Risk Factors for Low Birthweight in Southwest Trinidad: A Case-control Study

NC Roopnarine[1], RG Maharaj[2]

ABSTRACT

Objective: *Newborns with low birthweight (LBW) have poorer outcomes compared to normal weight infants. There was a reported 19% prevalence of LBW in Trinidad and Tobago compared with an average 9% in Latin America and the Caribbean between 2000 and 2007. Our objective was to identify the risk factors for LBW in south west Trinidad.*

Methods: *This was a case-control study of all births at six health centres in south west Trinidad, between 2008 and 2010. All eligible cases of low birthweight (< 2.5 kg) and a random sample of twice the number of controls of normal birthweight (≥ 2.5 kg) were included.*

Results: *Six hundred and twenty-seven medical records (209 cases and 418 controls) were used out of a possible total of 3241. The mean birthweight in the cases was 2.14 kg and in the controls was 3.14 kg. Regression analysis suggested that the factors that were predictive of higher birthweight were early (< 16 weeks) and adequate number (nine or more) of antenatal visits [OR 0.57 (0.35, 0.92)* p *= 0.023]; male gender [OR 0.69 (0.49, 0.98)* p *= 0.040]; and vaginal delivery [OR 0.61 (0.40, 0.96)* p *= 0.031]. The factors that predicted low birthweight were maternal age ≤ 19 years [OR 1.78 (1.05, 2.93)* p *= 0.031] low booking maternal weight (< 50 kg) [OR 1.86 (1.18, 2.93),* p *= 0.007]; and a low weight gain (0 – 5 kg) [OR 1.88 (1.28, 2.75),* p *= 0.001]. Factors that were not predictors of birthweight in this study were parity, maternal anaemia and employment status.*

Conclusion: *Risk factors for LBW in Southwest Trinidad are similar to those identified internationally.*

Keywords: Low birthweight, maternal anaemia, Trinidad and Tobago

Factores de Riesgo del Bajo Peso al Nacer en el Sudoeste de Trinidad: un Estudio de Casos y Controles

NC Roopnarine[1], RG Maharaj[2]

RESUMEN

Objetivo: *Los recién nacidos con bajo peso al nacer (BPN) tienen resultados más pobres en com-paración con los bebés de peso normal. Se reportó una prevalencia de 19% de BPN en Trinidad y Tobago, comparada con un promedio del 9% en América Latina y el Caribe entre 2000 y 2007. Nuestro objetivo fue identificar los factores de riesgo BPN en el sudoeste de Trinidad.*

Métodos: *Se trató de un estudio de casos y controles de todos los nacimientos en seis centros de salud en el sudoeste de Trinidad, entre 2008 y 2010. Se incluyeron todos los casos elegibles de bajo peso al nacer (< 2,5 kg) y una muestra aleatoria de dos veces el número de controles de peso normal al nacer (≥ 2.5 kg).*

Resultados: *De un total posible de 3241, se usaron seiscientos veintisiete historias clínicas (209 casos y 418 controles). El peso promedio al nacer en los casos fue de 2.14 kg y en los controles fue de 3.14 kg. El análisis de regresión sugirió; que los factores que fueron predictivos de mayor peso al nacer fueron: el tiempo temprano (< 16 semanas) y el número (nueve o más) de consultas prenatales [OR 0.57 (0.35, 0.92)* p *= 0.023]; el sexo masculino [OR 0.69 (0.49, 0.98)* p *= 0.040]; y el parto natural [OR 0.61 (0.40, 0.96)* p *= 0.031]. Los factores que predijeron el bajo peso al nacer fueron: la edad de la madre ≤ 19 años [OR 1.78 (1.05, 2.93)* p *= 0.031]; el bajo peso inicial de la madre (< 50 kg) de reserva [OR 1.86 (1.18, 2.93),* p *= 0.007]; y una baja ganancia de peso gestacional (0–5 kg) [OR 1.88 (1.28, 2.75),* p *= 0.001].*

From: [1]Primary Care Physician, South West Region, Trinidad and Tobago and [2]Unit of Public Health and Primary Care, Faculty of Medical Sciences, The University of the West Indies, St Augustine, Trinidad.

Correspondence: Dr RG Maharaj, The Unit of Public Health and Primary Care, The Faculty of Medical Sciences, The University of the West Indies, St Augustine, Trinidad, West Indies. Fax: 868 645 2018, email: rohan.maharaj@sta.uwi.edu

DOI: 10.7727/wimj.2014.161

Los factores que no fueron predictores del peso al nacer en este estudio fueron: la paridad, la anemia materna, y la situación laboral.
Conclusión: *Los factores de riesgo del bajo peso al nacer en el sudoeste de Trinidad son similares a los identificados internacionalmente.*

Palabras claves: Bajo peso al nacer, anemia materna, Trinidad y Tobago

West Indian Med J 2017; 66 (1): 89

INTRODUCTION

A low birthweight (LBW) infant is one who weighs less than 2.5 kg irrespective of gestational age (1, 2). Low birthweight is associated with maternal, placenta and fetal factors among others (3). Maternal factors include a pre-pregnancy weight of less than 50 kg, poor weight gain during pregnancy, poor nutrition, maternal illness, primiparity, grand multiparity, premature rupture of the membranes and illicit drug use. Placental factors include infection by the TORCH agents (toxoplasmosis and other agents, rubella, cytomegalovirus, herpes simplex), abruptio placenta, and diffuse fibrosis of the placenta. Fetal factors include multiple gestation, congenital malformations, metabolic disorders, chromosomal abnormalities and infection.

The prevalence of LBW has decreased in many developed nations in the last thirty years accounting for between 4.4–7% of global prevalence (1, 2). Previous studies have elucidated risk factors for LBW in the Caribbean (4–6). However, these studies have not been replicated in Trinidad and Tobago. According to UNICEF, between 2000–2007 Trinidad and Tobago had about 19% of its births classified as LBW (2). This is higher than the Latin American and Caribbean average of 9%. This coupled with Trinidad's high infant mortality rate of 19 per 1000 live births in 2013 means that there is still significant improvement to be made (18).

Many developing countries, Trinidad and Tobago included, have struggled with a less than satisfactory infant mortality rate (1). Infant mortality rate is correlated to LBW as there is higher perinatal mortality in this weight category. Infant mortality rates are largely governed by prematurity and this is reflected by the elevated mortality in infants born with LBW (7–9). Prematurity and birthweight share this relation because birthweight increases largely in the third trimester, so the premature infant misses out on this period of weight gain (10).

It is well established that the outcome of LBW is poor when compared to that of normal weight infants (11, 12). There is a close link between preterm birth, LBW and neonatal mortality (13). This is based on epidemiological evidence that infants weighing less than 2.5 kg are approximately 20 times more likely to die than heavier babies (1).

Infants with LBW, both those who are small for gestational age and preterm babies, have an increased risk of epilepsy (14). There is also a small positive association between low birthweight and reduced childhood cognitive ability (15). It should be noted that infants with LBW are at greater risk of Type 2 diabetes, high blood pressure and coronary artery disease [CAD] (16, 17). There are social and economic ramifications of LBW. Low birthweight increases the burden of chronic disease in individuals (19) and populations (20) with associated increased costs and loss of human resources, both in the immediate care for Low birthweight and in the long-term care of patients with non-communicable diseases. The resulting burden to the health system is large and there are multiple identifiable and correctable factors that contribute to the problem. Our objective then was to determine the risk factors for LBW in Southwest Trinidad.

SUBJECTS AND METHODS

This was a case-control design. The population consisted of mothers who gave birth in the South Western district of Trinidad, West Indies, between January 2008 and December 2010. Six Health Centres were used with a total of 3241 attendant mothers. Each health centre made a contribution to the overall cases in that all eligible case notes (babies that were born under 2.5 kg) were utilized in this arm of the study for that centre. The controls (babies that were greater than or equal to 2.5 kg) were randomly selected from all eligible normal weight babies at each health centre and were two times the number of cases identified at the respective health centres. The random sampling technique for controls was done in two steps. The control number was first calculated then the remaining medical record numbers were placed in a bag and chosen to meet the required control number. For example, in one health centre there were 40 cases identified and subsequently 80 controls were chosen. This follows the format for an unmatched case control study as no deliberate attempt at matching patient characteristics was used.

The inclusion criteria were: women who delivered between January 2008 and December 2010 and must have visited the community health centre at least twice. The Exclusion criteria were: attendees' files that were incomplete – that is if both the mother and child files/records were not available for scrutiny, and files that had missing risk factors of interest, for example the number of pregnancies or employment record.

Variables were selected based on the literature review and comparison made with patient notes and information included in standardized data collection forms used at the clinics. The information collected was guided by the Maternal and Child Health Manual for Trinidad and Tobago (21). The variables which were available for extraction include – maternal age, parity, occupation, maternal co-morbidity (the presence

of any other medical condition, including diabetes mellitus, hypertension, asthma, epilepsy), number of attendances at the antenatal clinics (more than 9 and more is regarded as satisfactory), initial booking weight and weight gain (achieved over the entire pregnancy, using the first visit as baseline), haemoglobin level, gender of the child, weight of the child, first booking visit [less than 16 weeks was considered as early] (22), delivery type and certain complications of the pregnancy.

Using the standard formula for case control studies and an adjustment factor of 3/4 the sample size (n) was calculated to be 546 (23, 24). The principal investigator (PI) (NR) trained the clerical staff and/or nurse at the centre on the data fields that were required. The training included the identification of the data in the medical records and transcription into the data entry form. All of the eligible records were firstly viewed together by the clerical staff and PI to determine the number of cases. All of the controls were then placed in a bag and then drawn until the calculated 'control number' was reached. These chosen/selected file numbers were kept apart until the data entry process was complete. The data entry fields, categories and units and the data abstraction form are available on request from the corresponding author.

The data from the entry forms was cleaned, collated and imported into SPSS version 12. Descriptive statistics was used to compare the cases and controls. Chi-squared analysis was conducted to look for associations between the distribution of cases and controls within the demographic sub-groups. Binary logistic regression was used to determine the predictive factors for low birthweight using the following variables: maternal age (≤ 19 years *versus* > 19 years), booking weight (< 50 kg *versus* ≥ 50 kg), maternal weight gain (0−5 kg *versus* > 5 kg), parity (one pregnancy *versus* greater than one pregnancy), antenatal care (early *versus* all other care), blood count (no anaemia (≥ 11.0 g/dL) *versus* anaemia (< 11.0 g/dL), complications (no complication *versus* any complication), employment (employed *versus* unemployed), infant gender (male *versus* female) and delivery type (vaginal delivery *versus* Caesarean section).

RESULTS

The total sample was 627 made-up of 209 cases and 418 controls. The mean birthweight in the < 2.5 kg category was 2.14 kg and in the ≥ 2.5 kg category was 3.14 kg, the difference being 1 kg. The mean weight of the entire sample was 2.81 kg. The mean age of mothers in the < 2.5 kg category was 25.23 years and in the ≥ 2.5 kg category was 25.85 years, the difference being just over seven months. The mean maternal weight gain in the < 2.5 kg category was 5.82 kg and in the ≥ 2.5 kg category was 7.89 kg, the difference being just over 2 kg. The mean booking week in the < 2.5 kg category was 17.97 weeks and in the ≥ 2.5 kg category was 17.53 weeks, the difference being just over three days.

The mean number of visits in the < 2.5 kg category was 6.55 visits and in the ≥ 2.5 kg category was 7.73 visits, the difference being over one visit. Of the mothers, 127 had medical or obstetric complications, this included 17 (2.7%) with asthma, 4 (0.6%) with diabetes, 22 (3.5%) with hypertension, 14 (2.2%) with multiple pregnancies and 58 (9.3%) with obesity. Table 1 presents the demographics of the cases and controls and Table 2 presents the demographics and distribution of variables among cases and controls and the level of statistical association.

Table 1: Characteristics of pregnancies at six health centres in Southwest Trinidad 2008–2010

	Birthweight (< 2.5 kg) n = 209	**Birthweight (≥ 2.5 kg) n = 418**	**Overall mean n = 627**
Mean birthweight (kg)	2.136	3.142	2.807
Mean booking maternal age	25.230	25.849	25.643
Mean maternal weight gain (kg)	5.818	7.888	7.198
Mean maternal booking week	17.967	17.526	17.673
Mean number of visits	6.545	7.727	7.333

The significant factors and the corresponding 95% confidence intervals are shown in Table 3 with an elaboration of the logistic regression factors for the specific subcategory, the corresponding significance levels and confidence levels. The factors that were predictive of higher birthweight were early and adequate number of antenatal visits [OR 0.57 (0.35, 0.92) $p = 0.023$]; male gender of infant [OR 0.69 (0.49, 0.98) $p = 0.040$]; and vaginal delivery [OR 0.61 (0.40, 0.96) $p = 0.031$]. The factors that predicted low birthweight were maternal age ≤ 19 years [OR 1.78 (1.05, 2.93), $p = 0.031$]; low booking maternal weight (< 50 kg) [OR 1.86 (1.18, 2.93), $p = 0.007$]; and a low weight gain (0 – 5 kg) [OR 1.88 (1.28, 2.75), $p = 0.001$]. Factors that were not predictors of birthweight in this analysis were parity, maternal anaemia and employment status.

DISCUSSION

A landmark World Health Organization (WHO) bulletin in 1987 identified seven broad categories for LBW as follows: genetic and constitutional factors, demographic and psychosocial factors, obstetric factors, nutritional factors, maternal morbidity during pregnancy, toxic exposures and antenatal care (25). In this study, we investigated infant gender, mater-

Table 2: Chi-squared analysis to determine associations with birthweight

		Birthweight = < 2.5 kg (%) n = 209	**Birthweight = > 2.5 kg (%) n = 418**	***p*-value**
Maternal age (years)	</= 19	44 (46.8)	50 (53.2)	0.005
	20–35	148 (30.2)	342 (69.8)	
	36 +	17 (39.5)	26 (60.5)	
Maternal booking weight (kg)	< 50	49 (44.1)	62 (55.9)	0.020
	50–75	125 (33.1)	253 (66.9)	
	75.1–90	23 (25.3)	68 (74.7)	
	> 90	12 (25.5)	35 (74.5)	
Maternal weight gain (kg)	0–5	95 (42.4)	129 (57.6)	0.000
	5.1-13	98 (30.2)	226 (69.8)	
	>13	16 (20.3)	63 (79.7)	
Parity	1	78 (39.6)	119 (60.4)	0.004
	2–4	103 (28.1)	263 (71.9)	
	>5	28 (43.8)	36 (56.2)	
Antenatal care	Early booking (< 16weeks) and adequate visits (9)	28 (21.4)	103 (78.6)	0.005
	Early booking (< 16 weeks) and inadequate visits (< 9)	80 (36.4)	140 (63.6)	
	Late booking and inadequate visits	101 (36.6)	175 (63.4)	
Maternal haemoglobin (g/dL)	<11	72 (34.4)	137 (65.6)	0.370
	>/= 11	137 (32.8)	281 (67.2)	
Employment status	Unemployed	160 (33.9)	312 (66.1)	0.337
	Employed	49 (31.6)	106 (68.4)	
Infant gender	male	87 (28.9)	214 (71.1)	0.015
	female	122 (37.4)	2014 (62.6)	
Delivery mode	vaginal	160 (31.1)	354 (68.9)	0.008
	Caesarean	49 (43.8)	63 (56.2)	

Table 3: Binary logistic regression to determine the independent variables associated with birthweight

Variable	**OR (95% CI)**	***p*-value**
Maternal age ≤ 19 years *versus* > 19 years	1.78 (1.053 – 2.934)	0.031
Booking weight < 50 kg *versus* ≥ 50 kg	1.858 (1.180 – 2.926)	0.007
Maternal weight gain 0–5 kg *versus* > 5 kg	1.878 (1.284 – 2.747)	0.001
Parity One pregnancy *versus* > one pregnancy	1.423 (0.953 – 2.125)	0.085
Antenatal Care Early and adequate *versus* all other care	0.568 (0.349 – 0.923)	0.023
Blood count No anaemia (≥ 11.0 g/dL) *versus* anaemia (< 11.0 g/dL)	0.923 (0.633 – 1.346)	0.628
Complications No complication *versus* any complication	0.809 (0.522 – 1.254)	0.343
Employment Employed *versus* unemployed	0.908 (0.600 – 1.375)	0.649
Infant Gender Male *versus* female Gender	0.693 (0.488 – 0.983)	0.040
Delivery type Vaginal delivery *versus* Caesarean section	0.614 (0.395 – 0.956)	0.031

nal weight, maternal age, employment, parity, maternal weight gain, anaemia, maternal disease/complication, first antenatal care visit and number of antenatal care visits as determining factors for LBW.

Being male was significantly protective in this study. Similar results have been described recently (26). Maternal weight was significant in association with LBW in this study with an odds ratio of 1.86. Other studies have demonstrated similar results (27). Mavalankar also illustrated that LBW was greater linked to maternal weight rather than height (28).

Maternal age

In this study, maternal age was significantly associated with low birthweight (OR = 1.78). This is supported by similar evidence from Jamaica (29). In many teenagers, their bodies are not fully developed and their needs would compete with the needs of the growing fetus. It is often the psychosocial burden associated with teen pregnancy that has a negative impact (30). This psychosocial burden may include being single and having little emotional and financial support from the father and family, the emotional stress of an unplanned and unwanted pregnancy, lower educational achievement and competing adolescent interests. Current data forms in Trinidad and Tobago do not capture this information and these could be areas for future study.

There are conflicting views on whether socio-economic status, including employment contributes to LBW, with several studies finding no associations (31) and others a positive association (32, 33). This study supports the former. The literature suggests that the effects of employment on birthweight works in two ways. First, in North America and Ireland, mothers working more than 40 hours per week were more likely to have low birthweight ≥ 37 weeks than women who were working less (32, 33) and secondly, compared with women who remained employed at a financially adequate level during their pregnancy, those who became unemployed, involuntarily switched to part-time work or transitioned to work paying poverty wages bore lighter infants, had elevated odds of giving birth to a low birthweight infant or both. These associations appeared to be mediated in part by infant gestational age (34). Again, there were limitations in the extent of economic information available on the mothers and these are areas for future study.

Parity did not appear to play any significant role in this sample. Primiparity usually conveys more risk than multiparity in terms of LBW. Several studies have illustrated that mothers who had previous children were less likely to deliver LBW infants (35, 36). Parity may be confounded by maternal age as younger mothers tend to be nulliparous.

Optimal weight gain is the weight that is associated with the best infant survival rate. This optimal weight gain has been updated to 25 to 35 lbs if mother starts at a BMI of 19.8–26.0 kg/m^2 (37). Maternal weight gain has been shown to be positively correlated to birthweight as was shown in this study. Mothers who were underweight at the start of pregnancy and gain greater weight will potentially benefit more and thus, have a lower number of babies with LBW (38).

Anaemia in pregnancy is described as a low haemoglobin level that occurs in pregnancy with the diagnosis being made from a purely laboratory (haematological) basis. The WHO uses the value of less than 11.0 g/dL of haemoglobin (39). Interestingly, despite previous studies that suggest that many Trinidadian females carry low haemoglobin values in early pregnancy (40), in this study it was shown that anaemia was not statistically associated with LBW. A recent study in China suggests otherwise for anaemia [< 10 g/dL at 8–10 weeks gestation] (41). Future studies could look at the lower levels of haemoglobin than that used in this study and its association with LBW.

In this study about 80% of mothers had no identifiable complication or disease. All of the four diabetic mothers had babies that were in the ≥ 2.5 kg category. All of the infants from multiple pregnancy deliveries were low birthweight as expected due to size and weight restriction to the growing fetuses.

Antenatal care has been shown to affect birthweight in many studies. Two components of antenatal care are important and these are – gestational age at first visit and the number of visits. The Maternal and Child Health Manual of Trinidad and Tobago deals specifically with these variables and it is ideally suggested that the first clinic visit be before 16 completed weeks and that there should be at least nine clinic visits (21). In this study, there was a significant correlation between birthweight and the number of visits as supported by recent research (42). There was no such correlation with week of first/booking visit as also shown in the Kramer meta analysis (25).

No information on participant ethnicity was available in this study, however, the population of the South Western region of Trinidad has a high proportion of South Asians (SA) and there is evidence that SA infants with the serum paraoxonase/arylesterase 2 (PON2) and human paraoxonase (PON) genes have lower birthweights (43).

The contribution from each centre depended on the number of cases initially included / obtained from each of the health centres in the primary care setting. As these two arms of the study consisted of persons from the same centres, the two groups should have similar general demographics. The differences in the risk factors should generally be the only differing features between the groups as a large sample was utilized.

Limitations of this study are in keeping with a case control design requiring retrospective data extraction. These included challenges with incomplete records – 126 sets of notes had to be excluded. There were incomplete records on weight gain, haemoglobin levels, past maternal medical history, past abortions (as these are illegal in Trinidad and Tobago), fetal growth (as ultrasounds are not always available). Many other hypotheses could not be tested because of inadequate data collection including information on ethnicity, diet and height, smoking, alcohol, drug use, supplements and socio-economic variables such as marital status, maternal stress in pregnancy, maternal education and financial support.

Recommendations

The authors are of the view that what is now needed is action through policies, plans and programmes to address the preventable aspects of LBW. There has been very few new developments in antenatal care in Trinidad over the past 20 years. There are opportunities for reviewing our national policy, for developing a more extensive data collection tool than currently applies, which will include many of the variables listed above and digitizing the information to make this type of study quicker and easier will make the study of the other variables and evaluation simpler in the future.

CONCLUSION

The factors that were significantly associated with LBW in this study were – teenage maternal age, < 50 kg maternal booking weight and ≤ 5 kg maternal weight gain. The factors that were significantly associated as protective against LBW in this study were - early and adequate antenatal care, male gender and vagi-nal delivery. The factors that showed no association with LBW in this study were – parity, maternal anaemia and employment status.

The most important recommendations coming from this study would be to promote more extensive antenatal care, continue to encourage maternal education and encourage teens in delaying their first pregnancy. These recommendations if instituted should allow for a decrease in the prevalence of LBW and help reach Millennium Development Goals (MDGs) 4 (reduction in child morbidity) and 5 [improving maternal health](44), reduce the burden of future chronic diseases and reduce the overall economic burden and costs that are all associated with LBW.

ACKNOWLEDGMENTS

The authors wish to thank Dr G Legall and the dedicated nursing and clerical staff at the health centres, South West Regional Health Authority and Ministry of Health.

AUTHORS' NOTE

Approval for conducting the study was granted in 2011 by the Ethics Committees of both the Medical Sciences Faculty, The University of the West Indies, St Augustine, Trinidad and the SouthWest Regional Health Authority.

REFERENCES

1. WHO Low Birth Weight. Available from: http://www.childinfo.org/files/low_birthweight_from_EY.pdfAccessed on 23 May 2014.
2. UNICEF data Low Birth Weight. Available from: http://www.childinfo.org/low_birthweight_profiles.php Accessed on 21 November 2014.
3. Hoekelman RA, Adam HM, Nelson NM, Weitzman ML, Wilson MH eds. Primary pediatric care 4th Ed. St Louis, Missouri: Mosby; 2001; p. 595–8.
4. Young J, Trotman H, Thame M. The Impact of Antenatal Care on Pregnancy Performance between Adolescent Girls and Older Women. West Indian Med J 2007; **56:** 414–20.
5. Trotman H, Lord C. Outcome of extremely low birth weight infants at the University Hospital of the West Indies. Jamaica. West Indian Med J 2007; **56:** 409–13.
6. Poonai APV, Morris DEU, Persaud TVN, Poonai PV. Birth weight in Jamaican twins. West Indian Med J 1973; **22:** 77–84.
7. Sparke B, Lowry MF. Neonatal Death at the University Hospital of the West Indies. West Indian Med J 1978; **27:** 130–6.
8. Meadow W, Lee G, Lin K, Lantos J. Changes in mortality for extremely low birth weight infants in the 1990s: implications for treatment decisions and resource use. Pediatrics 2004; **113:** 1223–9.
9. Stanley F. Addressing low birth weight and infant mortality. Am J Pub Health 1993; **83:** 119–20.
10. Baby Center. Expert Advice. Fetal Parameters. Available from: http://www.babycenter.com/average-fetal-length-weight-chart. Accessed on 23 May 2014.
11. Goldstein H. Factors related to birth weight and perinatal mortality. Br Med Bull 1981; **37:** 259–64.
12. Ceesay SM, Prentice AM, Cole TJ, Foord F, Weaver LT, Poskitt EM et al. Effects on birth weight and perinatal mortality of maternal dietary supplements in rural Gambia: 5 year randomized controlled trial. BMJ 1997; **315:** 786–90.
13. De Silva OP. Prevention of low birth weight/preterm birth. In: Canadian Task Force on the Periodic Health Examination. Ottawa: Health Canada; **1994:** 38–50.
14. Sun Y, Vestergaard M, Pedersen CB, Christensen J, Basso O, Olsen J. Gestational age, birth weight, intrauterine growth, and the risk of epilepsy. Am J Epidemiol 2008; **167:** 262–70.
15. Shenkin SD, Starr JM, Deary IJ. Birth Weight and cognitive ability in childhood: a systematic review. Psychol Bull 2004; **130:** 989–1013.
16. Ravelli AC, van der Meulen JH, Michels RP, Osmond C, Barker DJ, Hales CN et al. Glucose tolerance in adults after prenatal exposure to famine. Lancet 1998; **351:** 173–7.
17. Barker DJ. Intrauterine programming of adult disease. Mol Med Today 1995; **1:** 418–3.
18. UNICEF. Under five and infant mortality. Available from: http://data.unicef.org/child-mortality/under-five. Accessed on 21 November 2014.
19. Sicuri E, Bardají´ A, Sigauque B, Maixenchs M, Nhacolo A. Costs associated with low birth weight in a rural area of Southern Mozambique. PLoS ONE 2011; **6:** e28744.
20. Lewit EM, Baker LS, Corman H, Shiono PH. The direct cost of low birth weight. Future Child 1995; **5:** 35–56.
21. Office of Chief Medical Officer. Maternal and Child Health Manual for Trinidad and Tobago. Port of Spain, Ministry of Health, Government of Republic of Trinidad and Tobago, 1992.
22. WHO 2006. whqlibdoc.who.int/publications/**2006**/924159084x_eng.pdf
23. Woolson RF, Bean JA, Rojas PB. Sample size for case control studies using Cochran's statistic. Biometrics 1986; **42:** 927–32.
24. Cochran WG. Some methods for strengthening the common χ^2 tests. Biometrics 1954; **10:** 417–51.
25. Kramer MJ. Determinants of low birth weight: methodological assessment and data analysis. Bull World Health Org 1987; **65:** 663–737.
26. Khanal V, Sauer K, Karkee R, Zhao Y. Factors associated with small size at birth in Nepal: further analysis of Nepal Demographic and Health Survey 2011. BMC Pregnancy Childbirth 2014; **14:** 32.
27. Revilane Parente de Alencar Britto, Telma Maria Toledo Florêncio, Ana Amelia Benedito Silva, Ricardo Sesso, Jairo Calado Cavalcante, and Ana Lydia Sawaya. Influence of Maternal Height and Weight on Low Birth Weight: A Cross-Sectional Study in Poor Communities of Northeastern Brazil PLoS One. 2013; **8:** e80159.
28. Mavalankar DV, Trivedi CC, Gray RH. Maternal weight, height and risk of poor pregnancy outcome in Ahmadabad, India. Indian Pediatr 1994; **31:** 1205–12.
29. Thame M, Wilks R, Matadial L, Forrester TE. A comparative study of pregnancy outcome in teenage girls and mature women. West Indian Med J 1999, **48:** 69–72.
30. Hashim TJ, Moawed SA. The relation of low birth weight to psychosocial stress and maternal anthropometric measurements. Saudi Med J 2000; **21:** 649–54.
31. Kozhimannil KB, Attanasio LB, McGovern PM, Gjerdingen DK, Johnson PJ. Reevaluating the relationship between prenatal employment and birth outcomes: a policy-relevant application of propensity score matching. Womens Health Issues 2013; **23:** e77–85.

32. Peoples-Sheps MD, Siegel E, Suchindran CM, Origasa H, Ware A, Barakat A. Characteristics of maternal employment during pregnancy: effects on low birthweight. Am J Public Health; **8:** 1991.
33. Niedhammer I, O'Mahony D, Daly S, Morrison J, Kelleher C. Occupational predictors of pregnancy outcomes in Irish working women in the lifeways cohort. BJOG 2009; **116:** 943–52.
34. Dooley D, Prause J. Birth weight and mothers' adverse employment change. J Health Soc Behav 2005; **46:** 141–55.
35. Muula AS, Siziya S, Rudatsikira E. Parity and maternal education are associated with low birth weight in Malawi. Afr Health Sci 2011; **11:** 65–71.
36. Hirve SS, Ganatra BR. Determinants of low birth weight: a community based prospective cohort study. Indian Pediatr 1994; **31:** 1221–5.
37. Rasmussen KM, Catalano PM, Yaktine AL. New guidelines for weight gain during pregnancy: what obstetrician/gynecologists should know. Curr Opin Obstet Gynecol 2009; **21:** 521–6.
38. Walker SP, Ewan-Whyte C, Chang SM, Powell CA, Fletcher H, McDonald D et al. Factors associated with size and proportionality at birth in term Jamaican infants. J Health Popul Nutr 2003; **21:** 117–26.
39. World Health Organization (WHO) The prevalence of Anaemia in women: a tabulation of available information. Geneva, Switzerland: WHO; 1992. WHO/MCH/MSM/92.2.
40. Uche-Nwachi EO, Odekunle A, Jacinto S, Burnett M, Clapperton M, David Y. Anaemia in pregnancy: associations with parity, abortions and child spacing in primary healthcare clinic attendees in Trinidad and Tobago. Afr Health Sci 2010; **10:** 66–70. PMCID: PMC2895803.
41. Bian Y, Zhang Z, Liu Q, Wu D, Wang S. Maternal risk factors for low birth weight for term births in a developed region in China: a hospital-based study of 55,633 pregnancies. J Biomed Res 2013; **27:** 14–22.
42. Khatun S, Rahman M. Quality of antenatal care and its dose-response relationship with birth weight in a maternal and child health training institute in Bangladesh. J Biosoc Sci 2008; **40:** 321–37.
43. Busch CP, Ramdath DD, Ramsewak S, Hegele RA. Association of PON2 variation with birth weight in Trinidadian neonates of South Asian ancestry. Pharmacogenetics 1999; **9:** 351–6.
44. Improve Maternal Health. MDG 4 and 5. Available from: http://www.un.org/millenniumgoals/ Accessed on 18th. November 2014.