designated interviewers recruited from the midwifery staff. These primary interviewers were managed by local supervisors, who checked on progress and data quality. The local staff were in turn trained and monitored by main supervisors delegated from the MIRA panel. These main supervisors made site visits, trained the local supervisors and interviewers in the required anthropometric techniques and questionnaire completion and monitored their progress. The personnel framework is summarised in Figure 2.2.

Figure 2.2 Organisation of the study.



Data were recorded on a preprinted form developed in Filemaker Pro 2.0v2 for Macintosh (Claris Corporation, USA). The pro forma is appended in Annex B.

2.6 Content of data collection.

2.6.1 Socioeconomic and demographic characteristics of mothers and their families, together with potential environmental and habitual risk factors for LBW.

1. Maternal age.
2. Rural or urban residence.
3. Maternal and paternal occupations.
4. Maternal education.
5. Ethnic group.
6. Smoking and alcohol use.
7. Cooking fuel and ventilation in the kitchen.

2.6.2 Details of previous pregnancies.

1. Ongoing medical illness.
2. Previous stillbirth, neonatal death or preterm delivery.

2.6.3 Details of the index pregnancy.

1. Parity.
2. Dates.
3. Birth spacing.
4. Pregnancy-related illness.
5. Uptake of antenatal care.
6. Receipt of tetanus toxoid
7. Use of iron and folic acid supplements.
8. Activity in later pregnancy, food restriction or augmentation.
9. Type of delivery.
10. Peripartum blood loss.

2.6.4 Maternal anthropometry and investigations.

1. Postdelivery maternal weight, height and mid-upper arm circumference (MUAC). Weight was measured on a Seca Nera adult mechanical scale with an accuracy of 1 kg, height using a locally made stadiometer and MUAC with a standard inelastic plastic tape.
2. Predelivery blood haemoglobin level. In order to keep our findings comparable, blood samples were taken on admission for delivery. Haemoglobin concentration was estimated using the HemoCue method (HemoCue AB, Angelhom, Sweden) in Kathmandu. At the other three sites, estimation was carried out by the standard colorimetric method common to all blood banks in Nepal.

2.6.5 Infant anthropometry.

1. Birth weight, length and head circumference. Weight was measured on a Globe Brand mechanical scale with an accuracy of 50g, height using a locally made infantometer and head circumference with an inelastic plastic measuring tape.

2.6.6 Infant sex and wellbeing.

1. Infant sex.
2. Neonatal illness and condition at discharge from hospital.
3. Method of feeding.

2.7 Data handling.

The information gathered was entered directly onto paper forms by interviewers. These forms were checked and collated by local supervisors and sent to Kathmandu for further treatment. The responses to items on each form were entered into a microcomputer database in Epi Info 6 for Windows (CDC, USA and WHO, Switzerland). Range checks and cleaning were carried out and the data were transferred into SPSS (SPSS Inc., USA. Release 6.1.3, 1995 for Windows) and Intercooled Stata 5 for Power Macintosh (Stata Corporation, USA) for further checking and analysis. The main outcomes were expressed as measures of central tendency for continuous variables and proportions for categorical variables. Bivariate analysis for associations was by means of risk ratio statistics, and multivariate analysis employed multiple logistic regression.

After the initial phase of evaluation and basic analysis, a workshop was convened to discuss approaches and key issues for further analysis. The resulting recommendations were considered and adopted for the data analysis and presentation. The process is summarised in Annex D.

3 Study results.

The study enrolled 3636 mother-infant pairs, 2283 in Kathmandu, 704 in Pokhara, 453 in Biratnagar and 196 in Nepalgunj.

3.1 Baseline characteristics of the cohorts.

This section presents a summary of the results of the questionnaire and illustrates the variation between sites in four groups:

11. Socioeconomic and health factors.
12. Factors related to previous pregnancies.
13. Factors related to the index pregnancies.
14. Factors related to demography and nutrition.

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3.1.1 Socioeconomic and health factors.

The findings are summarised in Table 3.1.

Table 3.1 Baseline findings: socioeconomic and health factors.

Factor	Categories	Kathmandu %	Biratnagar %	Pokhara %	Nepalgunj %
Mother's education	Illiteracy	35	33	12	47
	Primary school	30	22	25	27
	Secondary school	23	26	44	21
	Higher education	12	19	19	5
Mother's occupation	Housewife	84	94	79	95
	Business	2	1	6	1
	Service	4	4	6	1
	Daily wage	1	0	1	3
	Agriculture	6	1	6	0
	Other	3	0	2	0
Father's occupation	Daily wage	10	18	13	9
	Business	20	19	22	19
	Service	42	42	44	41
	Agriculture	15	18	14	20
	Other	13	3	7	11
Residence	Rural	34	42	44	62
	Urban	66	58	56	38
Ethnic group	Brahmin	18	31	32	25
	Chhetri	24	11	23	25
	Newar	30	5	7	4
	Magar	4	2	8	3
	Rai or Limbu	4	2	1	1
	Gurung	2	0.5	15	1
	Tamang	4	0.5	1	0
	Other	14	48	13	41
Smoking		4	1	3	6
Alcohol use		14	2	1	5
Cooking fuel	Gas	16	20	38	13
	Kerosene	69	37	32	33
	Firewood	15	43	30	54
Kitchen	Ventilated	91	85	99	69

About half of the women in Nepalgunj were illiterate, as were a third of women in Kathmandu and Biratnagar, whereas only 12% were illiterate in Pokhara. Women living in Pokhara were most likely to have attended school, 44% of them to secondary level. The definition of occupation for women in Nepal and analogous settings has proved difficult. The vast majority of women defined their occupation as "housewife". Within this definition, a range of physical activity and tasks is possible. Paternal occupation, on the other hand, was evenly distributed and showed little variation between the sites. 15-20% of men were primarily engaged in agriculture and 40% in service occupations. Between 35% and 60% of families were resident in rural areas, the distribution of the figures reflecting the degree of urbanisation of the catchment areas of the study hospitals. The ethnic group distribution reflected the different sample sites. Smoking and alcohol use were relatively uncommon in the respondents. Site differences were reflected in the use of cooking fuel: half of Nepalgunj respondents used firewood, while 70% of Kathmandu respondents used kerosene. Similarly, women in Nepalgunj were much less likely to work in ventilated kitchens.

3.1.2 Factors related to previous obstetric experience.

The findings are summarised in Table 3.2.

Table 3.2 Baseline findings: previous obstetric experience.

Factor	Kathmandu %	Biratnagar %	Pokhara %	Nepalgunj %
Previous stillbirth	2	3	3	6
Previous neonatal death	1	4	3	12
Previous termination	3	<1	4	0

It appears that stillbirth, neonatal death and previous termination of pregnancy were relatively uncommon in the sample groups.

3.1.3 Factors related to the index pregnancy.

The findings are summarised in Table 3.3.

Table 3.3 Baseline findings: the index pregnancy.

Factor	Categories	Kathmandu %	Biratnagar %	Pokhara %	Nepalgunj %
Infant sex	Female	48	47	43	45
	Male	52	53	57	55
Birth spacing	< 2 years	10	22	27	26
Antenatal care (Number of visits)	None	17	12	9	16
	1 – 2	10	29	17	44
	3 – 4	37	30	23	35
	More than 4	36	29	51	5
Parity	Primipara	53	55	54	53
	Multipara	45	41	38	35
	Grand multipara	2	4	8	12
Tetanus toxoid (Number of doses)	None	19	9	11	8
	1	9	9	16	10
	2	69	74	59	77
	More than 2	3	8	14	5
Pregnancy complications*		2	8	1	3
Blood loss	Normal	88	97	79	88
	Moderate	9	2	20	11
	Severe	3	1	1	1
Activity in later pregnancy	Usual	64	86	54	97
	Moderate	34	13	44	2
	More than usual	2	1	2	1
Food during pregnancy	Extra food	32	12	3	4
	Restricted food	1	4	2	6
Iron supplementation (Duration)	None	24	34	26	50
	1 month	9	20	24	22
	2 – 3 months	39	23	26	26
	Over 3 months	28	23	24	2

* Pregnancy-induced hypertension, pre-eclamptic toxaemia, eclampsia and antepartum haemorrhage

The infant sex differential was consistent across the sites. Between 10% and 26% of infants were born less than two years after the birth of a previous infant. Such short birth spacing is a risk factor for LBW, and up to a quarter of infants are therefore at risk.

Levels of antenatal care usage showed variation: half of women in Pokhara had attended more than four times during the index pregnancy. This level of attendance fell across the other sites, to a minimum of only 5% in Nepalgunj. Interestingly, the percentage of women who had had no antenatal care was more consistent, varying between 9% and 17%. The NFHS found that 56% of women received no antenatal care and that about 9% had four or more visits [48], while the NMIS Fifth Cycle found that 76% of women had no antenatal care and that 8% had four or more visits [50].

Just over half of women were delivering their first baby. Comparing the figures as above, both the NFHS and NMIS Fifth Cycle found that half of women had not had any tetanus toxoid during the pregnancy. The current figures suggest that in the sample groups, 80-90% had received at least one dose.

Less than 10% of women experienced major complications of pregnancy, and between 10% and 20% experienced moderate or severe blood loss in the perinatal period. Physical activity during pregnancy was maintained by the vast majority of women in Biratnagar and Nepalgunj, but there was evidence of a greater tendency to reduce activity in both Kathmandu and Pokhara. Likewise, a third of women in Kathmandu said that they took extra food during pregnancy; this was not echoed by women from the other sites.

Between a quarter and a half of all women did not take iron supplements during the pregnancy, and around a quarter took them for longer than three months. The most noticeable feature of this and the other distributions is the clustering of higher uptake of health services and lower risk behaviours in centres such as Kathmandu and Pokhara compared with the less urbanised picture in Nepalgunj.

3.1.4 Factors related to demography and nutrition.

The findings are summarised in Tables 3.4 and 3.5. The economic, social and cultural situations within which women live are reflected in nutritional status. Nutrition has short and long term effects on anthropometric indicators, and transgenerational effects on the infant both before and after birth.

Table 3.4 Baseline findings: demographic and nutritional factors (1).

Factor	Kathmandu	Biratnagar	Pokhara	Nepalgunj
Mean maternal weight in kg (95% ci)	49.9 (49.70 – 50.20)	51.6 (50.94 – 52.30)	48.8 (48.34 – 49.30)	47.3 (46.49 – 48.13)
Mean maternal height in cm (95% ci)	153.2 (152.95 – 153.43)	150.9 (150.18 – 151.55)	152.2 (151.76 – 152.66)	152.3 (151.46 – 153.20)
Mean maternal Hb in g/dl (95% ci)	11.4 (11.30 – 11.44)	10.5 (10.35 – 10.61)	10.9 (10.72 – 10.99)	9.5 (9.30 – 9.78)

Mothers' weight and height were normally distributed in the samples and are summarised using mean values. Women's weights were significantly different between the four sites. In general, mean predelivery weight was around 50 kg. However, women in Nepalgunj had a mean weight of 47 kg. Height tends to reflect longer-term nutrition, and there was evidence of a tendency for women to be taller in Kathmandu, at 153 cm.

Maternal blood haemoglobin values were also normally distributed, and again the mean level of 9.5 g/dl in Nepalgunj is significantly lower than in other groups. The level of 11.4 g/dl in Kathmandu is likewise significantly higher.

Table 3.5 Baseline findings: demographic and nutritional factors (2).

Factor	Kathmandu %	Biratnagar %	Pokhara %	Nepalgunj %
Adolescent mother (< 20 yrs)	17	16	18	23
Low BMI (< 18.5)	9	5	13	18
Anaemia (blood Hb < 11 g/dl)	39	58	40	80
Maternal height < 148 cm	13	23	20	12
Maternal weight < 45 kg	15	12	20	25

Important results are summarised in Table 3.5, using cut-off points for clarity.

- Conception at a young age is a well-known risk factor for LBW, and about one fifth of mothers in the sample were teenagers.
- Height and weight are combined in body mass index (BMI: weight/square of height). About 10% of women have a low BMI (almost 20% in Nepalgunj).
- Anaemia is a major problem. In the best case samples – Kathmandu and Pokhara - 40% of women are anaemic around the time of delivery according to WHO guidelines. In the worst – Nepalgunj – the figure reaches 80%.
- Using a cut-off point of 148 cm, 10-23% of women are of short stature.
- Using a cut-off point of 45 kg, about one fifth of women are underweight.

3.1.5 Summary of baseline findings.

Table 3.6 summarises important findings for women in the four study cohorts. Poor education, an agrarian lifestyle, poor nutrition, early conception, limited birth spacing and low levels of antenatal care are all evident from the figures.

Table 3.6 Key baseline findings for women in the four cohorts.

Findings (See previous for definitions)	Kathmandu (%)	Biratnagar (%)	Pokhara (%)	Nepalgunj (%)
Illiteracy among mothers	35	33	12	47
Rural residence	34	42	44	62
Fathers working in agriculture	25	36	27	29
Adolescent mothers	17	16	18	23
Mothers with low weight	15	12	20	25
Mothers with short stature	13	23	20	12
Mothers with low BMI	9	5	13	18
Anaemic mothers	39	58	40	80
First time mothers	53	55	54	53
Birth interval under 2 years	10	22	27	26
Minimal antenatal care (0, 1 or 2 visits)	27	41	26	60

3.2 Birth weight and low birth weight.

Since there were differences between the numbers of infants enrolled at each site, the data have been presented both in site-specific form and after weighting to generate composite estimates of mean birth weight and LBW prevalence. The weighting was achieved with correction factors for each site derived to make the site-specific figures comparable on a one-to-one basis.

3.2.1 Mean birth weight.

Birth weight was normally distributed in all the cohorts. Table 3.7 shows that there were differences between mean birth weights at the different sites, from a maximum of 2.84 kg in the Pokhara cohort to a minimum of 2.68 kg in the Biratnagar cohort. The weighted mean birth weight for the study overall was 2.77 kg.

Table 3.7 Mean birth weights for the study cohorts.

Site	Total infants	Mean birth weight in kg *(sd)*	95% confidence interval for mean	Interquartile range
Kathmandu	2283	**2.83** *(0.44)*	2.82 – 2.85	2.5 – 3.1
Biratnagar	453	**2.68** *(0.47)*	2.63 – 2.72	2.5 – 3.0
Pokhara	704	**2.84** *(0.48)*	2.80 – 2.87	2.5 – 3.2
Nepalgunj	196	**2.78** *(0.49)*	2.71 – 2.85	2.5 – 3.0
Weighted mean		**2.77**		

3.2.2 Low birth weight prevalence.

The prevalence of low birth weight was 20% in Kathmandu, 22% in Pokhara, 26% in Nepalgunj and 35% in Biratnagar (Table 3.8). The overall weighted prevalence was 27%.

Table 3.8 **Prevalence of LBW for the study cohorts.**

Site	LBW Number	LBW prevalence (%)	95% CI for prevalence (%)
Kathmandu	466	**20.4**	18.76 – 22.06
Biratnagar	157	**34.7**	30.28 – 39.04
Pokhara	157	**22.3**	19.23 – 25.37
Nepalgunj	51	**26.0**	19.88 – 32.16
Weighted proportion		**27.2**	

The weighted mean birth weight of female infants was 2.71 kg, lower than the mean birth weight for males at 2.81 kg. Similarly, the prevalence of LBW in females was 26% and in males 20%.

Table 3.9 **Mean birth weights for female and male infants.**

Infant sex	Mean birth weight *Unweighted* (kg)	sd	Mean birth weight *Weighted for site* (kg)	LBW prevalence (%)
Female	2.77	0.44	2.71	26
Male	2.85	0.47	2.81	20

LBW may be the result of preterm birth or intrauterine growth retardation leading to LBW at term (or a combination of both). Table 3.10 compares preterm LBW with term LBW. Gestational age was calculated using the last menstrual period technique.

Table 3.10 Contribution of preterm and term LBW to total LBW.

Site	Preterm LBW (n)	Term LBW (n)	Preterm : Term (%)
Kathmandu	85	381	18:82
Biratnagar	36	121	23:77
Pokhara	26	131	17:83
Nepalgunj	20	31	39:61
Weighted mean	**31**	**69**	**31:69**

Overall, about 70% of LBW infants were born at term and 30% were preterm.

3.2.3 Summary of key birth weight findings.

Box 3.1 presents the three major findings of the study, a mean birth weight of 2.8 kg, a LBW prevalence of 27% and a preterm:term ratio of 30:70.

Box 3.1 Summary of key birth weight findings.

Mean birth weight overall	**2.8 kg**
LBW prevalence overall	**27 %**
Preterm:Term LBW overall	**30% : 70 %**

3.3 Bivariate analysis for risk factors.

3.3.1 Approach to the data.

The bivariate analysis was carried out as follows. Potential risk factors for LBW were coded or recoded as binary variables, with the adverse category playing the part of an exposure, for example primiparity versus non-primiparity, or short birth interval versus a longer birth interval. This allowed computation of risk ratios for the relevant exposures. Both the outcome variable – LBW – and the basic dataset were treated in several ways after discussion during the interim workshop. The workshop recommendations are summarised in Annex D and the multiple analyses are considered in Annex C. In general, manipulation of the outcome variable and the dataset did not alter the implications of the results.

The results presented in this section derive from an analysis employing LBW as the outcome variable within a dataset from which all values of exactly 2.5 kg had been dropped. The relevant binary exposure variables were defined on the basis of the findings of the baseline analysis, as follows:

- Adolescent mother: Under 20 years old at the time of interview.
- Minimal antenatal care: 0, 1 or 2 antenatal visits.
- Low maternal body mass index: BMI less than 18.5.
- Maternal anaemia: Predelivery blood haemoglobin less than 11g/dl.
- Maternal illiteracy: Illiteracy and no schooling.
- Shorter birth interval: Birth interval less than 2 years.
- Low maternal weight: Weight less than 45 kg.
- Low maternal height: height less than 148 cm

3.3.2 Results of the bivariate analysis.

Table 3.11 summarises the important results. Only risk ratios (RR) whose 95% confidence intervals do not include unity have been taken as significant. The exposures are presented in descending order of the magnitude of their effects, the greatest effect (RR 2.22) being that of low maternal weight and the least effect (RR 1.21) being that of maternal anaemia.

The findings suggest that either underweight women (RR 2.2) or women who have previously delivered a preterm infant (RR 2.1) are twice as likely to have a LBW infant as those who have not. Maternal stunting (RR 1.7) is a significant risk factor, as is the composite finding of low BMI (RR 1.8). Nutritional deficiency is similarly reflected in the higher risk for anaemic mothers (RR 1.2). Birth spacing of under two years increases the risk of LBW by 50% (RR 1.5). Adolescent mothers (RR 1.4) and women delivering their first babies are at higher risk (RR 1.43). A rural lifestyle (RR 1.3) and agricultural work (RR1.4) increase the risk of LBW by some 30-40%, as does the lack of education (RR1.3) that often accompanies them. Finally, a relative lack of antenatal care increases the risk of LBW by 30% (RR 1.3).

Table 3.11 **Bivariate analysis: risk ratios (RR) for binary exposures with respect to LBW as the outcome variable.**

Exposure	RR for LBW	95% confidence interval for RR
Low maternal weight	2.22	1.91-2.57
Previous preterm infant	2.13	1.31-3.46
Low maternal body mass index	1.84	1.53-2.22
Low maternal height	1.72	1.46-2.01
Shorter birth interval	1.54	1.16-2.04
Agricultural paternal occupation	1.45	1.25-1.69
Primiparity	1.43	1.23-1.66
Adolescent mother	1.38	1.17-1.64
Minimal antenatal care	1.33	1.16-1.55
Rural residence	1.32	1.14-1.52
Maternal Illiteracy	1.30	1.12-1.50
Maternal anaemia	1.21	1.02-1.42

Although the association between infant sex and LBW has been mentioned above, it has been omitted from the present summary because it has little relevance to policy. The same can be said for gestational duration.

The relation between ethnic group and LBW prevalence is summarised in Table 3.12. The table presents LBW prevalence by site for each of the eight ethnic group categories used in the questionnaire. Cells containing less than five data points have been left empty in order to minimise inaccurate implications. The differences are significant when birth weight is subjected to analysis of variance (oneway ANOVA), and also when LBW prevalence is compared using confidence interval methods for contingency tables. The most notable finding is the higher prevalence of LBW in Brahmin and Chhetri groups. This may, however, reflect socioeconomic status rather than any inherent risk in ethnicity itself.

Table 3.12 **Relation between ethnic group and LBW prevalence.**

Site	Prevalence of LBW for different groups (%)							
	Brahmin	Chhetri	Newar	Magar	Rai Limbu	Gurung	Tamang	Other
Kathmandu	23	24	18	11	12	17	18	24
Biratnagar	28	25						43
Nepalgunj	20	28						30
Pokhara	35	26	10	15		12		12

3.4 Multivariate analysis for risk factors.

3.4.1 Approach to the data.

This section examines the determinants of LBW through logistic regression modelling. The results from the foregoing bivariate model describe gross effects, while the results in the multivariate models describe net effects after controlling for the effects of other variables. Only the exposures that were significant on bivariate analysis were considered candidates for multivariate models. A variable coding for site was introduced into all levels of analysis to account for differences between the cohorts.

Potential risk factors were divided into three groups:

3.4.2 Group 1 Variables reflecting lifestyle and education.

- Rural residence
- Paternal agricultural employment
- Maternal illiteracy
- Ethnic group

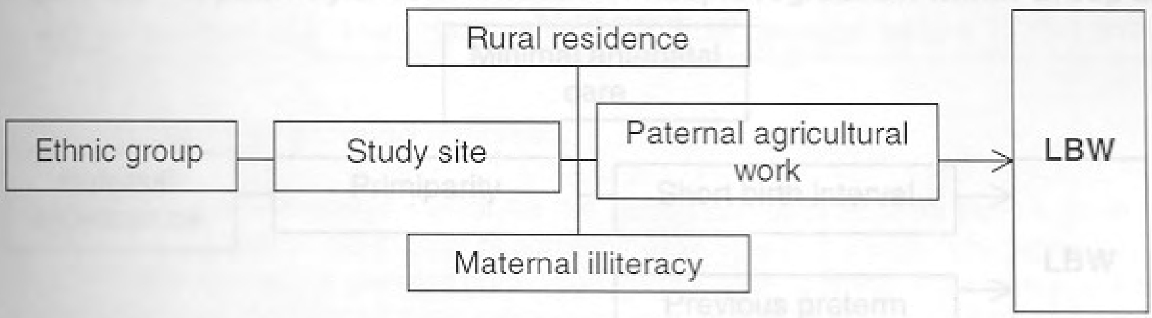
The first step was to carry out a logistic regression within this group. The results are presented in Table 3.13.

Table 3.13 Multiple logistic regression results for the effects of Group 1 exposures on LBW prevalence.

Exposure	Odds ratio	P value	95% confidence interval
Rural residence	1.34	0.002	1.11 – 1.61
Paternal agricultural work	1.49	0.000	1.21 – 1.82
Maternal illiteracy	1.22	0.055	0.99 – 1.51
Ethnic group	0.89	0.005	0.82 – 0.96
Site variable	1.22	0.000	1.10 – 1.36

Odds ratios less than unity imply a diminution of risk as the values of the variable increase. The result of the multiple regression is an attenuation of the effects of some exposures at the expense of others. The implication is that the effects of such exposures seen in the bivariate analysis could be explained by confounding by other exposures. In this analysis, the effect of maternal illiteracy on LBW prevalence seems to be explained to some degree by other exposures. This grouping is, however, only one of several possible groupings of these exposures. If the process is repeated for all possible groupings of the exposures of Group 1, it is possible to describe the statistical effects of each exposure on every other, both singly and in groups. This process permits the rough construction of a sequential path of exposures in terms of their degrees of mutual confounding. Such a path is presented in Figure 3.1

Figure 3.1 **A pathway to LBW based on multiple regression within Group 1.**



The nature of the path is such that the effects of ethnic group are at least partly explained by those of other socioeconomic factors such as place of residence and agricultural employment. The most robust association is that between paternal agricultural employment and LBW.

The procedure was repeated for exposures within the other two groups:

3.4.3 Group 2 Variables reflecting pregnancy and healthcare factors.

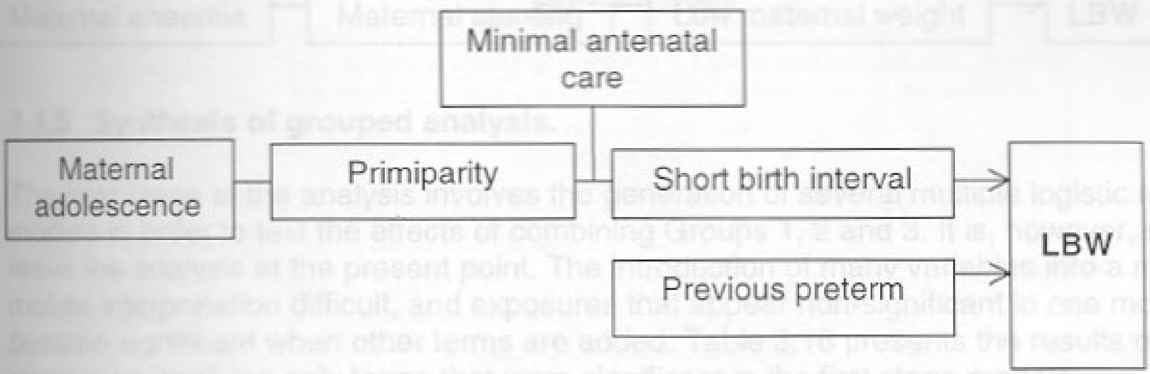
- Adolescent motherhood
- Primiparity
- Short birth interval
- Previous preterm delivery
- Minimal antenatal care

Table 3.14 Multiple logistic regression results for the effects of Group 2 exposures on LBW prevalence.

Exposure	Odds ratio	P value	95% confidence interval
Adolescent motherhood	1.61	0.175	0.81 – 3.20
Primiparity	0.88	0.877	0.18 – 4.22
Short birth interval	1.58	0.013	1.10 – 2.27
Previous preterm delivery	2.93	0.013	1.25 – 6.90
Minimal antenatal care	1.09	0.595	0.80 – 1.47
Site variable	1.11	0.240	0.93 – 1.31

Table 3.14 shows that – within Group 2 as a whole – only short birth interval and previous preterm delivery retain significance at the 5% level. However, regressions performed with less than the total number of exposures in the group reveal a chain of influence shown in Figure 3.2. The risks of adolescent pregnancy are to some degree explained by primiparity. Previous preterm delivery emerges as an independent risk factor for LBW. The basis for the path description (Figure 3.2) is statistical, and there are occasions when it seems difficult to relate the statistical outputs to practical situations. For example, it is not easy to draw a link between antenatal care and short birth interval. The most robust associations are between LBW and short birth interval and previous preterm delivery.

Figure 3.2 A pathway to LBW based on multiple regression within Group 2.



3.4.4 Group 3 Variables reflecting nutrition.

- Maternal weight
- Maternal height
- Maternal anaemia

BMI was omitted from the model since the introduction of a term that is closely associated with other terms (in this case weight and height) can lead to confusion. BMI itself is not as strongly associated with LBW as maternal weight.

Table 3.15 Multiple logistic regression results for the effects of Group 3 exposures on LBW prevalence.

Exposure	Odds ratio	P value	95% confidence interval
Maternal weight	0.92	0.000	0.90 – 0.94
Maternal height	1.00	0.803	0.98 – 1.02
Maternal anaemia	1.06	0.572	0.86 – 1.32
Site variable	1.43	0.000	1.27 – 1.62

Table 3.15 illustrates the powerful effect of maternal weight on LBW prevalence. This effect is strong enough to act as a confounder for other nutritional variables such as height and anaemia, and to eliminate their significance in a combined model. Systematic analysis of the mutual confounding within Group 3 produces the path to LBW shown in Figure 3.3. Maternal weight explains the effects of maternal height, which in turn explains the effects of anaemia.

Figure 3.3 A pathway to LBW based on multiple regression within Group 3.

3.4.5 Synthesis of grouped analysis.

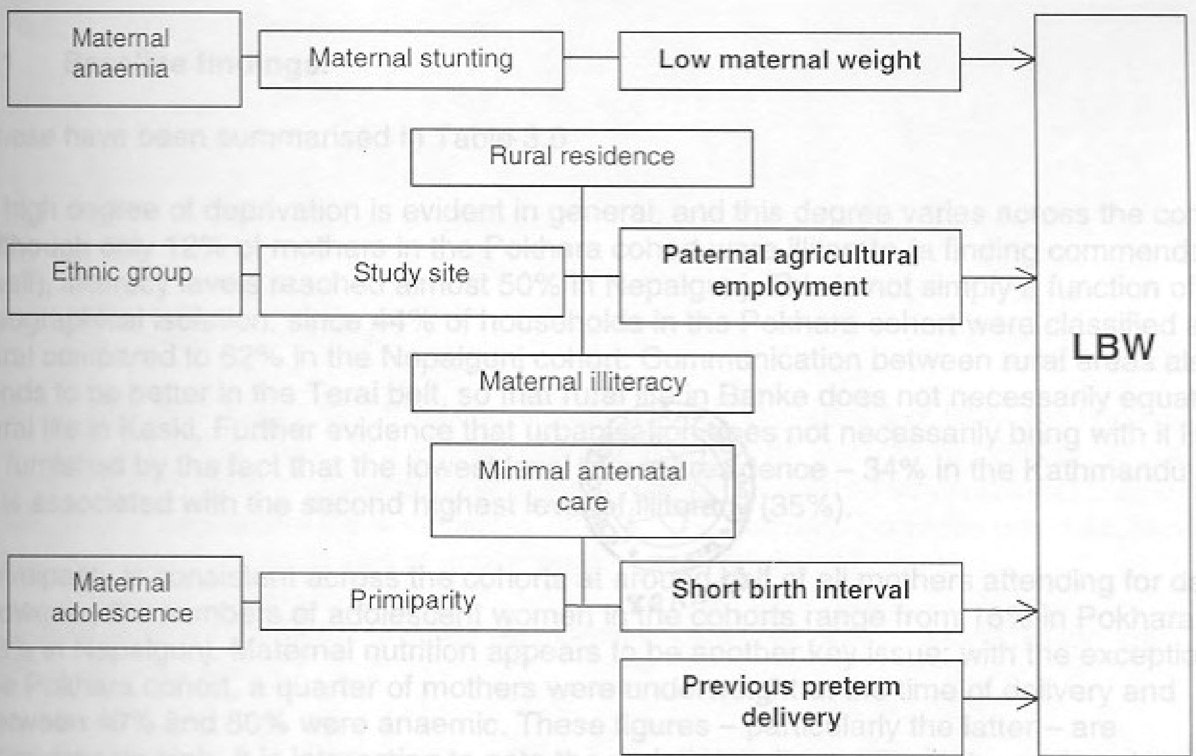
The next stage of the analysis involves the generation of several multiple logistic regression models in order to test the effects of combining Groups 1, 2 and 3. It is, however, sufficient to leave the analysis at the present point. The introduction of many variables into a model makes interpretation difficult, and exposures that appear non-significant in one model may become significant when other terms are added. Table 3.16 presents the results of a multiple regression involving only terms that were significant in the first stage models.

Table 3.16 Multiple logistic regression results for the effects of combined exposures shown to be strongly associated with LBW prevalence in Groups 1, 2 and 3.

Exposure	Odds ratio	P value	95% confidence interval
Rural residence	0.82	0.207	0.60 – 1.11
Paternal agricultural work	1.60	0.003	1.17 – 2.18
Ethnic group	0.88	0.064	0.78 – 1.01
Short birth interval	1.66	0.007	1.15 – 2.39
Previous preterm delivery	2.57	0.035	1.07 – 6.17
Maternal weight	0.92	0.000	0.90 – 0.95
Site variable	1.43	0.056	1.00 – 1.42

Although the model is one of many possible, it illustrates the robust nature of the association of LBW with four exposures: paternal agricultural occupation, short birth interval, previous preterm delivery and maternal weight. The significance of these four exposures is preserved across several models, models through which a composite path diagram was derived (Figure 3.4). The existence of the three major pathways is the result of the original groupings. However, they are conceptually rational and combination of the exposures across groups was not helpful in developing an understandable picture.

Figure 3.4 Summary of pathways to LBW based on multiple logistic regression.



4 Discussion.

4.1 Baseline findings.

These have been summarised in Table 3.6

A high degree of deprivation is evident in general, and this degree varies across the cohorts. Although only 12% of mothers in the Pokhara cohort were illiterate (a finding commendable in itself), illiteracy levels reached almost 50% in Nepalgunj. This is not simply a function of geographical isolation, since 44% of households in the Pokhara cohort were classified as rural compared to 62% in the Nepalgunj cohort. Communication between rural areas also tends to be better in the Terai belt, so that rural life in Banke does not necessarily equate with rural life in Kaski. Further evidence that urbanisation does not necessarily bring with it literacy is furnished by the fact that the lowest level of rural residence – 34% in the Kathmandu cohort – is associated with the second highest level of illiteracy (35%).

Primiparity is consistent across the cohorts at around half of all mothers attending for delivery. However, the numbers of adolescent women in the cohorts range from 16% in Pokhara to 23% in Nepalgunj. Maternal nutrition appears to be another key issue: with the exception of the Pokhara cohort, a quarter of mothers were underweight at the time of delivery and between 40% and 80% were anaemic. These figures – particularly the latter – are intimidatingly high. It is interesting to note the variation in figures for birth spacing. Although about a quarter of infants were born after an interval of less than two years, the figure for the Kathmandu cohort (10%) is much lower than that for the others. The rate of 27% in the Pokhara cohort, for example, raises questions about the connection between birth spacing and other health indices. The Pokhara cohort appear less deprived by many other indices, but this relatively better status is not paralleled by longer birth spacing. The influence that family planning programmes have on the figures is a matter for discussion.

A quarter of women from Kathmandu and Pokhara have either no antenatal care or one or two visits. This rises to 40% in Biratnagar and 60% in Nepalgunj. The current recommendation for four visits is clearly far from being met. Antenatal visits represent a window of opportunity for education, screening and treatment, and this opportunity is not available for a large proportion of women. The fact that the study took place in an urban setting is sobering. The low levels of antenatal care seen in the cohorts are likely to be still lower in other areas.

The box below summarises high-risk attributes of an archetypal woman based on the findings. Elements of the archetype probably exist in every woman involved in the study, but the composite creates a powerful mental image.

Box 4.1 **A woman at risk for a LBW infant.**

> **She is a young woman who cannot read and write.**
> **Her family live an agrarian life in a rural setting.**
> **As a result of lifelong undernutrition, she is stunted, underweight and anaemic**
> **She has her first baby in her teenage years.**
> **She receives little or no antenatal care and conceives her children at short intervals.**

4.2 Birth weight findings.

With a mean birth weight of 2.8 kg and an overall LBW prevalence of 27%, the findings suggest that LBW in Nepal is a serious problem. The World Summit for Children adopted the goal of reducing LBW prevalence to less than 10% and the WHO suggests that public health action should be initiated if it is in excess of 15%. The question (to which this discussion will return) remains as to what sort of action would be most helpful.

The findings of the study accord well with those of other Nepalese studies, which are summarised in Table 4.1.

Table 4.1 **Assessments of LBW prevalence in Nepal.**

Investigator	Year	Site	n	LBW prevalence (%)	Mean birth weight (kg) *(sd)*
NFHS* [48]	1996	All Nepal	4375	25	Estimate based on mothers' recall of infant size
NMIS* [50]	1998	All Nepal	17243	19	Estimate based on mothers' recall of infant size
Dali [51]	1989	Tribhuvan University Teaching Hospital	1000	20	2.91 *(0.50)*
Manandhar [52]	1997	Maternity Hospital, Kathmandu	578	32	2.71 male 2.66 female
WHO/SEARO [53]	1990	Chitwan District	2284	14	2.78 *(0.41)*
WHO/SEARO [53]	1990	Maternity Hospital, Kathmandu	3096	22	2.78 *(0.47)*
Present study	1999	Multicentre	3636	27	2.85 (0.47) male 2.77 (0.44) female

* NFHS: Nepal Family Health Survey 1996.
* NMIS: Nepal Multiple Indicator Surveillance Fifth Cycle 1998.

Lower rates in some studies may be explained by site selection (Tribhuvan University Teaching Hospital, for example), and by assessment based on maternal recall. Indeed, the NFHS assumes to some extent that its figures represent an underestimate. It may be appropriate to set the national estimation of LBW prevalence at around 30%, since the order of magnitude is high enough to make tackling it a priority.

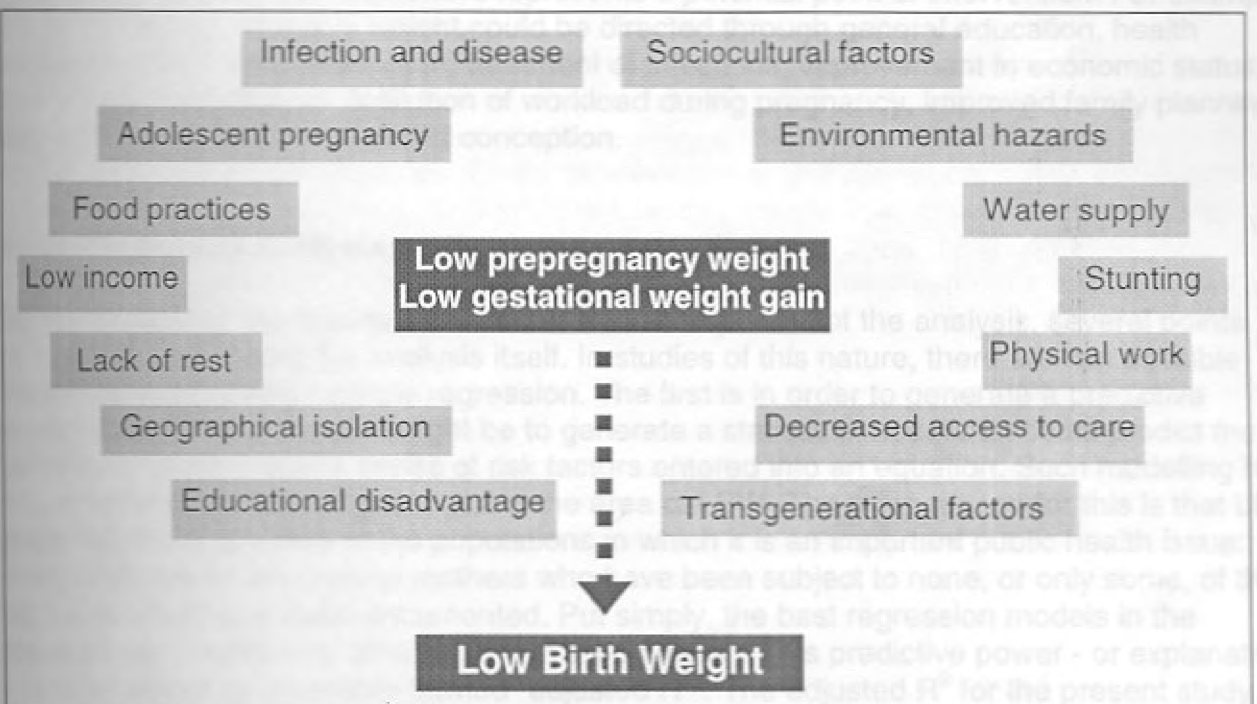
The contribution of preterm birth to LBW – at 30% - accords with expectation. 70% of LBW infants were born at term, which implies that the greater part of LBW depends on intrauterine growth retadation (IUGR). This dominance has led to an emphasis on IUGR in discussions of LBW worldwide. The first issue is that interventions are likely to have a greater overall effect if they address the larger group of LBW infants. The second issue is that of the effects of IUGR on health in later life. It appears that IUGR predisposes to illnesses such as myocardial infarction, diabetes and stroke, and it is probable that the burden of these illnesses is now being felt by populations in the developing world. However, such longer term morbidity and mortality should not be allowed to divert attention from the primary issue, which remains the high rate of early infantile mortality in countries such as Nepal.

4.3 Analysis of risk factors for LBW.

4.3.1 Bivariate analysis.

The findings of the study underline the complexity of risk factor analysis with respect to LBW. LBW represents a point on a transgenerational cycle of poverty, undernutrition and inadequate healthcare, and as such is subject to many influences. Some of these influences are summarised in Figure 4.1.

Figure 4.1 The wide range of environmental risk factors for LBW.



Each of the factors presented in the figure may appear as significant on bivariate analysis. This is because each factor is associated with all the others, but there may be mutual confouncing. The factors that were found to be important in the study were – in order of degree of relative risk - maternal underweight, the birth of a previous preterm infant, maternal stunting and low BMI, a short birth interval, paternal employment in agriculture, primiparity, adolescent motherhood, deficiencies in antenatal care, rural residence, maternal illiteracy and anaemia during late pregnancy. It appears that the strongest effect of these factors is mediated at least partly through low maternal weight.

There are other potential risk factors that did not emerge as significant within the study. The reason for this was either that they were not part of the ambit of enquiry of the study (skinfold thickness is an example) or that their levels within the study population were not sufficient to achieve statistical significance within the sample frame. An good example of this is malaria. In many populations, malarial infection is common and emerges as a major risk factor for LBW. This illustrates the concept of population attributable risk (or aetiological fraction): a risk factor may be significant, but its effects may not be important on a population basis. Conversely, a factor may have marginal effects on LBW but be so widespread in a population that a small effect has a large impact. Within the study, smoking and alcohol use, previous stillbirth and neonatal death, consumption of iron supplements during pregnancy, rest in the third trimester and dietary alterations during pregnancy did not emerge as key risk factors for LBW. Some of these – such as smoking – are known risk factors for LBW, but the nature of the sample was such that their population attributable risks were low. This is an important point, because it would be unwise to omit antismoking interventions from a package of healthcare on the basis of the present statistics. Likewise, there is evidence that rest during pregnancy and increased food intake can improve birth weight, but these entities are difficult to quantify without accurate measures of energy intake and expenditure.

Each of the documented risk factors represents a potential point of intervention. For example, efforts to improve women's weight could be directed through general education, health education and nutrition education, treatment of infections, improvement in economic status, nutrient supplementation, reduction of workload during pregnancy, improved family planning and an increase in the age at first conception.

4.3.2 Multivariate analysis.

Before discussing the results of the multivariate component of the analysis, several points need to be made about the analysis itself. In studies of this nature, there are two possible reasons for performing multiple regression. The first is in order to generate a predictive model. For example, the aim might be to generate a statistical model that could predict the prevalence of LBW from a series of risk factors entered into an equation. Such modelling has not, unfortunately, been of great use in the area of LBW. The main reason for this is that LBW is (by definition) common in the populations in which it is an important public health issue: many LBW infants are born to mothers who have been subject to none, or only some, of the risk factors that have been documented. Put simply, the best regression models in the literature can predict only 30% of LBW in a population. This predictive power - or explanation – is represented by a variable termed "adjusted R^2". The adjusted R^2 for the present study in the most predictive model is 11%. The best combination of risk factors (in this case including infant sex and gestational age) does not explain about 90% of LBW in the study. The multivariate analysis was not, therefore, performed to generate predictive models.

The second reason for performing multiple regression is to derive an idea of how risk factors relate to one another. Since the purpose of the study was both to document and to suggest interventions, and since the risk factors for LBW are interrelated, the aim was to narrow the field for potential interventions. The chosen interventions would then have the greatest possible effect on levels of LBW.

A summary of the pathways to LBW that arose from the regression analysis has been presented in the Results section. The most strongly associated factors were maternal underweight, paternal agricultural employment, short birth spacing and the birth of a previous preterm infant. Since employment and previous events are difficult to address, the two areas in which intervention might be expected to lead to benefit are maternal underweight and short birth spacing. Possible interventions include education, nutritional support and family planning. However, this is not to suggest that risk factors that have less statistical association in the analysis should be ignored. The analytical process provides a framework that helps to focus potential intervention, but does not stand outside an approach based on the interrelation between factors. For example, although maternal illiteracy appears to be confounded by other factors, an approach based on general female education would not only have effects on literacy rates, but also on nutritional status, economic factors, family planning, age at first pregnancy and uptake of micronutrient supplements (see Recommendations). Many studies have failed to take the step from risk factor analysis to advocacy. There are, however, notable exceptions from India [54] and from Argentina [55], particularly where attempts have been made to draw up lists of risk factors for screening of pregnant women.

4.4 Comparison with other studies.

The findings with respect to risk factors for LBW generally agree with those of investigators worldwide. There is a rough dichotomy between studies from industrialised and studies from developing countries. Although a risk factor in one setting is also a risk factor in others, there are differences in the prevalence of risks between richer and poorer countries. For example, the distribution of both smoking and other risk factors means that, in general, the population attributable risk for smoking is higher in industrialised than in developing countries. This is also because other risk factors such as malnutrition are far less prevalent in the industrialised world, and because the actual levels of LBW are much lower.

Table 4.2 summarises risk factors for LBW from a range of studies and compares them with those of the present study. The developing country risk factors are based on studies from Africa and Latin America [55-60]. They also include factors described with data from South Asian populations. [51 61-68]. The industrialised country risk factors are based on studies from Europe and the USA [57 69-73] Some studies have addressed the differential risk factors for IUGR and preterm birth separately, although these tend to have been performed in the USA [70-72].

Table 4.2 Summary of risk factors for LBW derived from multivariate analyses in a number of studies worldwide.

Risk factors	Studies from industrialised countries	Studies from developing countries	Present study
Nutrition	Lower maternal weight	Lower maternal weight	Lower maternal weight
	Poor weight gain in pregnancy	Poor weight gain in pregnancy	
	Lower maternal height	Lower maternal height	Lower maternal height
		Low skinfold thickness	
		Anaemia	Anaemia
Social status and behaviour	Ethnicity	Ethnicity	Ethnicity
	Lack of maternal education	Lack of maternal education	Illiteracy
	Lower socioeconomic status	Lower socioeconomic status	Rural/agricultural work
	Low level of income	Inadequate water supply	
		Young maternal age	Young maternal age
	Smoking	Smoking or tobacco chewing	
	Drug use		
Pregnancy and healthcare	Primiparity	Primiparity	Primiparity
	Previous LBW infant	Previous LBW infant	Previous preterm infant
		Short birth interval	Short birth interval
	Problematic obstetric history	Problematic obstetric history	
	Low levels of antenatal care	Low levels of antenatal care	Low levels of antenatal care
	Vaginal bleeding during pregnancy	Illness during pregnancy	
		Malaria during pregnancy	
		Consanguinity [66]	

The findings in the table echo those of the present study. Factors such as water supply are intimately related to many of the factors that have already been discussed. Interestingly, adolescent motherhood has tended to be significant in bivariate analyses, but often loses significance in multivariate analyses because of confounding by parity, as seen in the present study. The same holds for maternal haemoglobin levels or anaemia. The discussion of ethnic group is exemplified by work from the USA: it is generally felt that ethnicity itself is not a risk factor for LBW, but that there is residual confounding by socioeconomic factors [74]. This is not the whole story, however, as ethnicity may also be associated with protective cultural practices [75 76]. The role of consanguinity relects its higher prevalence in certain societies compared to others.

5 Conclusions.

1. LBW prevalence in Nepal is high. Although it is not as high as in some estimates from countries such as Bangladesh and India, the cohorts were hospital-based, and it seems likely that prevalence would be higher in more isolated rural settings. LBW levels are likely to be at least 27% in most areas of the country, and this is far higher than the figure of 15% suggested as a trigger for public health intervention.

2. LBW prevalence is higher in some areas than in others, with particularly high levels in Biratnagar (34%) and Nepalgunj (26%)

3. The contribution of IUGR to LBW (70% of LBW was referable to term small for gestational age) is comparable with that of other developing countries, and far exceeds the contribution of preterm birth. A greater proportion of preterm infants will die, but IUGR may bring with it a larger burden in terms of later morbidity and mortality.

4 Risk factors for LBW in Nepal are comparable with those from other published accounts worldwide. These factors cluster around, and are intimately related to, poverty and the status of women: malnutrition, lack of education, isolation from health service provision and usage and lack of control over conception. The findings are not surprising, but underline the importance of interventions based on social development, poverty alleviation, education and healthcare services.

6 Recommendations.

6.1 Preparing for and dealing with the consequences of LBW.

6.1.1 Antenatal care: increased provision of services and efforts to increase user demand and uptake.

The study identifies a range of risk factors for LBW that present logistic problems for screening. In many situations in Nepal, the majority of women will give birth in a high-risk situation: poverty, illiteracy and undernutrition are common. This makes risk-factor screening difficult, since it is likely that the number of women at risk will exceed the practical limits of intervention. Secondly, it has been pointed out that screening on the basis of known factors will fail to predict a large proportion of LBW. Thirdly, only the minority of women attend for antenatal care, and therefore only a minority of women will be available for screening.

A more pragmatic recommendation is to approach the problem in a general sense through antenatal care itself. With the assumption that a "homogeneity of deprivation" exists in many areas, the study team recommends an emphasis on increasing provision and uptake of antenatal care services. This will bring with it opportunities to address health and nutrition education, to provide micronutrient supplements, to discuss issues around birth and the neonatal period and to improve the standing of women's health in Nepal. Antenatal care is also a key forum for the dissemination of information and training on essential newborn care, which would improve the prognosis for all babies, including those who are LBW.

6.2 Preventing LBW.

The documented risk factors may be divided into three groups:

1. Risk factors about which little can be done: ethnic group, place of residence, paternal work, primiparity, previous preterm birth.
2. Risk factors which would be difficult to address in the short term, but which would be amenable to change over a longer period: stunting.
3. Risk factors which would be amenable to change in the short term: illiteracy, adolescent pregnancy, lack of antenatal care, maternal underweight, anaemia and short birth interval.

The third group forms the basis of the following recommendations.

6.2.1 Non-health processes.

1. Education. General education for girls and women will have an effect on many risk factors. It will have primary effects on literacy and secondary effects on age of marriage and first conception, nutritional status and health seeking behaviour.

6.2.2 Health processes.

1. Health education. Specific health education will have effects on family planning, uptake of antenatal care, essential newborn care, health seeking behaviour when problems arise for mother or infant and nutritional status.
2. Antenatal care. Provision of good quality antenatal care will have effects on early identification of potential problems, health education and subsequent uptake of services.
3. Family planning. The availability of advice and support will have effects on age at conception and on birth spacing.

6.3 Recommendations for further research.

6.3.1 Health services research.

1. What are the effects of different approaches to improve knowledge, attitudes and practice with respect to health?
2. How can family planning information, service and uptake be improved?
3. How can provision, quality and uptake of antenatal care be improved?
4. How can essential newborn care practices develop at the community level?

6.3.2 Nutritional research.

1. What means exist to improve the nutritional status of women in resource poor environments?
2. How and at what points in life can we help women to attain their nutritional health potential?
3. What is the place of macronutrient supplementation?
4. What is the place of micronutrient supplementation?

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8 Annexes.

Annex A Contributors to the study.

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Annex C Details of the analysis.

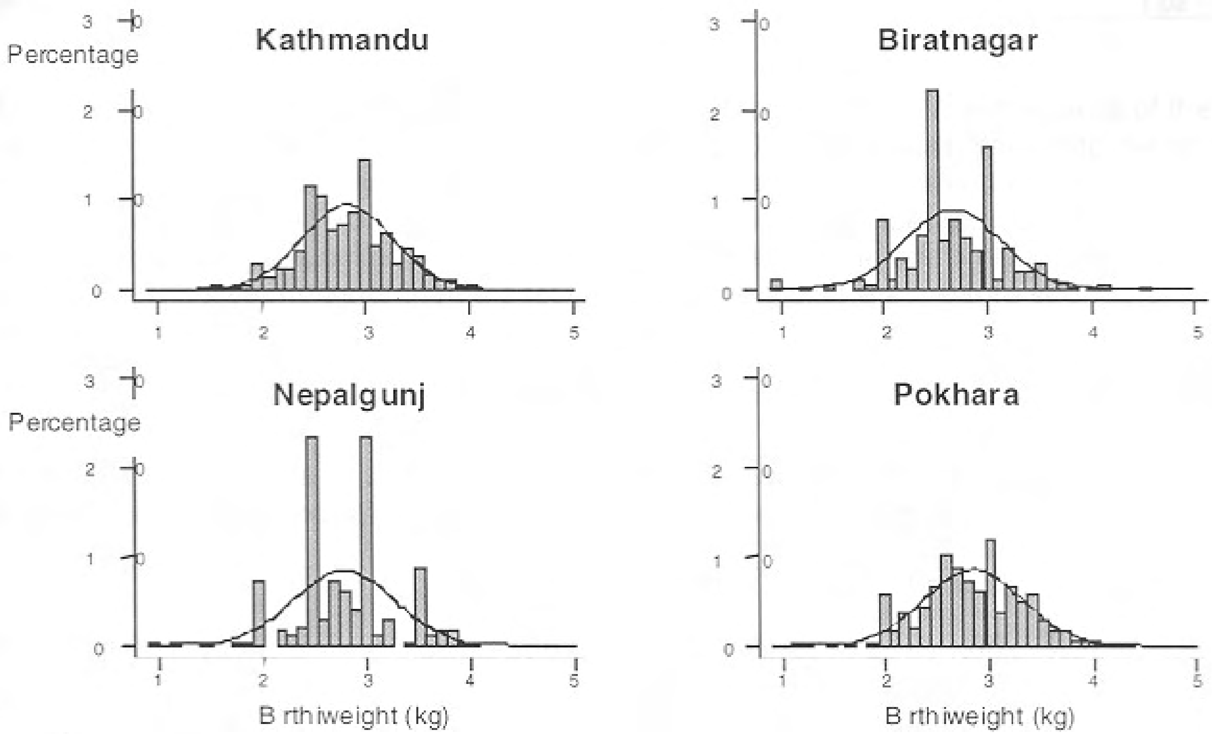
C.1 Birth weight distribution.

The analysis was designed to address two features of the data that periodically arise in similar studies. First, an understandable lack of sophistication in the measurement technology resulted in the recording of birth weight to one decimal place. Because the cut-off point for LBW is 2500 g, a question arises as to the treatment of recorded values of 2.5 kg. For LBW prevalence, this was managed by categorising half of the infants with recorded birth weights of 2.5 kg as LBW and half as non-LBW. The split was non-random, but justifiable since the treatment was designed to produce aggregate figures. For the bivariate and multivariate analyses, the data were treated differently.

The second feature of the data that required consideration was digit preference. Figure xx illustrates the distribution of birth weight in each of the four cohorts. All the distributions approximate to normal, but there is heaping of recorded birth weights at multiples of 0.5 kg. This is a common finding which suggests a degree of preference towards these multiples [46]. Again, in terms of aggregate LBW prevalence this does not affect the results: for LBW, and infant either weighs less than or more than 2500g.

Figure C.1 Distribution of birth weight in the four cohorts.

Curved lines correspond to the normal distribution



Digit preference and the issue of the cut-off point also required consideration for the bivariate and multivariate analysis. In this case, the data points were linked (a particular infant has a particular combination of birth weight and maternal risk factors) and a non-random split at 2.5 kg would not have been acceptable. The dataset was therefore treated in several ways as recommended by the interim workshop. First, the analysis was performed on the full dataset. Second, it was repeated on a dataset from which all birth weight values of 2.5 kg had been dropped. This provided a clear demarcation on either side of the cut-off point for LBW and removed the problem of ambiguous ascription to one category or the other. The results of this treatment are presented in Table C.1, from which it will be clear that it had little effect on the appropriate inferences.

Table C.1 Analysis of risk ratios for binary exposures with outcome defined as LBW.

	Full dataset		Dataset without 2.5 kg infants	
Exposure	*RR*	*95% ci*	*RR*	*ci*
Low maternal weight	1.95	1.72 - 2.21	2.22	1.91 - 2.57
Previous preterm infant	1.99	1.34 - 2.95	2.13	1.31 - 3.46
Low maternal BMI	1.78	1.53 - 2.07	1.84	1.53 - 2.22
Low maternal height	1.51	1.32 - 1.73	1.72	1.46 - 2.01
Shorter birth interval	1.42	1.12 - 1.81	1.54	1.16 - 2.04
Agricultural paternal occupation	1.34	1.18 - 1.51	1.45	1.25 - 1.69
Primiparity	1.36	1.20 - 1.54	1.43	1.23 - 1.66
Adolescent mother	1.30	1.13 - 1.50	1.38	1.17 - 1.64
Minimal antenatal care	1.24	1.10 - 1.41	1.33	1.16 - 1.55
Rural residence	1.28	1.14 - 1.44	1.32	1.14 - 1.52

Maternal Illiteracy	1.20	1.06 - 1.36	1.30	1.12 - 1.50
Maternal anaemia	1.19	1.04 - 1.36	1.21	1.02 - 1.42

The third treatment involved redefinition of the cut-off point for LBW on the basis of the 10th centile for the whole sample. This level was below 2500 g, and again served to define the LBW group unambiguously. The results of this treatment are presented in Table C.2. The only association that moved from significance to non-significance appears to be previous preterm delivery, this being a function of the drop in data points and the relatively low frequency of the exposure. The treatments of the dataset and outcome variable appear to strengthen the documented associations, and the second treatment (dataset minus 2.5 kg) was selected for presentation.

Table C.2 Analysis of risk ratios for binary exposures with outcome defined as birth weight less than or equal to 10th centile of all recorded weights.

	Full dataset		Dataset without 2.5 kg infants	
Exposure	*RR*	*95% ci*	*RR*	*ci*
Low maternal weight	2.45	2.00 - 3.00	2.65	2.17 - 3.23
Previous preterm infant	1.95	0.94 - 4.02	2.12	1.05 - 4.28
Low maternal BMI	1.51	1.23 - 2.11	1.73	1.33 - 2.26
Low maternal height	2.04	1.65 - 2.52	2.06	1.67 - 2.54
Shorter birth interval	1.65	1.14 - 2.37	1.67	1.16 - 2.40
Agricultural paternal occupation	1.63	1.34 - 2.00	1.65	1.36 - 2.02
Primiparity	1.26	1.03 - 1.53	1.33	1.09 – 1.62
Adolescent mother	1.41	1.12 - 1.78	1.52	1.22 - 1.91
Minimal antenatal care	1.39	1.14 - 1.70	1.43	1.17 - 1.74
Rural residence	1.35	1.11 - 1.65	1.40	1.15 - 1.70
Maternal Illiteracy	1.35	1.10 - 1.65	1.38	1.13 - 1.68
Maternal anaemia	1.31	1.05 - 1.64	1.37	1.10 - 1.72

C.2 Multivariate analysis.

Since the purpose of this section of the analysis was not to estimate LBW levels but to examine the determinants and differentials of LBW, the analysis was based on unweighted data. There is some controversy about whether or not to weight data from a complex data file, and it has been suggested that the use of unweighted models is appropriate when differences between inclusion probabilities are a function of known design variables such as stratum identifiers and size measures, and if these design variables are included in the models [77]. In accordance with this view, a variable was included in the logistic models to describe the site of data collection so that differences between hospitals were taken into account.

Annex D Proceedings of the interim workshop

Multi-Hospital-Based Study of the Prevalence of and Factors associated with Low Birth Weight in Nepal

MIRA-UNICEF

Report of workshop

Hotel Mountain
28th June 1999

Chairman: Dr Q Al Nahi

Programme	
Introduction	Dr DS Manandhar
Methodology	Dr PS Shrestha
Sample size	Dr PD Pant
Characteristics of sample	Dr K Malla
LBW results	Dr DS Manandhar
Bivariate analysis	Dr D Osrin
Multivariate analysis	Dr PD Pant

This workshop was organised to discuss issues arising from the study and to present the results in first format to an interested group of commentators. The aim was to generate discussion and develop ideas for further analysis and revision.

List of participants

UNICEF	Dr S McNab
	Dr Q al-Nahi
	Dr F Menkir
	Dr G Regmi
NHRC	Prof SM Dali
IOM	Dr CK Gurung
FHI	Dr S Thapa
Prasuti Griha	Dr DS Malla
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SAMANTA	Dr G Rana
CDPS, TU	Dr PD Pant
Patan Hospital	Dr S Malla
MIRA	Dr DS Manandhar
	Prof R Adhikari
	Prof PS Shrestha
	Dr L Shrestha
	Dr D Osrin
	Ms PL Shrestha

The meeting began with a presentation of the broad issues around LBW. LBW prevalence in Nepalese samples had been documented as 20% at Tribhuvan University Teaching Hospital by Dali et al and 32% at the Maternity Hospital by Manandhar et al in a later study. A WHO/SEARO multicentre study had derived figures of 14.3% for rural and 22.3% for urban samples.

The current study had selected four major hospitals representing four of the five regions of Nepal. The design and execution were outlined. Enrollment had been time-bound over two months (Kartik – Mangsir 2055: mid-October – mid-December 1998). Maternal height and weight had been recorded early in the post-delivery period, and blood haemoglobin had been measured predelivery to optimise consistency of timing. A HemoCue method was used at the Maternity Hospital and Red Cross Blood Bank results at all other sites.

Sample size had been projected from an estimated LBW prevalence of 20%, but had been increased to ensure adequate cell frequencies at the level of four independent variables. The projected sample size of 2700 had been exceeded within the time-bound recruitment constraints. There was discussion about the merits of this strategy as opposed to the setting of individual enrollment targets at each site to ensure equal weighting between sites.

The sample characteristics were presented and the above discussion deepened, particularly in view of the higher prevalence of anaemia in the Nepalgunj sample. The ethnic group distribution was presented for each site. The proportion of Newars in the Maternity Hospital sample – higher than the proportion in the community based on census data – had implications in terms of the selectivity of the sample and the use of hospitals for delivery.

The birth weight results and derived LBW prevalences were presented. The problem of heaping at multiples of 500g was discussed. Data collection was identified as the key problem for the study. It was suggested that return visits might be made to sites in order to generate correction factors for measurements by simultaneous weighing by interviewers and supervisors. The potential benefits of a clear, bilingual instruction manual were highlighted.

The results of bivariate analysis were presented and discussed in light of the above.

Presentation of the multivariate analysis led to a discussion on the aims of such analysis and its usefulness for guiding recommendations.

Specific plans arising from the workshop

1. Weight the combined estimates to compensate for the dominance of the Maternity Hospital sample in the analysis.

2. Calculate prevalences with the total number of infants registered as 2.5 kg halved as previously.

3. Repeat the bivariate and multivariate analyses in two other ways: first, by dropping all infants registered as weighing 2.5 kg; second, by using a new binary variable for outcome based on the top of the lowest quintile of weights in the sample.

4. Consider collapsing the sample sites on the basis of mean birth weight. Since ethnic group is a proxy for acculturation, avoid collapsing the categories if possible.

5. Future work should limit the numbers of interviewers and incorporate stringent reliability testing, supervision and spot-checking.

6. Variables that lacked precision, such as antenatal care, bleeding and exertion, should receive deeper consideration at the design stage. Indicators of socioeconomic status and cultural factors need consideration.

7. For multivariate analysis, aim for parsimony and consider factors that would be amenable to intervention. Consider dropping known associations such as infant sex and gestation from the model, and minimise the

inclusion of conflicting variables such as adolescence and parity. Replace BMI with maternal weight, since it may have more influence on the basis of other studies.

8. Consider dropping the data from Biratnagar, which are inconsistent with the other sites. Alternatively, include a collapsed variable for site in the analysis.