Roy et al., Cell Biol: Res Ther 2015, 4:1
http://dx.doi.org/10.4172/2324-9293.1000115

Cell Biology: Research & Therapy

Research Article

A SCITECHNOL JOURNAL

Maternal Body-Mass-Index and Socioeconomic Factors Predict Gestational Duration and Birth Weight: A Cross-Sectional Study from India

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Abstract

Background: Women's health is important for a healthy pregnancy-outcome. It influences the health of the newborn from neonatal through their adulthood. Present investigation is designed to study the influence of some maternal-variables/socio-demographic-profile on the gestational-period, birth-weight and neonatal-health.

Methods: This is a prospective cross sectional study. Participants are ninety five low-birth-weight (LBW) singleton-babies (male-45) and their mothers (non-diabetic) from Medical College, Eastern India. Evaluations are performed of socio-demographic profiles, body-mass index (BMI), maternal blood-glucose, haemoglobin, neonatal APGAR score (A=Appearance, P=Pulse, G=Grimace, A=Activity, R=Respiration) and anthropometric-data. Statistical package SPSS-17 is employed for one way ANOVA and Tukey's post-hoc-test. Student-'t' test were performed for continuous variables and Pearson's $\chi 2$ test for categorical-variables. The correlation and multiple-regression-analysis were employed for continuous-dependent-variables.

Results: It is observed from the ANOVA result that the birth-order, mother's-education, socioeconomic-status are significantly related to APGAR score and some neonatal parameters. Maternal BMI directly correlates to the birth weight and some neonatal parameters except APGAR score. The study suggests a direct association between APGAR score and haemoglobin (Hb). The Hb level was found to be significantly and inversely correlated with the maternal BMI ($r=-0.204$; $P<0.05$). These findings are supported by correlation, and regression-analysis ($R2=0.497$, $F=45.46$, $P<0.001$). The underprivileged mothers are more anemic and they deliver larger number of very-preterm baby. The multiple regression analysis suggests that some independent predictors like maternal weight, BMI, and gestational periods are associated with neonatal biometric data.

Conclusions: Present data suggest that maternal education, BMI and socioeconomic-status significantly predict the pregnancy outcome. Though, most of the statistical analysis supports the present prediction, the disapproval by some analysis like logistic-regression necessitates more sample study. Early interventions of maternal and neonatal health may enable us to predict any possible disease outcome which will help for the effective therapeutic measure

Keywords: Maternal variable and health; APGAR score; BMI; Blood glucose; Gestational period; Haemoglobin; LBW; Socioeconomic status.

Introduction

The maternal health during gestational period is important for long-term positive impacts on children's health and intelligence-quotient. It may result in better school performance of the children and enhanced productivity in their adulthood [1]. The preterm birth, intrauterine growth restriction and low birth weight (LBW) are the leading causes of neonatal, infantile and childhood morbidity/mortality. These factors also cause the impairments in neuro-development and disabilities [2]. Low socioeconomic status, maternal undernutrition, anemia and illness, inadequate prenatal care, obstetric complications, and maternal histories of premature and/or LBW infants have all been reported to influence the occurrence of LBW and other abnormal pregnancy/ birth outcome [3]. The report reveals that more than 20 million LBW babies born every year, worldwide [4]. A 20-30% of this figure occurs in India [5]. The LBW babies are more than 17 times more likely than those normal birth weight babies (more than 2,500g, WHO), to die during the perinatal period, and more than 40 times likely to die during the neonatal period accounting 71% of global neonatal deaths [3]. The blood haemoglobin (Hb) and glucose levels may be assumed as important determinants of nutritional, physiological and metabolic marker of an individual. Maternal BMI is an indicator of nutritional status, which can initially predict pregnancy and neonatal health [4,5]. Beside the association between maternal and neonatal anthropometric data, maternal pre-pregnancy weight is found to be one of the best predictor of neonatal health [6]. The combined effect of excess maternal gestational weight gain (GWG) and pre-pregnancy obesity resulted in higher infant birth weight neonatal obesity [7]. These findings highlight the importance of the preconception and prenatal periods for pediatric obesity prevention [7]. In this background, the present investigation elucidates the influence of socio-demographic factors and maternal variable on the gestation period birth/and health outcomes of the children. This representative study is absolutely important for its analogy to a significant number of global populations. This investigation will focus and address the maternal and neonatal health outcome in a vast population of the South-East Asian countries. It is also important to recognize the multi-factorial etiology of LBW for developing its effective control program.

Experimental Methods

Study location and human participants

The present study was conducted under the strict observation of the registered medical practitioner in the special care, neonatal unit of Pediatrics, Department/Labor room and postnatal ward of Obstetrics and Gynecology Department of Gauhati Medical College, Assam in North-Eastern India.

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Received: August 30, 2014 **Accepted:** April 16, 2015 **Published:** April 22, 2015

Ethical consideration

The study was conducted by a registered doctor and health professional and it was approved by the Institutional Research Ethics Committee. The researcher explained the study to the potential participants. The anonymity of the participants was kept reserved.

Inclusion criteria

Randomly selected inborn singletons (N=95) LBW children (male; n1=45; female; n2=50) were considered from several successive cases of live birth. The socioeconomic status and related demographic profile of mothers of selected children were assessed by revised Kuppuswami's socioeconomic status scale [8]. Mothers from all the socioeconomic classes were included in this study, but the majority was from socio-economically marginalized group. From the response against a standard questionnaire method, it was documented that the participant were free from any significant health complications (viz. diabetes, hypertension and chronic infectious diseases).

Gestational age of mother

Gestational age was calculated as total duration (weeks) of pregnancy from the first date of the last menstrual period to the date of birth of the baby. The preterm birth was considered as the delivery of a baby before 37 weeks' of gestation [9,10].

APGAR scores of neonates

It is the widely used screaming test for the newborn babies to instantly assess the health of an infant in 2 different time points. The 1 minute score measures the response and the tolerance limit of the baby in the birth process. The 5 minute score defines how the newborn adapt to the environment. APGAR (A= appearance, P= pulse, G=grimace, A=activity, R=respiration) score of a newborn was taken at 1 and 5 minute after birth and that is represented by the score of 0, 1 or 2. The total score 0-3 indicates that the baby is severely depressed, 4-6 moderately depressed and 7-10 is normal [11].

Anthropometric measurements

All anthropometric measurements were made by the trained professionals using the standard techniques [12]. Height was measured using Martin's anthropometer. Body weight was recorded digitally and with weighing scale (Doctor Beliram and Sons, New Delhi, India). Body mass index was used to assess the nutritional status of the mother. Body mass index=weight in kg / (height in meter) 2 [13,14]. The babies with <2,500 g were designated as LBW and birth weight <1,500 g is considered as Very Low Birth Weight (VLBW) babies [9].

Determination of haemoglobin level

Two milliliters of venous blood were drawn from each participant. An aliquot of the blood was placed immediately in a tube containing Drabkin's solution for haemoglobin estimation [15]. Haemoglobin concentration of <11.0 g/dl was considered as an indication of anaemia. Three levels of severity of anaemia were distinguished: mild anaemia (10.0-10.9 g/dl), moderate anaemia (7.0-9.9 g/dl), and severe anaemia (<7.0 g/dl) (16).

Determination of blood glucose level

The blood glucose level of the mothers was measured at the time of 28 to 32 weeks of gestation by glucose assay kit employing the glucose oxidase and peroxidase method (Ranbaxy, India).

Statistical Analysis

The statistical analyses were done by using the SPSS for Windows statistical software package (SPSS Inc., Chicago, IL, USA, 2001). Normally distributed data were tested by Kolmogorov-Smirnov test. The group means were tested using one way ANOVA with Tukey's post hoc test. Pearson's chi-square test was used to determine significant differences within categories. Pearson correlation P value<0.05 is considered statistically significant. Birth weight and APGAR score are the primary outcome variable. Secondary outcome measures included head, chest, crown ramp, mid upper-arm, thigh, mid calf circumference, the incidence of LBW and early neonatal morbidity. Baseline variables and outcome measures are compared with the student's 't' test for continuous variables and the chi-square test for categorical variables. To estimate the relationships among variables, multiple regression analysis was performed for continuous dependent variables (i.e., birth weight and neonatal anthropometric measurement). Both linear and logistic regression was performed in this study.

Results

Socioeconomic status

The present study population were consisting of 4 socioeconomic groups. The percentage of Group I, Group II, Group III and Group IV were 4.21%, 16.84%, 42.11% and 36.84% respectively and among these LBW babies the incidence of preterm birth was 25.00%, 50.00%, 57.50% and 51.43% respectively.

Maternal demographic profile

The residence of the mother (Rural-66, Urban-29) indicated that maternal parameters like BMI, blood glucose level were not affected by place of residence but maternal haemoglobin level was significantly higher (t=1.999; P<0.05) among rural mother (9.91 ± 1.95g/dl) than urban mothers (9.06 ± 1.81 g/dl). The neonatal/obstetrics parameters like birth weight, gestation, APGAR score, and other neonatal anthropometry shown no significant difference.

Mode of delivery

There were four types of delivery observed in this study viz. normal vaginal, caesarean, breech and forceps delivery. The haemoglobin level of these four categories was 10.03 ± 1.85 g/dl, 9.65 ± 1.77 g/dl, 7.75 ± 1.70 g/dl and 8.16 ± 2.17g/dl respectively. The mode of delivery was associated with maternal haemoglobin level (F=4.831; P=0.004), APGAR score (F=4.385; P=0.006), neonatal MUAC (F=5.298; P=0.002) and thigh circumference (F=2.917; P=0.038). This indicated that haemoglobin level at 2nd trimester was the good predictor of mode of delivery.

Maternal age

In this study, the average age of the mothers was 24.84 ± 5.14 years, (ranging 16-39 years). Most of the LBW babies (34.74%) were born to mothers of 21-25 years and 27.37% to 26-30 year age groups. While, the 24.21% of the babies were born to the mothers of age <20 years, the 13.38% babies were born to the mothers of age >30 years.

Birth weight

The mean birth weight of all babies was calculated as 1.98 ± 0.43 kg (Table 1), which was below the WHO defined value of normal birth weight (≥ 2.5 kg). In the present investigation it was noticed that

the birth weight of the babies of the working mothers (2.14 ± 0.36 kg) was an average 200 gm greater than the babies of housewife mothers (1.94 ± 0.44 kg) (t=1.840; P=0.069).

APGAR score

The descriptive statistical data represented in the Figure 2 which showed the higher occurrence of neonates in the ≥ 7 APGAR score group (60% and 90% in 1 and 5 min category respectively). A markedly higher occurrence (~35%) of the neonates was noticed in the 1min score groups (Figure 2). The birth weight of the babies does not correlate to APGAR score, but does show significant (1 min χ^2=21.929; P<0.01 and 5 min χ^2=19.211; P<0.001) relation to the maternal education level (Table 2). A significant variation of APGAR scores at 1 minute was observed with maternal education level (χ^2=21.929; P=0.01), anemia (χ^2=22.135; P<0.001), mode of delivery (χ^2=23.136; P<0.001) (Table 2). Similarly, APGAR scores at 5 minutes was also interfered by the same determinants like maternal education level (χ^2=19.211; P=0.001), anaemia (χ^2=20.569; P<0.001), and mode of delivery (χ^2=13.498; P=0.01) (Table 2).

Table1: Descriptive studies of maternal and neonatal parameters.

	Mean ±	95% CI
Maternal		
Age (years)	24.84 ± 5.14	23.80-25.89
Weight (kg)	49.18 ± 5.79	48.00-50.36
Height (cm)	151.32 ± 7.72	149.74-152.89
BMI (kg/m2)	21.45 ± 1.69	21.11-21.79
Pregnancy Interval	1.18+-1.17	0.94-1.42
Haemoglobin (g/dl)	9.65 ± 1.94	9.26-10.05
Blood glucose level (mg/dl)	86.73 ± 17.04	83.26-90.20
Gestation (weeks)	36.11 ± 2.74	35.55-36.66
Neonatal		
APGAR 1 min	6.79 ± 1.47	6.49-7.09
APGAR 5 min	8.39 ± 1.08	8.17-8.61
Birth Weight (kg)	1.98 ± 0.43	1.89-2.07
Head circumferance (cm)	30.67 ± 2.78	30.10-31.23
Chest circumferance (cm)	29.27 ± 2.54	28.76-29.79
Crown-ramp length (cm)	44.85 ± 3.63	44.11-45.59
MUAC (cm)	8.62 ± 1.47	8.32-8.92
Thigh circumference (cm)	10.99 ± 1.18	10.75-11.24
Midcalf circumference (cm)	8.38 ± 0.80	8.22-8.54

Growth rate

The growth rate was calculated as the individual birth-weight divided by the corresponding gestational period. The growth rate has a significant positive relation to the gestation period (r=0.439; P<0.001) and birth weight (r=0.954; P<0.001).

Maternal haemoglobin level and blood glucose level

Mean haemoglobin, blood glucose level was 9.65 ± 1.94 g/dl and 86.73 ± 17.04 mg/dl respectively (Table 1). The mothers of <8 g/dl Hb level have an average of 78 mg/dl blood glucose, but mothers of 8 to >10 g/dl Hb has 88 mg/dl blood glucose level. The maternal blood glucose level was found to be negatively correlated with birth weight (P<0.01) several biometric indices (P<0.01) of the neonates (Figure 1 and Table 3).

Maternal blood group

Maternal blood groups A and O show significantly higher birth weight and better biometric outcomes in neonate. The ANOVA study and the post hoc analysis were mentioned in the Table 4. Though not significant, an average 160 g greater birth weight and significantly higher thigh circumference was noticed in the babies of an Rh- mother than the Rh+ mother (t=3.205; P<0.002).

Maternal and neonatal anthropometry

It was noticed that maternal BMI was correlated to maternal education (F=4.042; P=0.005). Pearson correlation data show that neonatal anthropometric parameters like circumferences of head, chest, mid-upper arm, mid-calf were positively correlated with maternal body weight (P<0.01) and BMI (P<0.05) (Table 3). These

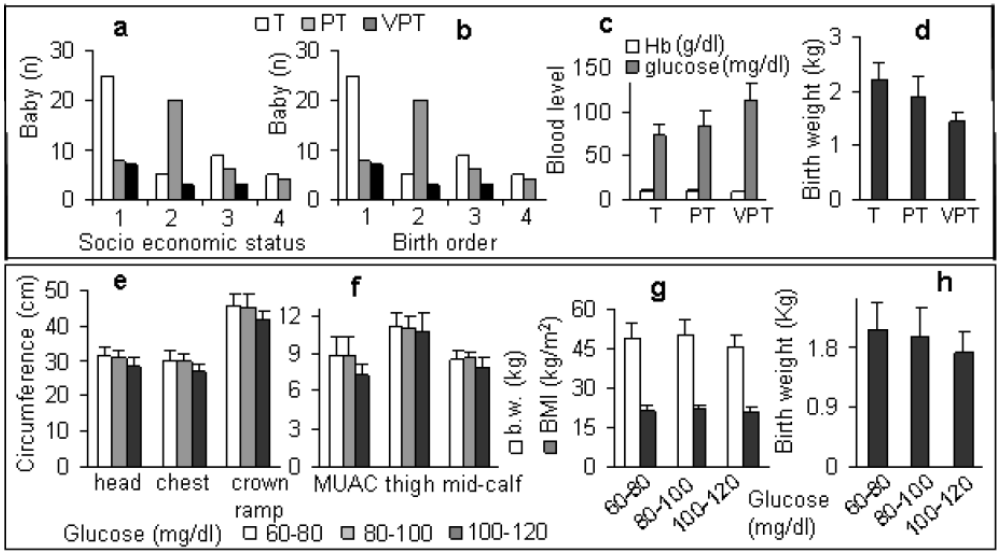

Figure 1: Relation between different socio-demographic profile and maternal metabolic factors (haemoglobin and blood glucose) on the rate of occurrence of gestation period. Bar in lower panel denotes as mean ± SD. In the upper panel figure: T represents Term birth, PT- Preterm birth and VPT-Very preterm birth. Relation between maternal blood glucose on the different parameters of neonatal health outcome. Bar in lower panel denotes as mean ± SD.

indices of the babies were found not to be associated with the maternal age group, race, socioeconomic status, education level, religion and residence (rural or urban).

Gestational period

In the present study, mean gestational period was found to be 36.11 ± 2.74 weeks (Table 1) and prevalence of preterm birth was 52.63%. Generally, the preterm delivery was the main cause of low birth weight among a high socioeconomic group and intrauterine growth retardation among low socioeconomic group. In the present study, the high blood glucose level was significantly associated with preterm and very preterm birth, but Hb level does not correlate with a gestation period (Figure 1).

The present study indicates the maternal weight, BMI and blood glucose, gestational age was correlated (P<0.05-P<0.01) to most of the neonatal parameters. The regression results (Table 3a) also support the χ2 and correlation result. The stepwise regression model shows that gestational age and blood glucose level were good determinant of birth weight (R2=497; adjusted R2=0.486; F=45.460 and P<0.001) (Table 3a). Though linear regression analysis suggests a correlation of birth weight versus blood glucose level and gestation period, but logistic regression analysis does not show any significant correlation.

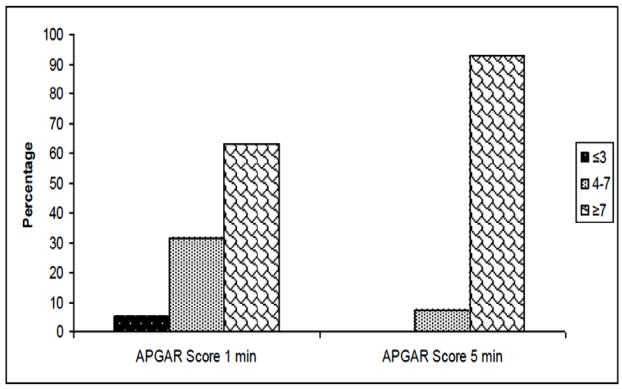

Figure 2: Groups based on APGAR score and % of neonates occurring in different groups.

Discussion

The small for gestational age (SGA) results in a greater risk of premature delivery, LBW and physical/mental abnormalities in the children. Socioeconomic condition, demographic profile, nutritional status and several other factors are associated with the pregnancy and birth outcome. Maternal physiological and metabolic profile like blood group, Rh factor, nutrition status, BMI, blood glucose, haemoglobin and several other parameters are relevant to gestation duration, birth outcome and neonatal/ childhood health status. This study is important because an appreciable fraction of the global population of similar category for developing/developed countries may be represented by the present study population and investigation outcome. The gynecologists and physicians categorically classify the potential impact of maternal lifestyle, education and physical activity in their glycemic control, gestational weight gain and fetal growth-outcomes which can be correlated with the present study [17].

In the present investigation, the neonatal biometric parameters like the circumference of the head, chest, crown ramp, MUAC and mid-calf are positively correlated with maternal weight and BMI (Table 2). Poor maternal weight-gain during pregnancy is associated with small for gestational age (SGA) infants, preterm births and LBW [18]. The report suggests that the pre-pregnancy BMI <19 is found to be associated with low neonatal birth weight [19]. The occurrence of LBW infant and their unhealthy biometric data are noticed in the underweight mothers [20]. Oppositely, it is also reported that severe

Table 2: Groups based on APGAR score and % of neonates occurring in different groups.

	TAPGAR score 1 min			APGAR score 5 min	
Parameters	≤3	4-7	≥7	4-7	≥7
Maternal Education					
Illiterate	0.00	26.32	73.68	0.00	100.00
Primary	0.00	46.67	53.33	0.00	100.00
Mid School	25.00	20.00	55.00	30.00	70.00
Higher Secondary	0.00	35.14	64.86	2.70	97.30
Graduation	0.00	25.00	75.00	0.00	100.00
	χ^2=21.929; P<0.01			χ^2=19.211; P<0.001	
Maternal Hamoglobin (g/dl)					
<8	26.32	15.79	57.89	31.58	68.42
8-10	0.00	33.33	66.67	0.00	100.00
>10	0.00	37.50	62.50	2.50	97.50
	χ^2=22.135; P<0.001			χ^2=20.569; P<0.001	
Maternal Blood Glucose (mg/dl)					
60-80	10.2	25.64	64.10	12.82	87.18
80-100	0.00	31.71	68.29	0.00	100.00
100-120	6.67	46.67	46.67	13.33	86.67
	χ^2=6.401; P=0.171			χ^2=5.742; P=0.057	
Mode of delivery					
Caesarian Section	0.00	40.91	59.09	4.55	95.45
Vaginal delivery	1.67	30.00	68.33	3.33	96.67
Breech delivery	37.50	12.5χ0	50.00	37.50	62.50
Forceps delivery	20.00	40.00	40.00	20.00	80.00
	χ^2=23.136; P<0.001			χ^2=13.498; P<0.01	

Table 3: Correlation between maternal factors and neonatal health outcome, Grey colored box demonstrates level of significance (*P<0.05; **P<0.01; ***P<0.001)

Maternal Parameters	Neonatal parameters						
	Birth weight (kg)	Head circumference (cm)	Chest circumference (cm)	Crown ramp length (cm)	MUAC (cm)	Thigh circumference (cm)	Mid-calf circumferance (cm)
Age (years)	.062	.115	.125	.088	.138	-.028	.102
Weight (kg)	.087	.284***	.288**	.321**	.269**	.168	.316**
Height (cm)	.122	.160	1.68	.181	.155	.133	.179
BMI (kg/m^2)	-.018	.232	.229*	.263**	.216**	.092	.255*
Haemoglobin (g/dl)	-.004	.051	0.46	-.016	-.100	-.002	.001
Blood Glucose (mg/dl)	-.296	-.313**	-.309**	-.287**	-.328***	-.138	-.205*
Gestational age (week)	0.681	0.416***	0.407***	0.364***	0.346***	0.246*	0.353***

Table 3a: Linear regression showing the weight of the maternal factors (independent variables) on birth weight (dependent variables).

	B	SE	Beta	t	Sig.	R	R^2	Adjusted R^2	F	Sig.
(Constant)	-1.299	0.483		-2.688	0.0090	0.0705	0.497	0.486	45.426	P<0.001
Blood Glucose level	-0.005	0.002	-0.185	-2.466	0.016					
Gestation	0.102	0.012	0.649	8.649	0.000					

Table 4: Relation between maternal blood group and blood glucose with neonatal health outcome- the ANOVA and stuewdy. Data are represented as mean ± SD, Grey colored data represents high level of significance

Blood Group	N	Birth weightd (kg)	Head Circumferance (cm)	Chest circumferanace (cm)	Crown ramp length	MUAC(cm)	Thigh circumferance (cm)	Mid calf circumferance (cm)
A	22	2.04 ± 0.44	31.21 ± 2.42	29.77 ± 2.29	45.74 ± 3.09	9.30 ± 1.57	11.54 ± 1.15	8.62 ± 0.76
B	7	1.84 ± 0.52	28.80 ± 1.97	27.40 ± 1.72	43.61 ± 3.13	7.89 ± 0.99	10.24 ± 0.70	7.90 ± 0.45
AB	12	1.77 ± 0.36	28.93 ± 2.42	27.66 ± 2.32	42.49 ± 3.24	7.50 ± 1.31	10.69 ± 1.17	7.72 ± 0.71
O	54	2.02 ± 0.42	31.07 ± 2.87	29.67 ± 2.57	45.18 ± 3.80	8.68 ± 1.35	10.94 ± 1.18	8.50 ± 0.78
Significance		0.206	0.017	0.011	0.052	0.003	0.036	0.002
Post doc LSD Significance Significance		A>AB 0.077 O>AB 0.07	A>B and AB 0.04 & 0.019 O>B and AB 0.037 & 0.014	A>B and AB 0.027 & 0.017 0>B and AB 0.022 & 0.011	A>AB 0.012 0>AB 0.019	A>B and AB 0.02 & 0.00 0>AB 0.009	A>B and AB 0.011 & 0.043 0>A 0.42	A>B and AB 0.03 & 0.001 0>B and AB 0.051 & 0.002
Blood Glucose (mg/dl)	N	**Birth Weight (kg)**	**Head Circumferance (cm)**	**Chest Circumferance (cm)**	**Crown Ram Length**	**MUAC (cm)**	**Thigh circumferance (cm)**	**Mid calf circumferance (cm)**
60-80	39	2.08 ± 0.43	31.34 ± 2.79	29.86 ± 2.71	45.50+-3.40	8.88+-1.43	11.09 ± 1.19	8.41 ± 0.87
80-100	41	1.98 ± 0.44	30.92 ± 2.46	29.58 ± 2.06	45.38 ± 3.62	8.84 ± 1.47	11.01 ± 0.99	8.58 ± 0.61
100-120	15	1.73 ± 0.33	28.21 ± 2.33	26.90 ± 2.01	41.73 ± 2.74	7.31 ± 0.77	10.69 ± 1.59	7.78 ± 0.83
Significance		0.03	0.001	0.001	0.001	0.001	0.543	0.003

over-nutrition and morbid obesity are associated with an increased risk of adverse perinatal outcome and mortality [7,21]. The risks of moderate hypertension, macrosomia and dystocia are found to be higher among overweight or obese diabetic/non-diabetic women, resulting in emergency labor, cesarean delivery and neonatal complications [22-24]. Mothers of low or high pre-pregnancy BMI category manifest a premature gestational age, unhealthy delivery and neonatal outcomes [25,26]. The report reveals that women with untreated mild gestational glucose-intolerance and low BMI are associated with increased gestational hypertension and birth weight [27].

Our present study suggests that maternal weight and BMI is the important predictor of neonatal health. The pregnancy period attributes to the adaptations of carbohydrate metabolism, glucose utilization and consequently increases in the glucose fluxes to the developing fetus [28,29]. Various clinical observations suggest that the interactions of hormones like insulin, estrogen/ progesterone to carbohydrate metabolism may modulate the blood glucose level at the gestation period [30,31]. All the respondent-mothers in the present study are non-diabetic. A significant number of mothers are found in an apparent hypoglycemic state resulting in a term birth. The report suggests that maternal hepatic glucose oxidation and glycogen storage are augmented at the time of pregnancy [32]. This adaptive mechanism favors the best possible nutritional interests of the fetus, which support our present results. A significant number of mothers of low socioeconomic group with higher blood-glucose level consequence in a preterm/very preterm operative delivery with poor birth outcome. In line of agreement with our present study; several reports explain the positive association among mild-hypoglycemic status, term birth and neonatal health outcome [33,34]. Several evidences suggest that maternal (non-diabetic) complications increase few folds with high glucose level [33,34]. These complications may result in a preterm or very preterm cesarean section with adverse pregnancy-birth outcomes which are noticed in some of the cases in the present investigation. This type of study is inadequate in the South East Asian perspective.

Beside undernutrition, several patho-physiological problems are also involved in this regard. These include the urinary tract infections, low dietary iron-intake, faulty food-habit, poor antenatal care and low hygiene related infestation [35]. One earlier study also showed that the female experience lower nutritional and impaired immune status with higher toxicity-sensitivity than male [36,37]. Though apparent, the neonatal parameters are assumed to be healthier in mothers of A or O blood groups (Table 3). These two blood groups constitute the major fraction of all blood groups (A-23%, B-7%, AB-13%, O-56%). It indicates that blood group may be a determinant of neonatal health [38,39]. In the present investigation, neonatal some

of the anthropometric data are found to be associated with maternal ABO blood group system. But the similar association is not found in case of neonatal birth-weight. Further investigation with large number of samples from different experimental settings is required for better conclusion. There are different opinion regarding the combined effect of the maternal and foetal blood group status that may result in adverse pregnancy, birth and neonatal outcome [38,39]. It may be due to the genetic variation and some genetic recessive genes are differentially present in different individual. Origin and ethnicity also play role in blood group associated intra-individual metabolic variability. ABO blood groups and other predisposing confounding factors (viz. smoking) might have interacted influences on birth weight and neonatal health [40,41]. Status of Rh factors is also found to be partially associated with the gestation period and pregnancy/ birth outcome in our present study.

The risk factors for LBW are hypertensive disorders, diabetes, malnutrition, bleeding, anemia, infection, placental or fetal anomalies and multiple pregnancies. These impairments have some compounding effects in mother with lesser knowledge of nutrition and health which is predominant in mother of lower educational qualification [42]. The morbidities of term and moderately preterm (>32 weeks) LBW are mainly related to the utero-placental insufficiency and poor energy-substrate transfer, resulting in neonatal complications like birth asphyxia/ hypothermia/ meconium aspiration/ polycythaemia/ hypoglycemia/ hypocalcaemia and thrombocythaemia. These may be reflected in some of the newborn terms of their unhealthy APGAR score results. One explanation for the lower mean neonatal birth weight may be that the fetus is prevented from receiving an adequate supply of nutrients from the mother due to impaired maternal hemodynamic status [43]. Moderately working and physically active women may have some good physiological conditioning, better nutrient mobilization and that may result in good metabolic effects. This entire positive outcome confers a better impact on growing fetus [44].

It also suggests that, in malnourished underweight women, lower volume expansion is related to the decreased micronutrient status and that might be associated with reduced fetal growth. The prevalence of anemia is found to be significant, but the contribution of anemia leading to LBW is controversial [43,45], which parallels with our present results. However, substantial iron deficiency anaemia (usually <80g/L) is associated with an increased incidence of LBW [46]. Beside iron deficiency [47], other important causes of anaemia are malaria, intestinal worms, antenatal care and low BMI [48]. The woman has a substantially higher need for iron during pregnancy, because of the increase in red cell volume of the maternal, placental and fetal growth [49]. Malnourishment and undernutrition which are regarded as good indicator of low socioeconomic status have been linked to the maternal health outcome [50,51].

Conclusion

In conclusion, the present outcome is very important for the evaluation of an association between socioeconomic and metabolic profile of mother with the pregnancy/fetal and birth outcome. The assessment of the role of maternal BMI, blood glucose and Hb/iron or other nutritional factors in the mother may be predictive of the pregnancy outcome. Present data strongly suggest that BMI is a good determinant of birth/ neonatal outcome. The present results may be helpful in the assessment of contributing factors to eradicate LBW globally. The understanding of how several factors attributing to LBW, vary by socio-demographic/ economic status will make it easier to design a global intervention that are more integrated and effective.

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