Original paper

Association of maternal socio-demographic factors, maternal anthropometric measurements, and foetal sex with LGA newborns in Sri Lanka

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Abstract

Introduction: There is an increased trend of delivering large for gestational age (LGA) newborns globally, which has already caused significant impact on health, nutrition, economics, and social aspects. LGA newborns are more vulnerable for complications developed from intrauterine life to adulthood and it is becoming additional burden to the health care and economic state of the country. However, we lack published data on incidence, trend and factors affecting LGA newborns in Sri Lanka. Determination of risk factors associated with LGA newborns would help to formulate and implement effective preventive measures.

Method: A case control study was carried out at obstetrics and gynaecology unit, Teaching Hospital Kandy from 01.01.2016 to 31.12.2016. Systematic sample technique was used, and study sample was consisted of 44 cases and 132 controls. Pretested interviewer administered questionnaire was used for data collection. Significance of associations between dependent and independent variables was estimated using probit regression model. Probit coefficient was estimated to assess the significance and respective marginal effects were estimated to assess the magnitude of significance. STATA software was used for analysis. Ethical clearance was obtained from ethical review committee, Teaching Hospital Kandy.

Results: According to probit regression estimates of socio-demographic factors, maternal parity of two (Coefficient 1.89: 95% CI 0.75-3.03: P <0.05) or more (Coefficient 2.37: 95% CI 0.92-3.82: P <0.05), Monthly family income of more than 30,000/= rupees (Coefficient 2.28: 95% CI 0.92-3.63: P<0.05) and Tamil ethnicity (Coefficient 2.10: 95% CI 0.69-3.52: P<0.05) were statistically significant risk factor. In the analysis, maternal age (Coefficient 0.09: 95% CI -0.05-0.23: P>0.05), mother's occupation (Coefficient 0.08: 95% CI -1.01-1.17: P>0.05) and maternal educational level (Coefficient 1.68: 95% CI -0.30-3.66: P>0.05) were not significant risk factors at 5% significance level. Considering the maternal anthropometric measurements, maternal weight gain during pregnancy (Coefficient 0.77: 95% CI 0.50-1.03: P<0.05) was a significant risk factor. Maternal BMI at booking visit (Coefficient 1.76: 95% CI -0.34-3.85: P>0.05), maternal weight at booking visit (Coefficient -0.63: 95% CI -1.5-0.26: P>0.05) and maternal height (Coefficient 0.56: 95% CI -0.08-1.2: P>0.05) were not significant risk factors in the analysis at 5% significance level. Foetal sex (Coefficient -0.69: 95% CI -1.5-0.13: P>0.05) was not a significant causative factor at 5% significance level.

Conclusions: Among maternal socio-demographic factors, high monthly family income, parity of 2 or more and Tamil ethnicity were determined as statistically significant risk factors for LGA newborns. Among maternal anthropometric measurements, increased weight gain during pregnancy was determined as significant modifiable risk factor for LGA newborns. Maternal weight gain during pregnancy should be monitored throughout the antenatal period from the booking visit to identify mothers at risk. Effective interventions should be designed to minimize the negative impact on mothers at risk.

Key words: large for gestational age, anthropometric, socio-demographic

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Introduction

Large for gestational age (LGA) newborn is defined as birth weight more than the 90th centile of the population specific customized growth charts[1]. Macrosomia is defined as birthweight more than 4000g irrespective of gestational age, by the American College of Obstetricians and Gynecologists[2]. LGA newborns are considered more liable to develop complications[3,4,5,6,7,8].

Increased infant, neonatal and perinatal mortality and morbidity are associated with LGA babies. LGA babies are more prone to have childhood obesity and diabetes mellitus in later life. Cardiovascular diseases and some metabolic syndromes in middle age of life are also associated with LGA newborns. Macrosomic newborns are more likely to develop perinatal complications such as intrauterine foetal death, birth asphyxia, assisted vaginal delivery, lower segment cesarean sections (LSCS) and birth injuries during delivery[3,4,5,6]. Most of intrapartum injuries are due to obstruction within the birth canal. Shoulder dystocia and brachial plexus injuries are more prevalent among babies with LGA newborns. Usually, they are having prolonged duration of labour which can lead to meconium aspiration, birth asphyxia and neonatal hypoglycaemia. Rate of admissions for special care baby units are increased among LGA babies. Ultimately the hospital stay of mother and baby will be prolonged.

Studies showed that there is an increased trend of delivering LGA newborns globally, which already caused significant impact on health, nutrition, economics, and social aspects. Kramer MS did a hospital-based cohort study[9] to describe temporal trends in foetal "growth" and to examine the roles of socio-demographic, anthropometric, and other determinants, using the data from 1978 to 1996 at Royal Victoria Hospital and McGill University Teaching Hospital, involving 61,437 non-malformed singleton live births. Results of the study found that term and post term LGA newborns increased from 8.0% to 11.5%. Study done in New South Wales[13], involving 1,273,924 singleton live births during year 1990 - 2005 found 18%-21% increased incidence of LGA newborns. A study done in South-East China[11], involving 594,472 singleton live births during 1994 to 2005 found that incidence of LGA births increased from 13.72% in 1994 to 18.08% in 2005. Another study done in Sweden[14], using the population-based Swedish birth register, involving 874,163 live singleton deliveries, from year 1992 to 2001, found that the risk of LGA birth increased by 23% over 10 years.

Studies on factors associated with LGA newborns were carried out worldwide. It was studied that factors associated with LGA newborns were different among different ethnic groups, different cultural backgrounds, and different geographical areas. According to available data, gestational diabetes, pre-gestational diabetes, maternal obesity, advanced maternal age, increased parity, history of previous LGA birth, ethnicity, marital status, increased maternal weight gain during pregnancy and post term delivery are considered to be statistically significant factors associated with LGA babies worldwide.

It was observed that there is an increasing trend of LGA newborns among Sri Lankan population too. However, we lack the published data on incidence, trend and factors affecting LGA newborns in Sri Lanka. Sri Lankan population is different from most of the other populations in the world due to differences in genetical and cultural factors. The adoption of an inappropriate reference can result in misleading inference, with the consequent possibility of invalid findings. Therefore, it was essential to identify the factors affecting LGA newborns in Sri Lanka. Rising trend of LGA newborns will have a significant negative impact on the healthcare, social care and economy of the country. Determination of risk factors associated with LGA newborns would help to formulate and implement effective preventive measures. Therefore, this study was intended to determine the association of socio-demographic and anthropometric factors with LGA newborns.

Methodology

This was a case control study carried out at the Obstetrics and Gynaecology Unit, Teaching Hospital Kandy for 12 months period from 01.01.2016 to 31.12.2016. The study population included all live births of uncomplicated singleton pregnancies which completed 24 weeks or more. A case constituted a mother with a singleton pregnancy, uncomplicated with diabetes and who delivered LGA newborn. A control constituted an uncomplicated mother with a singleton pregnancy, who had delivered an average for gestational age baby.

Estimated sample size was 176 and the required number of cases (44) and controls (132) were selected from the study population by systematic sampling. For each LGA newborn, three matched subsequent deliveries of normal for gestational age were taken according to the case/control definitions and inclusion criteria.The assumptions considered when calculating sample size included the probability that if the 2 samples differ, this reflects a true difference in the 2 populations (confident level or 1-α): 95.0%, the probability that if the 2 populations differ, the 2 samples will show a "significant" difference (power or 1-β): 80.0%, Odds ratio: 3, number of controls per case: 3 and expected frequency of possible exposure factors among control group: 50.0%.

Interviewer administered structured questionnaire was used as the study instrument. The questionnaire consisted of maternal socio-demographic characteristics, maternal anthropometric measurements, birthweight, and foetal sex. Since dependant variable is binary (1=LGA newborns and zero otherwise), associations between individual variable and dependent variable were estimated using Probit regression model. STATA software was used for estimations. Regression techniques outperform correlation analysis, given that regression techniques are capable of establishing the causality between independent and dependent variables. During this method of analysis, when calculating the association of dependent variable with a selected independent variable, all the other independent variables were kept constant to assure the causality of the selected variable. Since it is utmost important to investigate magnitude of all above mentioned relationships, we estimated respective marginal effects of the probit coefficients. 95% confidence interval / 0.05 probability cut off were applied for statistical significance.

Ethical approval was obtained from ethical review committee, Teaching Hospital Kandy.

Results

There were 176 participants in the study sample (Cases -44: Controls-132). All continuous data were categorised into groups and described by using frequencies and percentages. Mean and standard deviation were calculated for continuous variables.

Table 1 shows the distributions of socio-demographic factors of the study participants. Minimum age reported within the study sample was 18 years and the maximum age was 43 years. Mean age of the study participants was 30 years (SD=4.16 years). Among all the participants, 38% belonged to the age group of 25 to 29 years (N=67) and another 38% participants belonged to age group of 30 to 34 years (N=66). 41.2% of participants in the study presented with their second pregnancy (N=73).

All the participants in the study group were married (N=176: 100%). Majority of the participants were Sinhalese (N=154: 88%) while 8% were Tamils and 4% were Muslims.

Majority of the mothers were unemployed (N=145: 82%) and majority of participants were studied up to grade 11 (N=99: 56%). Most of the participants had monthly family income between 20,001/= to 30,000/ = rupees (N=93: 53%).

Table 2 shows mothers with parity of two (Coefficient 1.89: 95% CI-0.75-3.03: P <0.05) or more (Coefficient 2.37: 95% CI-0.92-3.82: P <0.05) were more likely to deliver LGA newborns compared to primi mothers.

The probability of having LGA baby in the second pregnancy was 20% higher (Table 3: dy/dx 0.22: 95% CI-0.02-0.44: P<0.05), whereas in the third or subsequent pregnancies it was 50% higher (Table 3: dy/dx 0.51: 95% CI-0.10-0.93: P<0.05) when compared to first baby.

It is shown in table 2 that mother's occupation (Coefficient 0.08: 95% CI-1.01-1.17: P>0.05) and maternal educational level (Coefficient 1.68: 95% CI -0.30-3.66: P>0.05) were not statistically significant risk factors for LGA newborns since respective coefficients were not significant at 95% confidence interval.

Mothers who had a monthly family income of more than 30,001/= rupees had a significant association with LGA newborns (Table 2: Coefficient 2.28: 95% CI 0.92-3.63: P<0.05). Among them, mothers who had family income of 30,001/= to 40,000/= rupees had 45% higher probability (table 03: dy/dx 0.45: 95% CI 0.03-0.86: P<0.05) of having LGA baby compared to low-income group. Monthly family income of more than 40,000/= rupees had even higher risk of 70% (Table 3: dy/dx 0.72: 95% CI 0.12-1.31: P<0.05).

Table 4 shows the distribution of maternal anthropometric measurements among study participants. BMI values of the study participants were ranged between 14.0kg/m^2 to 31.6kg/m^2.

Majority of the mothers belonged to normal BMI category of 18.5 to 24.9kg/m^2 (N=127; 72%). 20% of them were overweight (25 - 29.9kg/m^2) and only 2% were obese (>30kg/m^2). Mean BMI was 22.87kg/m^2 (SD=3.087kg/m^2).
Maternal weight was ranged between 34kg to 75kg.

Table 1. Distribution of socio-demographic factors

Variable	Subcategory	Frequency	Percentage
Age	<19	1	1%
	20-24	17	10%
	25-29	67	38%
	30-34	66	38%
	≥35	25	14%
	Total	**176**	**100%**
Parity	1	65	37%
	2	73	41%
	≥3	38	22%
	Total	**176**	**100%**
Marital Status	Married	176	100%
	Unmarried	0	0%
	Separated	0	0%
	Other	0	0%
	Total	**176**	**100%**
Ethnicity	Sinhala	154	88%
	Tamil	15	8%
	Muslim	7	4%
	Other	0	0%
	Total	**176**	**100%**
Occupation	Unemployed	145	82%
	Labourer Job	7	4%
	Clerical Job	14	8%
	Technical Job	2	1%
	Professional Job	8	5%
	Undetermined	0	0%
	Total	**176**	**100%**
Mother's Level of Education	No Schooling	0	0%
	Grade 1-5	12	7%
	Grade 6-11	87	49%
	Advance Level	66	38%
	Higher Studies	11	6%
	Total	**176**	**100%**
Monthly Family Income (Rupees)	<10,000	0	0%
	10,001 - 20,000	20	11%
	20,001 - 30,000	93	53%
	30,001 - 40,000	43	24%
	≥40,001	20	11%
	Total	**176**	**100%**

Table 2. Probit regression of socio-demographic factors

Variable	Coefficient	Standard Error	Z	P > |Z|	95% confidence interval	
Age	0.091	0.07	1.25	0.212	-0.052	0.235
Parity						
P2	1.891	0.58	3.25	0.001	0.752	3.031
≥P3	2.373	0.74	3.22	0.001	0.929	3.818
Marital Status	-	-	-	-	-	-
Occupation						
Employed	0.076	0.56	0.14	0.888	-1.014	1.171
Mothers level of education						
Grade 1 - 5	-0.770	1.57	-0.49	0.624	-3.848	2.307
Grade 6 - 11	1.516	1.10	1.38	0.167	-0.635	3.668
A/L - higher	1.680	1.01	1.67	0.096	-0.296	3.657
Monthly family income						
20,001 to 30,000	0.126	0.65	0.19	0.847	-1.153	1.404
30,001 to 40,000	2.282	0.69	3.3	0.001	0.926	3.638
≥40,000/=	2.778	1.07	2.6	0.009	0.682	4.874

Number of obs = 176, Wald chi^2 (15) = 79.88, Pseudo R^2 = 0.762

Table 3. Marginal effects after probit regression (socio-demographic factors)

Variable	dy/dx	Standard Error	Z	P > |Z|	95% confidence interval		X
Age	0.007	0.01	1.2	0.231	-0.004	0.017	29.858
Parity							
P2*	0.228	0.11	2.16	0.031	0.020	0.435	0.415
≥P3*	0.515	0.21	2.41	0.016	0.096	0.933	0.199
Marital Status	-	-	-	-	-	-	-
Occupation							
Employed*	0.006	0.04	0.14	0.89	-0.082	0.094	0.176
Mothers level of education							
Grade 1 - 5*	-0.031	0.04	0.85	0.39	-0.105	0.041	0.068
Grade 6 - 11*	0.137	0.13	1.05	0.29	-0.119	0.393	0.494
≥A/L *	0.208	0.19	1.1	0.27	-0.162	0.579	0.375
Monthly family income							
20,001 to 30,000*	0.009	0.05	0.19	0.84	-0.084	0.102	0.528
30,001 to 40,000*	0.446	0.21	2.1	0.03	0.029	0.863	0.244
≥40,001/=*	0.718	0.30	2.37	0.01	0.123	1.312	0.115

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Table 4. Distribution of anthropometric measurements of the study participants

Variable	Subcategory	Frequency	Percentage
Maternal BMI at booking visit (kg/m^2)	<18.5 18.5-24.9 25-29.9 ≥30	10 127 35 4	6% 72% 20% 2%
	Total	**176**	**100%**
Maternal weight at booking visit (kg)	<40 40-49.9 50-59.9 60-69.9 ≥70	5 32 73 55 11	3% 18% 41% 31% 6%
	Total	**176**	**100%**
Maternal height (cm)	<145 145-154.9 155-164.9 ≥165	8 38 116 14	5% 22% 66% 8%
	Total	**176**	**100%**
Maternal weight gain during pregnancy (kg)	<5 5-9.9 10.14.9 ≥15	0 35 120 21	0% 20% 68% 12%
	Total	**176**	**100%**

Mean weight of the participants was recorded as 56.13kg (SD=8.16kg). Mean height of study participants was 134.5cm (SD=6.01cm). Minimum height was 134.5cm and maximum height was 180.0cm. Maternal weight gain during pregnancy was ranged between 5kg to 20kg. Average weight gain during pregnancy was 11.13kg (SD=2.63kg).

Significance of the association between maternal anthropometric measurements and LGA newborns is shown in Table 5 and Table 6. Maternal weight gain during pregnancy was a statistically significant risk factor for LGA newborns (Table 5: Coefficient 0.77: 95% CI-0.50-1.03: P<0.05). There was a 5% increased risk of having LGA newborn with each 1-kilogram increase in maternal weight during pregnancy (Table 6: dy/dx 0.057: 95% CI-0.009-0.1: P<0.05).

BMI at booking visit (table 05: Coefficient 1.76: 95% CI -0.34-3.85: P>0.05) and maternal height (Table 5: Coefficient 0.56: 95% CI-0.08-1.2: P>0.05) were likely to cause LGA newborns, however the probit regression did not show statistically significant causality at 5% significance level. Maternal weight at booking visit did not show significant association (Table 5: Coefficient -0.63: 95% CI-1.5-0.26: P>0.05) with LGA newborns.

According to distribution of sex of newborn (Table 7), there were 96 male babies (55%) and 80 female babies (45%). There was no significant causality by foetal sex for LGA newborns at 5% significance level (Table 8: Coefficient -0.69: 95% CI-1.5-0.13: P>0.05).

Table 5. Anthropometric measurements of the study participants – probit regression

Variable	Coefficient	Standard Error	Z	P > |Z|	95% confidence interval	
BMI at booking visit	1.756	1.069	1.64	0.1	-0.339	3.852
Maternal height	0.562	0.327	1.72	0.085	-0.079	1.204
Maternal weight at booking	-0.625	0.450	-1.39	0.165	-1.508	0.258
Weight gain during pregnancy	0.768	0.137	5.62	0	0.501	1.037

Number of obs = 176, Wald chi^2 (15) = 79.88, Pseudo R^2 = 0.762

Table 6. Anthropometric measurements of the study participants – marginal effects after probit regression

Variable	dy/dx	Standard Error	Z	P > |Z|	95% confidence interval		X
BMI at booking visit	0.129	0.08	1.7	0.089	-0.019	0.278	22.88
Maternal height	0.041	0.02	1.73	0.084	-0.006	0.088	156.61
Maternal weight at booking	-0.056	0.03	-1.48	0.139	-0.107	0.015	56.13
Weight gain during pregnancy	0.057	0.02	2.32	0.02	0.009	0.104	11.13

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Table 7. Distribution of sex of the newborn

Variable	Subcategory	Frequency	Percentage
Sex of the baby	Male	96	55%
	Female	80	45%
	Total	**176**	**100%**

Table 8. Foetal sex – probit regression

Variable	Coefficient	Standard Error	Z	P > |Z|	95% confidence interval	
Sex of the baby	-0.690	0.42	-1.66	0.097	-1.505	0.125

Number of obs = 176, Wald chi^2 (15) = 79.88, Pseudo R^2 = 0.762

Table 9. Foetal sex – marginal effects after probit regression

Variable	dy/dx	Standard Error	Z	P > |Z|	95% confidence interval		X
Sex of the baby*	-0.056	0.04	1.41	0.159	-0.135	0.022	0.545

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Discussion

This study found evidence to claim that parity of two or more, high monthly family income and increased weight gain during pregnancy were statistically significant causal factors for LGA newborns at 5% significance level.

Even though there was no significance at 95% confidence level, maternal height, education above the grade 11 and sex of the newborn showed higher probability of delivering LGA newborns at 10% significance level. Advanced maternal age was only significant at 21.2% significance level; thus, the effect of maternal age was not highly influential according to the present study. Mother's occupation, maternal weight at booking visit and maternal BMI at booking visit were statistically insignificant in the analysis.

Shu et al in 2010 in Australia found that history of previous pregnancy has increased the risk of LGA newborns by 2 times 13 (OR- 2.03: 95% CI-1.08-3.81). The study done by Jaipaul et al in 2009 in Northern and Central Alberta and the study done by Jolly et al in 2003 in England, identified higher parity as a causative factor for LGA newborns[15,17]. Similarly, present study showed the parity of two or more was a significant risk factor for LGA newborns. Further, it sub-analyzed the number of parity, and found parity of 2 had 20% increased risk (dy/dx 0.22: 95% CI-0.02- 0.44: P<0.05) and parity of three or more had 50% increased risk (dy/dx 0.51: 95% CI 0.10-0.93: P<0.05) when compared to primi mothers.

Higher monthly family income was a significant independent risk factor in the present study. Mothers who had family income of 30,001/= to 40,000/= rupees had 45% higher probability (dy/dx 0.45: 95% CI-0.03-0.86: P<0.05) and mothers who had more than 40,000/= rupees had 72% higher probability (dy/dx 0.72: 95% CI-0.12-1.31: P<0.05) of having LGA newborns compared to lower income group. However, other studies had not identified higher family income as a causative factor.

According to present study, increased maternal weight gain during pregnancy was a statistically significant independent risk factor for LGA newborns. There was a 5% increased risk of having LGA newborn per each 1kg increase in maternal weight during pregnancy (dy/dx 0.057: 95% CI-0.009-0.1: P<0.05). The study done by Kramer et al in 2002 also concluded the increased maternal weight gain during pregnancy was associated with term and post term LGA deliveries[9].

Jolly et al in 2003 in England described the advanced maternal age more than 40 years had 1.22 times increased risk (OR 1.22: 95% CI-1.11-1.35) of having LGA newborns[15]. But age variable was not statistically significant at 5% significance level in the present study (Coefficient 0.09: 95% CI-0.05-0.23: P>0.05).

Contemporary literature does not provide adequate evidence on associations between mother's occupation and maternal educational level with LGA newborns. Present study attempted to investigate the associations between mother's occupation (Coefficient 0.08: 95% CI-1.01-1.17: P>0.05) and maternal educational level (Coefficient 1.68: 95% CI-0.30-3.66: P>0.05) with LGA newborns and found they were statistically insignificant.

Kramer et al in 2002 and Shu et al in 2010 had showed a positive association between pre gestational obesity and LGA newborns (OR=2.73: 95% CI-1.49-5.01)[9,13]. Further the study done by Jolly et al in 2003 found that BMI more than 30kg/m^2 had doubled the risk of delivering a LGA newborn compared to mother with normal BMI[15]. Even though the maternal BMI at booking visit appeared to be increased the likelihood of LGA newborns, present study did not find statistically significant causality by maternal BMI at booking visit (Coefficient 1.76: 95% CI-0.34-3.85: P>0.05), maternal weight at booking visit (Coefficient -0.63: 95% CI-1.5-0.26: P>0.05) and maternal height (Coefficient 0.56: 95% CI-0.08-1.2: P>0.05) at 5% significance level.

Conclusion

Among maternal socio-demographic factors considered in the study, parity of 2 or more was determined as statistically significant non-modifiable risk factors for LGA newborns, whereas high monthly family income was determined as statistically significant modifiable risk factor. Maternal age, mother's occupation and maternal educational level were not significant risk factors for LGA newborns at 5% significance level. Among maternal anthropometric measurements, increased weight gain during pregnancy was determined as significant modifiable risk factors for LGA newborns. Maternal BMI at booking visit, maternal height and maternal weight at booking visit were not significant risk factors for LGA newborns at 5% significance level. Foetal sex was not a significant risk factor for on LGA newborns at 5% significance level.

Limitations

This study was limited to a single treatment unit of a local hospital setting and the sample size was relatively small, and it may have caused the differences in the results of the study when compared with similar studies done at other countries of the world. Therefore, multicentered study design would be more accurate in generalizing the finding to Sri Lankan Population. However, this study will be continued, and a bigger sample will be analyzed resulting in more reliable findings.

Since this study was carried out at a hospital setting, there was a limitation for the external validity of the data. However, 99% of the child births in Sri Lanka occur at hospital setup and it is possible to assume that the effect of the systematic error created by using only hospital data was minimal.

A retrospective data collection method was applied in the study and data collection was done only by the principal investigator. Both these factors left a room to possible information bias in the study. The impact was minimized by asking closed ended questions and standard set of answers.

Previous birth weight is an identified associated factor for LGA babies. However, in the present study it was excluded since the methodology (probit regression model) used to analyze the association of factors with LGA newborns cannot be applied to analyze the association between previous birth weight and LGA newborns.

Since this was a retrospective case control study, there was not any verification regarding the accuracy of the instrumental measurements. Further, there was not any arrangement to evaluate the skills of the people who gathered those measurements and possible errors which could have happened while documentation. Therefore, both instrumental errors and observer errors were expected to occur, but there is no mechanism to minimize these errors in a retrospective study design.

References

1. Unterscheider J, Daly S, Geary MP, Kennelly MM, McAuliffe FM, Donoghue K, Hunter A, Morrison JJ, Burke G, Dicker P, Tully EC, Malone FD. Definition and management of foetal growth restriction: a survey of contemporary attitudes. European Journal of Obstetrics Gynaecology and Reproductive Biology 2014; 174: 41-5.
2. Boulet SL, Alexander GR, Hamisu MS. Macrosomic births in the United States: Determinants, Outcomes and proposed grades of risk. American Journal of Obstetrics and Gynaecology 2003; 188: 1372-8.
3. Hediger M, Overpeck M, McGlynn A, Kuczmarski R, Maurer K, Davis W. Growth and fatness at three to six years of age of children born small or large for gestational age. Paediatrics 1999; 104: 33-9.
4. Raio L, Ghezzi F, Di Naro E, Buttarelli M, Franchi M, Durig P, Bruhwiler H. Perinatal outcome of foetuses with a birth weight greater than 4500g. European Journal of Obstetrics Gynaecology and Reproductive Biology 2003; 109(2): 160-5.
5. Stotland NE, Caughey AB, Breed EM, Escobar GJ. Risk factors and obstetric complications associated with macrosomia. International Journal of Gynaecology and Obstetrics 2004; 87: 220-6.

6. Das UG, Sysyn GD. Abnormal foetal growth: intrauterine growth retardation, small for gestational age, large for gestational age. Paediatric Clinics North America 2004; 51: 639-54.
7. Giapros V, Evagelidou E, Challa A, Kiortsis D, Drougia A, Andronikou S. Serum adiponectin and leptin levels and insulin resistance in children born large for gestational age are affected by the degree of overweight. Clinical Endocrinology 2007; 66: 353-9.
8. Boney CM, Verma A, Tucker R, Vohr BR. Metabolic syndrome in childhood: association with birth weight, maternal obesity, and gestational diabetes mellitus. Paediatrics 2005; 115: 290-6.
9. Kramer MS, Isabelle M, Hong Y, Robert W, Robert U, McNamara H, Joseph KS, Shi WW. Why are babies getting bigger? Temporal trends in foetal growth and its determinants. The Journal of Paediatrics 2002; 141(4): 538-42.
10. Hadfield RM, Lain SJ, Simpson JM, Ford JB, Raynes GCH, Morris JM, Roberts CL. Are babies getting bigger? An analysis of birth weight trends in New South Wales, 1990-2005. The Medical Journal of Australia 2009; 190(6): 312-15.
11. Yanyu L, Jun Z, Xinrong L, Wei X, Zhu L. Secular trends of macrosomia in Southeast China, 1994-2005. BMC Public Health 2011; 11: 818.
12. Surkan PJ, Hsieh CC, Johansson ALV, Dickman PW, Cnattingius S. Reasons for Increasing Trends in Large for Gestational Age Births, Obstetrics and Gynaecology 2004; 104(4): 720-6.
13. Shu-Kay NG, Adriana O, Spinks AB, Cameron CM, Judy S, Mc Clure RJ. Risk factors and obstetric complications of large for gestational age births with adjustments for community effects. BMC Public Health 2010; 10: 460.
14. The HAPO Study Cooperative Research Group. Hyperglycaemia and Adverse Pregnancy Outcomes (HAPO study). New England Journal of Medicine 2008; 358: 1991-2002.
15. Jolly MC, Sebire NJ, Harris JP, Regan L, Robinson S. Risk factors for macrosomia and its clinical consequences. European Journal of Obstetrics Gynaecology and Reproductive Biology 2003; 111 (1): 9-14.
16. Yang J, Cummings EA, O'Connell C, Jangaard K. Foetal and neonatal outcomes of diabetic pregnancies. Obstetrics and Gynaecology 2006; 108: 644-50.
17. Jaipaul JV, Newburn-Cook CV, O'Brien B, Demianczuk N. Modifiable Risk Factors for Term Large for Gestational Age Births, Health Care for Women International 2009; 30(9): 802-23.
18. Mikolajczyk RT, Zhang J, Betran AP, Souza JP, Mori R, Gulmezoglu AM, Merialdi M. A global reference for foetal-weight and birth weight percentiles, Lancet 2011; 377: 1855-61.
19. Dias T, Shanmugaraja V, Ganeshamoorthy P, Kumarasiri S, Abeykoon S, Padeniya T, Birth weight standards – Ability of birth weight percentiles in predicting abnormal foetal growth and outcome, Sri Lanka Journal of Obstetrics and Gynaecology 2014; 36(4): 84-8.
20. Shanmugaraja V, Kumarasiri SG, Wahalawatte SL, Wanigasekara RV, Begam P, Jayasinghe PKCL, Padeniya T, Dias T. Sri Lankan foetal / birth weight charts: validation of global reference for foetal weight and birth weight percentiles, Ceylon Medical Journal 2013; 58(2): 62-5.