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MATERNAL INVESTMENT IN DETERMINING BIRTH WEIGHT: A STUDY IN WEST BENGAL

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ABSTRACT

The objective of this investigation was to understand how maternal investment determines birth weight of the last full term singleton live birth. We involved 130 mothers from Kolkata (70) and one adjoining district (60) of West Bengal who delivered singleton live birth at term. Data were collected on socio-demographic, reproductive characteristics, antepartum care, reported antepartum morbidities and lifestyle (consumption pattern and physical activities) of mothers during the last pregnancy. Multivariate analyses were conducted to understand the determinants of birth weight of children. The results suggested that mothers' educational attainment (below graduate), occupational types (homemaker), religious affinity (Muslim), age at conception (in case of the last child), ever use of oral contraceptives, parity, reported antepartum morbidities, passive smoking and practice of food taboo showed inverse association with birth weight of children. However, birth interval, antepartum care (use of iron-folic acid tablets and tetanus toxoid immunization) and lifestyle of mothers showed positive association with birth weight.

We conclude that socio-demographic, reproductive characteristics, antepartum care, reported antepartum morbidities, lifestyle of mothers were likely to be associated with birth weight of children. The findings of the study would help the policy makers to understand the importance of implementation of a comprehensive scheme for pregnant mothers that would not only emphasize on utilization of antenatal services but also in developing the maternal health awareness.

Keywords: *Birth weight, maternal investment, Kolkata, West Bengal*

INTRODUCTION

Globally, birth weight is considered to be one of the major risk factors for morbidity and mortality of children. The World Health Organization estimated

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that more than 20 million low birth weight (LBW) children are born each year in developing countries (Watanabe 2008, Blencowe *et al.,* 2019). It is found that about 72% of LBW children are born in Southern Asia, while about 22% of LBW in sub Saharan Africa. In India, about 40% of LBW live births occur every year; however, the incidence of LBW has declined from 20.4% to 16.4% in the last decade (Khan et al., 2019)

Birth weight is largely associated with factors like, socio-economic milieu of the family, duration of gestational period, intrauterine growth, maternal age, nutritional status, antepartum care (including morbidities and lifestyle). Studies in sub Saharan Africa revealed that lower level of maternal education (Adam et al., 2019), resource poor condition of the family (Agorinya et al., 2018), maternal age at conception (Agorinya et al., 2018; Endalamaw et al., 2018), short birth interval (Endalamaw et al., 2018), lower gestational weeks (Muchemi et al., 2015), twin pregnancy (Dahlui et al., 2013), maternal dietary practices (Abubakari ,2019; Girma et al., 2019), inadequate intake of iron supplement (Adam et al., 2019; Girma et al., 2019), reported antepartum morbidities (anemia) (Agorinya et al., 2018) are significantly associated with odds of LBW children. Such postnatal outcomes are largely associated with maternal investment throughout the life. For example, better nutrition received by mothers since her childhood or at the time of antepartum promotes the nutritional investment in foetus that subsequently costs to the birth weight of the child. Thus, LBW is one of the main indicators of lower maternal investment during pregnancy. Again, reproductive history of mothers (like, birth spacing, healthy pregnancy at proper age, parity, duration of lactation) also signifies the effect of the maternal investment on the subsequent reproduction (Coall and Chisholm, 2003; Merklinger-Gruchala, 2019).

In Indian subcontinent, the incidence of LBW has been predicted by various maternal factors. For example, a study in Pakistan showed that the odds of LBW live birth increased with reduced intake of vitamin C among pregnant mothers (Janjua et al., 2008). One recent study in Afghanistan reported that the incidence of LBW was likely to be lower with increase in educational attainment of mothers, birth spacing and economic status of family (Das Gupta et al., 2019). In Nepal, the odds of LBW increased with preterm births, delayed first antenatal care (ANC) visit, reduced number of ANC visit, lack of consumption of balanced foods, and iron and calcium supplementation and with reported co-morbidities (hypertension) during pregnancy (Bhaskar et al., 2015; Bansall et al., 2019). Similarly, in Bangladesh, preterm births (<37 weeks) and other maternal factors (like, delayed conception, advanced maternal age and inadequate ANC visits) were found as the significant predictors of LBW (Kader and Tripathi 2013; Mahumud et al., 2017).

A study in central India documented that reported antepartum morbidities (like, anaemia, pregnancy induced hypertension, haemorrhage) were significantly associated with LBW (Jadhao et al., 2016). Taywade and Pisudde

(2017) reported that maternal age (<20 years or >30 years), nuclear family, poor standard of living, absence of sanitary latrine were likely to increase the odds of LBW in Maharashtra. In Tripura, factors like, administration of tetanus toxoid and regular intake of iron and folic acid tablets during pregnancy lowers the odds of LBW (Bhattacharjya et al., 2015). Metgud et al. (2012) showed that exposure to passive smoking, weight gain during pregnancy, birth interval <2 years, early age at first pregnancy and previous history of having child with LBW were the significant determinants of LBW in rural Karnataka.

In West Bengal, studies revealed that factors like, low gestation, poor economic status, higher parity, rural residence, inadequate food intake and irregular consumption of iron and folic acid tablets, obstetric complications, reported anaemia, addiction to tobacco during pregnancy significantly increased the odds of LBW (Dasgupta and Basu, 2011; Manna et al., 2013; Kumar et al., 2018; Chouhan, 2019).

It appears from the review of literature that LBW is a complex phenomenon and is guided by a plethora of factors, ranging from reproductive history to socio-economic condition to lifestyle variables. These factors are not universal, varies widely across the country. Thus, studying the determinants associated with birth weight would help to understand the overall scenario of health risk among the children who are the potential human resource of a country. Thus, we aimed to understand how maternal investment determines birth weight of the last full term singleton live birth.

MATERIALS AND METHODS

Study area

We conducted this study in the districts of Kolkata and North 24 Paraganas, West Bengal. Kolkata is a metropolitan city and also the state capital of West Bengal. The district of North 24 Paraganas is located adjacent to the city of Kolkata. We chose one public health institution (Nil Ratan Sarkar Medical College and Hospital) from the city of Kolkata as the study unit. This hospital is located in the central part of the city, has good infrastructure and facilities and caters to the needs of a large section of the people. In North 24 Paraganas, the study was conducted in a health centre (Patulia Health Centre), which is located at the Khardah Municipality area under the jurisdiction of Barrackpore subdivision. Both the study areas were selected due to operational convenience.

Study participants

Initially, a total of 165 study participants (mothers) were approached for this study based on the sole inclusion criteria (i.e. they had delivered singleton live birth at term).The age of these study participants ranged 15-45 years. Only 70 study participants (those who delivered their last child within the last three days) were recruited from Nil Ratan Sarkar Medical College and Hospital (NRS),

Kolkata and 60 participants (those who had their last child less than two years old) from the Patulia Health Centre. The birth weight of the children was collected from the official records of both the public health institutions. In NRS, the birth weight (children born within last three days) was collected from the records of hospital, while in Patulia Health Centre, the birth weight (children aged less than two years old) were recorded from the health card of the respective child who came to visit the health centre for immunization or check up. All these study participants voluntarily agreed to participate in this study. Only 35 participants (21%) from Patulia Health Centre were excluded from the study as they could not report the birth weight of their own child. Verbal informed consent was obtained from the participating mothers. The written informed consent was received from the authorities of both the NRS Hospital and the Patulia Health Centre.

Data collection

Each participant was interviewed for socio-demographic characteristics, reproductive history, antepartum care, reported anterpartum morbidities and lifestyle (consumption pattern and physical activities) with respect to their last full term singleton live birth using a pre-tested schedule. This cross-sectional study was conducted during the months of May to June in the year 2017. The face to face interview was done by a same sex interviewer (NK).

Data types

Socio-demographic characteristics: Socio-demographic characteristics including participants' ages at time of interview and marriage (years), educational levels and occupational types of both participants and their spouses, and monthly household expenditure (in Indian Rupees) were recorded.

Reproductive history: Reproductive history including the participants' ages at first conception and last conception (years), gestational age of last live birth (weeks), birth interval (months), parity, ever use of oral contraceptives, mode of delivery of the last child were recorded.

Antepartum care, morbidities during last pregnancy: Data on antepartum care during the last pregnancy were collected. The participants were asked to understand whether they administered tetanus toxoid (TT) injection and iron and folic acid tablets, the number and interval of TT injection administered, and the centre from where TT immunization have been taken and the centre where the participants visited for antenatal check up during the last pregnancy. Data on reported antepartum morbidities were recorded.

Consumption pattern: The participants were asked to report the food items consumed during the last pregnancy. Several foods (like carbohydrates, animal protein, milk and milk products, vegetables, fruits, highly processed foods) were included in the schedule to record the patterns of food consumption among the

participants. The participants were further asked whether they remained on special diet during the last pregnancy. Additionally, information on passive smoking and practice of food taboo were collected. Each question had a choice with two binary responses (yes or no).

Physical activities: Physical activities of the participants (regular physical exercise, sitting light work, sitting moderate work, standing light work, standing moderate work, standing heavy work and walking a distance) during the last pregnancy were recorded using a pretested schedule. Each of the activities was presented with binary response choices (i.e. yes or no). The participants were asked to respond whether they perform these activities at least three days in a week during the months of last pregnancy. Sitting light work includes reading book, working on computer, watching television, listening music while sitting. Sitting moderate work includes mopping the floor, cooking, cleaning utensils and washing clothes while sitting. Standing light work indicates cooking while standing. Standing moderate work indicates cleaning home, dusting while standing. Standing heavy work denotes picking heavy weight while standing (e.g. collecting water from well while standing). Walking a distance denotes walking for work.

Statistical analyses

Descriptive statistics were used to understand the trend in socio-demographic characteristics, reproductive history, antepartum care, reported antepartum morbidities and intrapartum problems, lifestyle (physical activities and consumption pattern) of the mothers. The quartile distribution of birth weight of the child and gestational age were estimated. Frequencies of both normal and low birth weight (LBW) were calculated with respect to parity, ages of mothers at first conception, at the respective conception and gestational age. LBW was defined by World Health Organization as the birth weight less than 2500grams (United Nations Children's Fund, & World Health Organization 2004). Chi square test was applied to examine the association of the birth weight of the last full term singleton live birth with parity, ages of mothers at first conception as well as for respective live birth, and gestational age. Binary logistic regression analysis was conducted to predict the occurrence of LBW. Here, birth weight of the last full term singleton live birth (in binary category: normal birth weight and low birth weight) was used as dependent variable. Other variables like socio-demographic characteristics, reproductive history, antepartum care and reported antepartum morbidities, lifestyle (physical activities and consumption pattern) were incorporated as independent variables. The reference categories of the independent variables were as follows: [religion= Hindu; educational levels of both participants and spouses= non literate; occupational types of the participants= service; occupational types of spouses= others]. Later, hierarchical linear regression analysis was applied to understand the association of birth weight with socio-demographic characteristics, reproductive history, antepartum care and reported antepartum morbidities and lifestyle (physical

activities and consumption pattern). In model I, socio-demographic and reproductive variables were incorporated as independent variables. In model II, variables, like antepartum care and reported antepartum morbidities, lifestyle (physical activities and consumption pattern) were used as independent variables. Here, birth weight was incorporated as the dependent variable. Some of the categorical variables (educational levels and occupational types of participants and spouses) were converted into dummy variables as these variables had more than two categories. All the statistical procedure were performed using SPSS (Statistical Package for Social Science) version 20.0 (IBM 2011).

RESULTS

The mean ages of the participants and their spouses at the time of interview were 25.57±5.3 years and 30.75±5.6 years respectively. The mean age at marriage of the participants was 19.80±4.1 years. About 9.2% of the participants and 4.6% of their spouses had no formal education, while majority of them attained education below the 10^{th} standard. The study participants were mostly homemakers. Spouses of the participants were mostly involved in either business or service. The median monthly household expenditure was Rs. 5,000. More than 70% of the participants belonged to the Hindu ethnic group.

The same table also shows that the mean ages at first and last conception of the participants were 21.41±4.0 years and 24.72±5.2 years respectively. More than half of the participants had single child. Most of the participants did not use oral contraceptives. Incidence of caesarean section (70%) during delivery was common among the participants. The mean gestational age of the participants during the last pregnancy was 36.20±2.09 weeks. Mean birth interval was 30.20±4.1 months (Table-1).

Table-1: Socio-demographic characteristics and reproductive history of the participants (n=130)

Socio-demographic characteristics	n	%
Age of the participants at time of interview (years) mean±sd	25.57± 5.31	
Age of the spouse at time of interview (years) mean±sd	30.75±5.68	
Age at marriage of the participants (years) mean±sd	19.80±4.10	
Educational levels of the participants		
Non literate	12	9.2
Primary	49	37.7
Secondary	31	23.8
Higher secondary	20	15.4
Graduate	18	13.8
Educational levels of the spouse		
Non literate	6	4.6
Primary	51	39.2
Secondary	34	26.1
Higher secondary	20	15.4
Graduate	19	14.6
Occupational types of the participants		
Home maker	125	96.1

Service	3	2.3
Business	2	1.5
Occupational types of the spouse		
Service	46	35.4
Business	47	36.1
Others*	37	28.5
Monthly household expenditure (Indian rupees) median	5,000	
Religious affinity		
Hindu	94	72.3
Muslim	36	27.7
Reproductive history		
Age at first conception (years) mean±sd	21.41±4.09	
Age at last conception (years) mean±sd	24.72±5.21	
Gestational age of the last pregnancy (weeks) mean±sd	36.20±2.09	
Birth interval (months) mean±sd	30.20±4.10	
Parity		
One	72	55.4
Two	50	38.5
Three	8	6.2
Ever use of oral contraceptives		
Yes	8	6.2
No	121	93.9
Mode of delivery of the last child		
Vaginal	39	30.0
Caesarean section	91	70.0

*others: pension holders, labours

Birth weight of the last full term singleton live birth increased with the increase in gestational weeks. For example, children who were born with weight less than 2.6 kg. had gestational age of 34 weeks and those of 2.8kg, 3.0kg and 4.0 kg had gestational ages of 36, 39 and 41 weeks respectively. An appreciable section of the participants (39.4%) who had conceived between the ages 26 and 29 years delivered child with LBW. On the other hand, most of the children with normal birth weight were delivered by the participants who had conceived below the age of 25 years. Birth weight had significant association with age of the participants at the time of conception (p=0.007). However, the association of birth weight with age of the participants at first conception (p=0.689), gestational age (p=0.084) and parity (p=0.482) were not significant (Table-2).

Table 2: Birth weight of the last full term singleton live birth (n=130)

Quartile distribution of the birth weight and gestational age of the last full term singleton live birth						
Quartile		Birth weight (kg)		Gestational age (weeks)		
1st		2.6		34		
2nd		2.8		36		
3rd		3.0		39		
4th		4.0		41		
Birth weight of the last full term singleton live birth with respect to the age at first conception						
Age at first conception (years)	Normal birth weight		Low birth weight		Chi square value	p value
	n	%	n	%		
20 and below	40	83.3	9	16.7	1.472	0.689
21-25	21	72.4	8	27.6		
26-29	19	82.6	4	17.4		
Above 30	23	79.3	6	20.7		
Birth weight of the last singleton full term live birth with respect to age at respective conception						
Age at first conception (years)	Normal birth weight		Low birth weight		Chi square value	p value
	n	%	n	%		
20 and below	34	81.0	8	19.0	12.057	0.007
21-25	27	93.1	2	6.9		
26-29	20	60.6	13	39.4		
Above 30	23	88.5	3	11.5		
Birth weight of the last full term singleton live birth with respect to gestational age						
Gestational age (weeks)	Normal birth weight		Low birth weight		Chi square value	p value
	n	%	n	%	2.995	0.084
≤36	75	76.5	23	23.5		
>36	29	90.6	3	9.4		
Birth weight of the last full term singleton live birth with respect to parity						
Parity	Normal birth weight		Low birth weight		Chi square value	p value
	n	%	n	%		
One	56	77.8	16	22.2	0.498	0.482
More than one	48	82.8	10	17.2		

About 99% of the participants completed the course of tetanus toxoid injection and iron and folic acid tablets during the last pregnancy. More than 80% of the participants administered TT injection twice during the pregnancy period. Furthermore, about 65% of the participants administered this injection during the 3rd to 5th months of pregnancy. The participants obtained this tetanus toxoid injection from the public health institutions (Table-3).

Table 3: Antepartum care of the participants during the last pregnancy (n=130)

Antepartum care	n	%
Administered tetanus immunization		
Yes	129	99.2
No	1	0.8
Tetanus Toxoid (TT) immunization administered		
Once	3	2.3
Twice	105	80.8

Thrice	22	16.9
TT immunization administered during months of pregnancy		
<3	11	8.5
3-5	85	65.4
>6	34	26.2
Centre of taking immunization		
Government hospital	58	44.7
Private clinic	15	11.5
Voluntary health clinic	57	43.8
Administered iron and folic acid tablets		
Yes	129	99.2
No	1	0.8
Centre of visiting doctor		
Government hospital	85	65.4
Private clinic	43	33.1
Voluntary health clinic	2	1.5

Less than 15% of the participants reported swelling in hands and feet during the last pregnancy. The problems of hypertension (6.2%), severe vomiting (7.7%) and hypothyroidism (6.9%) were also reported by the participants. Apart from these, a few of the participants reported several health problems, like asthma, shoulder pain, heartache, urinary infection, anaemia and haemorrhage (Table-4).

Table-4: Reported Antepartum morbidities of the participants during the last pregnancy (n=130)

Morbidities	n	%
Antepartum morbidities		
Swelling hands and feet	19	14.6
Diabetes	3	2.3
Hypertension	8	6.2
Hypotension	2	1.5
Hyperglycaemia	4	3.1
Severe vomiting	10	7.7
Hypothyroidism	9	6.9
Asthma	6	4.6
Shoulder pain	4	3.1
Stomach upset	2	1.5
Heartache	5	3.8
PCOS	1	0.8
Knee pain	1	0.8
Bleeding/ haemorrhage	3	2.3
Urinary infection	4	3.1
Constipation	1	0.8
Anaemia	3	2.3

Most of the participants were rarely or not engaged in regular physical exercise during the last pregnancy period, rather were engaged in sitting light work or in sitting moderate work. Only 40% of the participants were engaged in standing light work during the last pregnancy. Most of the participants (90.8%) were not engaged in standing moderate work. None of the participants were involved in standing heavy work during the pregnancy (not presented in table). Almost all the participants (99.2%) consumed carbohydrates and vegetables during the last pregnancy. More than 60% of the participants consumed animal

protein and milk/milk products and fruits. Around one third of the participants remained on special diet and observed food taboos independently. A substantial section of the participants (36.9%) was exposed to passive smoking (Table-5).

Table 5: Physical activities and consumption pattern of the participants during the last pregnancy (n=130)

Physical activities	n	%
Regular physical exercise		
Yes	5	3.8
No	125	96.1
Sitting light work		
Yes	108	83.1
No	22	16.9
Sitting moderate work		
Yes	91	70.0
No	39	30.0
Walking a distance		
Yes	98	75.4
No	32	24.6
Standing light work		
Yes	54	41.5
No	76	58.5
Standing moderate work		
Yes	12	9.2
No	118	90.8
Standing heavy work		
Yes	-	-
No	130	100.0
Consumption pattern		
Carbohydrates		
Yes	129	99.2
No	1	0.8
Animal protein		
Yes	90	69.2
No	40	30.8
Milk/ milk products		
Yes	79	60.8
No	51	39.2
Vegetables		
Yes	129	99.2
No	1	0.8
Fruits		
Yes	108	83.1
No	22	16.9
Highly processed foods		
Yes	57	43.8
No	73	56.2
On special diet		
Yes	49	37.7
No	81	62.3
Passive smoking		
Yes	48	36.9
No	82	63.1
Followed food taboo		
Yes	44	33.8
No	86	66.2

Result of binary logistic regression analysis showed that the incidence of LBW was likely to increase with increase in participants' age at respective conception (last live birth) (OR= 1.286), educational levels [(below graduate level) OR= 1.72], occupational types [(homemakers) OR= 2.20], religious affinity [Muslim (OR=1.05)], parity (OR= 1.10), use of oral contraceptives (OR= 1.14), reported antepartum morbidities (OR=1.69), exposure of participants to passive smoking (OR=1.80), practice of food taboo during pregnancy (OR=1.18). On the other hand, the incidence of LBW remained lower with increase in participants' educational levels [graduate (OR=0.21)], monthly household expenditure (OR=0.99), age at first conception (OR=0.99), gestational age (OR=0.98), birth interval (OR=0.30), antenatal care [use of TT immunization (OR=0.45), iron/ folic acid tablets (OR=0.09)], physical activities [regular physical exercise (OR=0.09), sitting light work (OR=0.36), sitting moderate work (OR=0.99), walking a distance (OR=0.78), standing moderate work (OR= 0.31), standing light work (OR=0.92)], and food consumption [carbohydrate (OR=0.81), animal protein (OR=0.06), milk products (OR=0.57), vegetables (OR=0.67), fruits (OR=0.53), calorie dense foods (OR=0.84)] (Table-6).

Table 6: Results of binary logistic regression analysis (n=130)

Dependent variable	Odds ratio(OR)	p value
Independent variables		
Birth weight of the last full term singleton live birth(occurrence of LBW)		
Educational levels of the participants		
School levels	1.721	0.802
Graduate	0.217	0.901
Educational levels of spouse	0.413	0.553
Below graduate	0.433	0.638
Graduate		
Occupational types of the participants	2.203	0.999
Home makers		
Occupational types of the spouse	0.718	0.737
Business	0.742	0.617
Service		
Religion	1.056	0.966
Muslim		
Monthly household expenditure (Indian rupees)	0.999	0.322
Age at marriage (years)	0.993	0.981
Age at first conception (years)	0.993	0.983
Age at conception of the last child (years)	1.286	0.967
Gestational age of the last child (weeks)	0.983	0.924
Parity	1.102	0.927
Birth interval	0.309	0.783
Ever use of oral contraceptive	1.140	0.808
Administered TT. immunization	0.450	0.998
Administered iron/ folic acid tablets	0.093	0.999
Reported antepartum morbidities	1.693	0.043
Regular physical exercise	0.090	0.144
Sitting light work	0.360	0.412
Sitting moderate work	0.997	0.998
Walking a distance	0.787	0.786

Standing moderate work	0.313	0.534
Standing light work	0.926	0.925
Intake of carbohydrates	0.810	0.998
Intake of animal proteins	0.061	0.055
Intake of milk products	0.573	0.555
Intake of vegetables	0.675	0.976
Intake of fruits	0.532	0.559
Intake of calorie dense foods	0.845	0.839
Passive smoking	1.803	0.614
Followed food taboo	1.188	0.832
Remained on special diet	0.126	0.016

Results of hierarchical linear regression analysis demonstrate the association of birth weight with socio-demographic characteristics and reproductive history, antepartum care and reported antepartum morbidities and lifestyle of mothers. In both the models (model I and model II), all the independent variables did not show significant association with birth weight. In both the models, variables like educational levels (up to school level), occupational types (homemaker), religious affinity (Muslim), age at conception of respective pregnancy (last live birth), ever use of oral contraceptives and parity of the participants showed inverse association with the birth weight. In model II, variables like, reported antepartum morbidities, passive smoking and practice of food taboo showed inverse association with the birth weight. However, antepartum care (like, TT. immunization, use of iron and folic acid tablets) and lifestyle [physical activities (regular physical exercise, sitting light work, sitting moderate work, walking distance, standing light work, standing moderate work) and consumption pattern (intake of carbohydrate, animal protein, milk/milk products, vegetables, fruits, and highly processed food)] showed positive association with the birth weight. A change in R^2 value [model II (0.325) - model I (0.206)] indicates that model II is more better than model I (Table-7).

Table 7: Results of hierarchical linear regression analyses (n=130)

Dependent Variable	Independent variables	B*	SE	t value	p value	Independent variables	B*	SE	t value	p value
	Model I					**Model II**				
Birth weight of last full term singleton live birth	Educational levels of the participants Below graduate Graduate	-0.322 0.204	0.192 0.216	1.679 0.942	0.096 0.349	Educational levels of the participants Below graduate Graduate	-0.430 0.443	0.212 0.254	2.027 1.742	0.046 0.085
	Educational levels of the spouse Below graduate Graduate	0.060 0.093	0.251 0.285	0.239 0.325	0.812 0.746	Educational levels of the spouse Below graduate Graduate	0.064 0.115	0.269 0.307	0.239 0.374	0.812 0.709
	Occupational types of the participants Home makers	-0.555	0.348	1.593	0.114	Occupational types of the participants Home makers	-0.606	0.406	1.490	0.140
	Occupational types of the spouse Business Service	0.201 0.074	0.128 0.143	1.567 0.515	0.120 0.608	Occupational types of the spouse Business Service	0.175 0.084	0.145 0.162	1.203 0.520	0.232 0.605
	Monthly household expenditure (Indian rupees)	1.428	0.035	0.755	0.452	Monthly household expenditure (Indian rupees)	2.901	0.053	0.133	0.894
	Religious affinity (Muslim)	-0.050	0.109	0.462	0.645	Religious affinity (Muslim)	-0.057	0.143	0.399	0.691
	Age at marriage of the participants (years)	0.051	0.032	1.587	0.116	Age at marriage of the participants (years)	0.021	0.037	0.562	0.576
	Age at conception of the last child (years)	-0.029	0.043	0.673	0.503	Age at conception of the last child (years)	-0.064	0.050	1.280	0.204
	Age at first conception (years)	0.021	0.037	0.558	0.578	Age at first conception (years)	0.010	0.042	0.236	0.814
	Gestational age of the last child	0.008	0.021	0.367	0.715	Gestational age of the last child	0.025	0.005	0.985	0.328
	Ever use of oral contraceptives	-0.277	0.210	1.316	0.191	Ever use of oral contraceptive	-0.197	0.249	0.149	0.882
	Parity More than one	-0.192	0.141	1.358	0.178	Parity More than one	-0.045	0.163	0.274	0.785
	Birth interval	0.105	0.010	1.273	0.193	Birth interval	0.608	0.245	1.899	0.467
						Reported antepartum morbidities problems	-0.018	0.119	0.149	0.882
						Administered TT. immunization	0.181	0.648	0.279	0.781
						Administered iron and folic acid tablets	0.650	0.530	1.226	0.224
						Regular physical exercise	0.328	0.295	1.111	0.270
						Sitting light work	0.069	0.183	0.378	0.708
						Sitting moderate work	0.020	0.133	0.153	0.878
						Walking distance	0.105	0.140	0.751	0.455

Standing light work	0.010	0.115	0.089	0.929
Standing moderate work	0.304	0.190	1.597	0.114
Intake of carbohydrate	0.280	0.547	0.511	0.611
Intake of animal protein	0.192	0.115	1.668	0.099
Intake of milk products	0.062	0.112	0.550	0.584
Intake of vegetables	0.130	0.552	0.236	0.814
Intake of fruits	0.222	0.168	1.320	0.191
Intake of calorie dense foods	0.045	0.110	0.412	0.681
Passive smoking	-0.181	0.160	1.128	0.263
Followed food taboo	-0.038	0.121	0.311	0.757
Remained on special diet	0.189	0.129	0.693	0.491

R^2 (Model I)= 0.202
R^2 (Model II)= 0.343

*B- unstandardized coefficients

DISCUSSION

We aimed to understand how maternal investment determines birth weight of the last full term singleton live birth. The study findings documented one fifth of the children were born with LBW, corroborating with the findings from other states of the country [Karnataka (22.9%), Tripura (23.9%,), Guwahati (26%), Bhopal (36%), Delhi (39%) and Haryana(17%)] (Chabbra et al., 2004; Metgud et al., 2012; Bhattacharjya et al., 2015; Gogoi, 2018; Kumar et al., 2017). When compared with the other districts of West Bengal [Burdwan (27%), Hooghly (28%), and Malda (36%)], the incidence of LBW among our study participants seem to be lower (Kumar et al., 2018; Dasgupta and Basu, 2011; Chouhan, 2019). In our study, birth weight of children was likely to be lower for mothers who were homemakers, attained education below graduate level and hailed from Muslim group. Similarly, other studies in India and elsewhere revealed that both maternal education and occupation significantly predicted the birth weight of children (Bhaskar et al., 2015; Kumar et al., 2017; Gogoi, 2018; Agorinya et al., 2018). Another study in rural West Bengal showed that the prevalence of LBW was higher among Muslims than the Hindus (Manna et al., 2013). Higher educational attainment of mothers probably increases the level of knowledge and concerns about antenatal care among them that eventually reduce the odds of LBW. Moreover, employed mothers being economically independent, could be able to take decision about their own health, access better medical facilities and develop positive attitudes towards antenatal

care which possibly lowers the odds of adverse postnatal outcomes.

Literature revealed that despite socio-demographic factors, reproductive history of mothers was indeed responsible to determine the birth weight of children. Maternal age at conception was a significant factor to predict postnatal outcomes (Kenny et al., 2013). Our study showed that the birth weight of children was likely to decline with early age at first conception and also with advanced age at respective conception. The odds of LBW increased if mothers conceived at an early age (Aras, 2013; Mahumud et al., 2017). It is probable that women belonging to economically deprived families usually get married and conceive at an early age and remain casual in availing antepartum care (Boamah et al., 2016; Awasthi et al., 2018). Pregnancy at advanced age also increases the odds of LBW (Lampinen et al., 2009; Mahumud et al., 2017). However, a recent study in India documented that mothers of advanced age could have better knowledge about nutrition and access proper utilization of maternal health care services, which may lower the odds of LBW (Khan et al., 2019). Two case-control studies in Ghana and Ethiopia reported that the cases of LBW occurred mostly in association with short gestational weeks (Adam et al., 2019; Girma et al., 2019). Similarly, like other studies in India (Dasgupta and Basu, 2011; Jhadhao et al., 2016), our findings documented an association of the incidence of LBW with short gestational age. Perhaps, the growth and development of foetus become impaired with reduced gestational weeks (Di Pietro, 2008). Thus, it is evident that shorter length of gestation is usually related to the occurrence of preterm birth, which subsequently increases the odds of LBW and develops the risk for infant mortality (Bansall et al., 2019). An inverse association of birth weight with parity has been observed in our study supporting the fact that high parity could have some adverse effects on birth weight (Celik and Younis, 2007; Manna et al., 2013). Mothers having three or more children were at an increased risk of delivering live birth with LBW (Nobile et al., 2007). On the contrary, Boo et al. (2008) and Anitha et al. (2009) demonstrated that odds of LBW remained low in case of birth of first child. Parallel to this, birth interval becomes a major factor indicating the postnatal outcome. Studies showed that birth weight of children had positive association with birth interval, which corroborates with our study. It seems that short inter-pregnancy interval depletes maternal nutrient stores which adversely affects on maternal weight gain and haemoglobin level. These adversities in maternal health increase the odds of LBW for subsequent live births (Zhu et al., 1999; Black et al., 2008; Misra, et al., 2015). Our findings showed that the birth weight of children was likely to be lower with ever use of oral contraceptives. Prolonged use of oral contraceptives before conception imposes a greater risk on birth outcome (Hatch et al., 2015). However, contraception is highly recommended to increase inter pregnancy interval, thereby mothers are advised to adopt exclusive breastfeeding as a dedicated method of contraception (Sridhar and Salcedo, 2017).

Studies showed that antepartum care and morbidities had significant effect on birth weight of children (Abdal Qader et al., 2012; Palve, 2016). It is usually

found that those mothers who received antenatal care were more likely have live births with normal birth weight compared to those who never received such care (Malik et al., 1997; Ahmed et al., 2012). Regular intake of iron and folic acid tablets and administration of complete course of TT immunization by the mothers in our study might indicate higher level of awareness about antepartum care. Thus, the positive association of birth weight with antepartum care (like use of iron-folic acid tablets and TT immunization) as found in our study supports the existing literature (Sinha, 2006). Simultaneously, antepartum morbidities as reported by the mothers in our study possibly leads to growth retardation in foetus (Sharma et al., 2016; Battarbee et al., 2019). Therefore, the chances of LBW increase if mothers develop co-morbidities during pregnancy (Bhaskar et al., 2015; Girma et al., 2019). Hence, late visits to doctors during pregnancy could bring the complicacy in health and subsequently may increase the odds of LBW (Manna et al., 2013).

Lifestyle (consumption pattern and physical activities) of mothers during pregnancy also affects birth weight of children. The consumption of balanced foods provides nutrition among pregnant mothers and subsequently helps in development of foetus. Thus, healthy dietary habits of mothers during pregnancy promote healthy live birth with normal body weight and simultaneously reduce the odds of LBW. One study showed that LBW is primarily caused by low gestational weight gain due to low energy intake (Kramer, 2003). Our study revealed that birth weight was likely to increase if mothers consumed animal proteins, carbohydrates, milk/ milk products, vegetables and fruits during antepartum period. This finding corroborates with others studies (Poon et al., 2013; Abubakari and Jahn, 2016). However, two studies in Ethiopia reported that taboos related to intake of certain food items might cause adverse effects on nutritional status of pregnant mothers, thereby resulting into adverse pregnancy outcomes (Zerfu et al., 2016; Vasilevski and Carolan-Olah, 2016). A study in rural West Bengal reported that pregnant women followed food taboos in order to prevent miscarriage and foetal malformation, and promote delivery with ease. In addition to unhealthy dietary practices, substance use is also responsible for developing the odds of LBW. For example, the habit of smoking and alcohol consumption at the time of pregnancy may diminish foetal growth by altering the function of the placenta (Wang et al., 2014). In our study, it appears that reduction in birth weight is likely to be reduced for women who were passive smokers. Likewise, a recent study in Malaysia found that mothers who remained passive smokers during pregnancy had delivered the child with LBW (Norsa'adah and Salinah, 2014). Physicians generally advice pregnant mothers to get involved in either light household chores or light physical exercise on the regular basis that would maintain the regulation of hormonal levels in body and subsequently alleviate the problems at intrapartum. Some studies reported that intrapartum issues often caused to affect postnatal outcomes (Muchemi et al., 2015). Thus, regular involvement in physical activities (like physical exercise and light household chores) was positively associated with birth weight of children as observed in our study.

Recently, Government of India has implemented a scheme through Pradhan Mantri Matru Vandana Yojona to ensure the utilization of antenatal services among pregnant mothers in exchange of conditional cash transfer and thereby encourages them to register at the health centre within four months of conception, attend at least one prenatal care session and regular use of iron-folic acid tablets and TT immunization. However, various factors (like, lower maternal education, lower economic status, spouse negligence during antenatal visits, higher parity, pregnancy at adolescence and unintended pregnancy) were found to be associated with lower odds of full ANC utilisation (Kumar et al., 2019). Our findings implied how socio-demographic, reproductive characteristics, antepartum care, reported antepartum morbidities and lifestyle of mothers during pregnancy determined the birth weight of children.

LBW is indicative of lower maternal investment that can be traced back throughout the lives of mothers. Here, life history of mothers provides important insights into the potential role on birth weight of children in human reproductive strategies. Understanding the effects of life history and subsequent maternal investment on birth weight of child indicates the trade-off between current and future reproduction. Furthermore, maternal nutritional investment throughout the life and also at antepartum stage promotes the growth and development of foetus that eventually have an influence on the birth weight of children (Coall and Chisholm, 2003; Merklinger-Gruchala, 2019). Repetition of this type of study focusing on relation between maternal investment and birth weight would perhaps be useful in further reducing the LBW across the country.

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