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Original Article

Nutrition Section

Effect of Maternal Diet Diversity and Physical Activity on Neonatal Birth Weight: A Study from Urban Slums of Mumbai

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ABSTRACT

Introduction: India has the highest prevalence of low birth weight babies. Geographical variation and level of physical activity can influence diet diversity and maternal nutritional status which in turn influences the birth weight of the neonate. Mumbai is a large city comprising of slums in suburbs depicting diet diversity amongst populations.

Aim: To study the maternal diet diversity, physical activity and its effect on birth weight of the neonates in urban slums of Mumbai.

Materials and Methods: A six month follow-up study was carried out in three maternity homes representing different geographical areas of Western, Central and Southern Mumbai. A total number of 131 pregnant women were selected using simple random sampling. Final sample size was n=121 after follow-up loss of 9 and 1 miscarriage. Maternal anthropometric, socio-demographic, physical activity and diet diversity data was collected using structured questionnaires through personal interview after taking written informed consent. Birth weight of the neonate was recorded. Chi-Square, Correlation, ANOVA was used to test the significance. A p-value of <0.05 was considered to be significant.

Results: Nineteen (15.7%) were low birth weight (LBW) infants, 102 (84.3%) had normal weight. There was a significant association between place of Antenatal Clinic (ANC) visit and diet diversity score and its subsequent effect on birth weight (p<0.05). Geographic variation had an impact on diet diversity scores which in turn affected the birth weight of neonates. Women who delivered low birth weight babies were more involved in household domestic activities (p<0.05) compared to those women who delivered normal weight babies.

Conclusion: Diet diversity and physical activity influence the birth weight of neonates across different geographic locations. Despite of ample interventions available to prevent maternal malnutrition, the incidence of LBW was not decreased. Thus, this issue needs to be addressed at the national level to curb the problem of low birth weight especially among the urban slums that are rapidly encroaching.

Keywords: Low birth weight, Maternal nutrition, Maternal Physical activity, Mid-upper arm circumference

INTRODUCTION

Birth weight is an important indicator of status of public health, maternal health and nutrition. Globally low birth weight contributes to 40-60% of total newborn mortality [1]. Low birth babies are the one who weigh less than 2500g [2]. According to UNICEF, 2004 India and Bangladesh showed highest prevalence of low birth weight babies (30%) [3]. LBW babies are most prevalent in the rural areas of the society [4]. Mumbai has highest percentage (56%) of households in slum areas compared to other cities in the country National Family Health Survey-3 (NFHS-3) [5]. Women belonging to urban slums of Mumbai have access to Antenatal Clinics (ANC) however, has a compromised nutritional status [6]. Maternal nutritional status is crucial in determining the birth weight of the neonate [7]. Most of the literature points at the nutritional status based on energy and protein intake [8]. However, a few studies indicate use of diet diversity as a marker of assessing the nutritional status [9]. Diet diversity is a qualitative measure of food consumption that reflects household access to a variety of foods and, is also proxy for nutrient adequacy of the diet of individuals [10]. Thus, is an important factor as consuming monotonous diet will lead to micronutrient deficiencies which will further affect the growth of the foetus and hence, increase the chances of low birth weight. Heavy physical activity on the other hand is also associated with increased risk of LBW babies [11]. Hard physical work during pregnancy was significantly associated with birth of low birth weight babies [12]. Excessive physical activity in pregnancy was also associated with lower birth weight [13].

Amidst all the factors predisposing the risk towards low birth weight is the variation in the diet pattern in different geographical areas [14]. Mumbai, being one of the largest cities in the country, the food availability, access, socio-demographic characteristics vary in different geographical area. This may influence the maternal nutritional status which in turn determines the birth outcome in terms of birth weight of the neonate. Thus, this study aimed towards observing the effect of diet diversity and level of physical activity of pregnant women on birth weight of the neonates in urban slums of Mumbai.

MATERIALS AND METHODS

A six month follow up study was conducted by Symbiosis School of Biological Sciences, Symbiosis International University, Pune, India. It was carried out in ANC's of three maternity homes under the Municipal Corporation of Greater Mumbai (MCGM) viz., Maternity Home I situated in Borivali, Maternity Home II situated in Mulund and Maternity Home III situated in Prabhadevi during December 2015 to June 2016. These maternity homes were located in the western suburbs, central suburbs and southern Mumbai respectively, which would represent three different geographical areas. The sample size was calculated using a single population proportion formula- $n= (Z1-\alpha/2)^2[p(1-p)/d^2]$,

where, p= 30% Prevalence of low birth weight;

$[Z (1-\alpha/2)]$= Confidence level of 95%; and

d= 8% Degree of desired precision.

Thus, n=126 was the calculated sample size. We collected data of 131 pregnant mothers by using simple random sampling technique. However, there was a follow up loss of nine participants and one miscarriage, thus the final sample size was 121. Pregnant women in their 2nd and 3rd trimester were included in the study and were approached while they waited for their antenatal checkup, to introduce the objectives of the study to them and seek their consent to participate. Pregnant women suffering from chronic illness like hypothyroidism, hyperthyroidism, previously diagnosed diabetes, hypertension or gestational diabetes mellitus were excluded. Women in their first trimester were not considered due to time constrain. Voluntary participation was encouraged. Those who agreed to participate were taken through the consent processes, explaining to them the benefits and risks of participating in the study. Through an interview in their local language which was Marathi and Hindi the data was collected. Sufficient time was taken to complete the interview using questionnaire for 15 minutes to allow accuracy and avoid bias. This data was collected using three questionnaires first for anthropometry and socio-demographic characteristics such as maternal age, age of menarche, age of marriage, place of residence, marital status, family and previous pregnancy history and socio-economic status. The second questionnaire was related to information of physical activity; this questionnaire was adopted from validated maternal activity questionnaire and was used to determine the physical activity levels of the pregnant mothers [13]. It included hours spent in sleeping, travelling, leisure, work and mode of transport. It also included household work done. Resting scores for this questionnaire were computed on the basis of hours of night sleep, afternoon nap and number of programmes or movies watched. Higher resting scores reflected less rest whereas, less resting scores reflected more rest. On the other hand, the domestic scores were computed on the basis of activities like cooking, washing clothes, washing utensils, shopping and breastfeeding. The third questionnaire was adopted and pre-tested to suit the Indian context from the Food and Agricultural Organization (FAO) to understand the diet diversity [10]. The diet diversity scores consist of a simple count of food groups such as cereals, white roots and tubers, Vitamin A roots and tubers, dark green leafy vegetable, other vegetables, Vitamin A rich fruits, other fruits, organ meat, flesh meats, eggs, fish and seafood, legumes, nuts and seeds, milk and milk products, oils and fats, sweets, spices and condiments that an individual has consumed in 24 hours inclusive of the diet diversity within various food groups. The individual dietary scores reflected the nutrient adequacy. Increase in the dietary scores was considered to be directly proportional to the nutrient adequacy of the diet. The score ranged from 0-9 wherein a score less than three indicated low diet diversity, four-five as medium diet diversity and more than six as high diet diversity scores. All pregnant women were followed up during pregnancy and later after their delivery to record the birth weight of the neonate at the maternity homes.

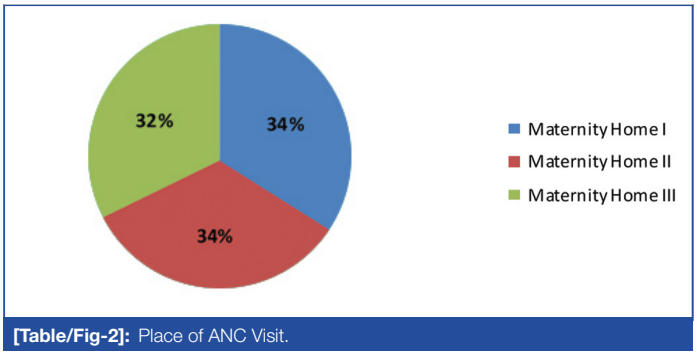
This study was approved by the Independent Ethics Committee (IEC) of Symbiosis International University in December 2015. Before commencement of data collection, permission was obtained from the Executive Health officer of Municipal Corporation of Greater Mumbai in September 2015. Permission was granted by the MCGM to collect the data from the three maternity homes in Mumbai. The data collected was checked for completeness, coded and entered into Microsoft excel and analysed using Statistical Package for Social Sciences (SPSS) version 23.0. The normality of data was tested using Shapiro wilk test and z scores for both skewness and kurtosis was within ±2.58 with p-value> 0.05. This indicated that data was normally distributed. The data was analysed using descriptive statistics comprising of frequencies, percentages and measures of central tendencies. Chi-Square test was done to find association of ANC visit and socio-economic status with diet diversity score and also to find association between occupation of mother and birth weight of neonate. Independent t-test was used to find the significant difference between gestational weight and Mid-Upper Arm Circumference (MUAC) in second and third trimester.

RESULTS

Socio-demographic characteristics of the participants are represented in [Table/Fig-1]. The mean age of the pregnant women was 25.16±3.61 years with the age range of 19-35 years. Maximum percentage of pregnant women (47.1%) belonged to the age category 24-29 years. Based on Kuppuswamy Socioeconomic status scale, 61.2% of the pregnant women belonged to middle class, followed by 33.1% in lower middle class and 4.1% in lower class.

Category	LBW N (%)	NBW N (%)	χ^2	p-value
Age of the Mother (Years)				
19-23	7 (36.8)	38 (37.2)	0.531 (NS)	0.767
24-29	10 (52.6)	47 (46)		
30-35	2 (10.5)	17(16.6)		
Mean±SD	25.16±3.61			
Age at Menarche (years)				
9-11	1 (5.2)	2 (1.96)	0.768 (NS)	0.681
12-14	14 (73.6)	80 (78.4)		
15-17	4 (21)	20 (19.6)		
Mean±SD	13.53±1.28			
Age at Marriage (years)				
<18	3 (15.7)	20 (19.6)	0.203 (NS)	0.903
18-25	14 (73.6)	70 (68.6)		
>25	2 (10.5)	12 (11.7)		
Mean±SD	21.46±3.47			
Kuppuswamy Socioeconomic status scale				
Middle Class	12 (63.1)	64 (62.7)	1.024 (NS)	0.599
Lower-Middle Class	7 (36.8)	33 (32.5)		
Lower Class	0 (0)	5 (4.9)		

[Table/Fig-1]: Socio-demographic characteristics of pregnant women.
χ^2 = Chi-Square Value, NS = Not Significant, LBW = Low birth weight, NBW = Normal birth weight.



[Table/Fig-2]: Place of ANC Visit.

As seen in [Table/Fig-2], there was an equal representation of pregnant women from all three maternity homes.

The mean Prepregnancy BMI was 20.9±4.78 kg/m². The mean gestational weight in second trimester was 53.3±9.245 kg which was significantly different from the mean gestational weight in third trimester 57.06±8.467 kg (p-value =0.039) [Table/Fig-3]. There was no significant association between pre-pregnancy weight, height, pre-pregnancy BMI and MUAC across birth weight of neonates.

As seen in [Table/Fig-4] the average gestational weight gain was higher for pregnant mothers who delivered normal weight babies as compared to pregnant mothers who delivered low- birth weight babies.

Maternal Anthropometric Characteristics	LBW N (%)	NBW N (%)	χ^2	p-value
Pre-Pregnancy Weight (kg)				
<40	6 (31.6)	27 (26.5)	0.21 (NS)	0.646
>40	13 (68.4)	75 (73.5)		
Mean±SD	47.35±9.95			
Height (cm)				
<145	4 (21.1)	29 (28.4)	0.44 (NS)	0.507
>145	15 (78.9)	73 (71.6)		
Mean±SD	151.6±10.67			
Pre-Pregnancy BMI (kg/m²)				
< 18.5	7(36.8)	31(30.3)	0.74 (NS)	0.864
18.6-22.9	8(42.1)	42(41.1)		
23- 24.9	1(5.2)	11(10.7)		
>25	3(15.7)	18(17.6)		
Mean±SD	20.9±4.78			
MUAC (cm)				
<24	7(36.8)	42(41.2)	0.125 (NS)	0.724
>24	12(63.2)	60(58.8)		
Mean±SD	25.19±2.70			
	Second Trimester	**Third Trimester**		**p-value**
Gestational Weight (kg)	53.3±9.24*	57.06±8.46*		0.039
MUAC (cm)	25.07±2.87	25.23±2.65		0.781
Gestational Week	14-27	28-39		

[Table/Fig-3]: Maternal anthropometric measurement.
χ^2 = Chi- Square Value, NS = Not Significant, MUAC = Middle Upper Arm Circumference
*Significant difference between gestational weight across two trimesters.

Variables	Low Birth Weight (kg) (N=17)	Normal Birth Weight(kg) (N=72)
Mean±SD	8.60±2.865	9.44±3.812
Median	8.5	10.00
Interquartile range	4.25	6.75

[Table/Fig-4]: Average gestational weight gain in third trimester across birth weight categories.

Physical activity scores were categorized on basis of three activities: Resting activities, Domestic Activities and Other Activities. As seen in [Table/Fig-5], there was no difference seen in sleep patterns of mothers who delivered low birth and normal weight babies. The mean resting scores for mothers who delivered LBW babies was lower as compared to one who delivered normal birth weight babies indicating that pregnant mothers took more rest. The mean domestic scores were more for LBW mothers indicating their physical activity levels to be high.

[Table/Fig-6] illustrates distribution of resting and domestic scores across birth weight of neonate. After computing resting and domestic scores, they were divided into two categories. Less resting scores indicated mothers who took more rest and vice a versa. A higher number of pregnant mothers (58%) who delivered LBW babies took more rest as compared to 45% pregnant mothers who delivered normal weight babies. Domestic Scores were more in pregnant mothers (21.1%) who delivered LBW babies as compared to 16.7% who delivered normal weight babies indicating high levels of physical activity and its effect on low birth weight.

The diet diversity score was computed based on the average number of food groups consumed daily. Across the birth weight categories the diet diversity scores were almost similar and non-significant.(p-value= 0.749) [Table/Fig-7].

Significantly higher percentages (23.6%) of women belonging to middle class had high diet diversity scores compared to lower middle class. Majority of women belonging to lower-middle and low class had medium diet diversity scores. (p-value< 0.05) [Table/Fig-8].

As depicted in [Table/Fig-9], there was a significant association between the place of ANC visit and diet diversity score (x^2= 8.269, p=<0.05). Majority of pregnant mothers in Maternity Home III had high diet diversity scores followed by Maternity Home I and II.

Physical Activities	Low Birth Weight Mean±SD	Normal Birth Weight Mean±SD
Resting Activities	20.05±2.65	21.05±2.92
Night Sleep	9.6±2.13	9.7±2.05
Afternoon Nap	5.4±0.77	5.8±0.90
Watching TV	4.9±0.88	5.4±1.11
Domestic Activities	16.04±3.55	15.75±3.53
Cooking (Making Roti)	3.1±1.08	5.4±1.11
Washing Clothes	4.7±1.67	4.2±1.50
Washing Utensils	4.7±1.73	4.6±1.72
Shopping	3.3±0.94	3.4±1.09
Other Activities		
Stitching	6.3±21.8	2.3±7.8
Breast Feeding	0.15±0.57	0.04±0.20

[Table/Fig-5]: Distribution of mean physical activity scores across the birth weight of the neonate.

Variables	Low Birth Weight N (%)	Normal Birth Weight N (%)	χ^2	p-value
Resting Score				
15-20.4 More rest	11 (57.9)	46 (45.1)	1.053 (NS)	0.305
20.5-26 Poor rest	8 (42.1)	56 (54.9)		
Domestic Scores				
12-19.4 Less active	15(78.9)	85 (83.3)	0.313 (NS)	0.576
19.5-27 More active	4(21.1)	17 (16.7)		

[Table/Fig-6]: Distribution of resting and domestic scores across the birth weight of the neonate.
χ^2 = Chi-Square Value, NS = Not Significant

Diet Diversity Score	LBW N (%)	NBW N (%)	χ	p-value
Low	0	3(2.9)	0.578(NS)	0.749
Medium	9(47.4)	46(45.1)		
High	10(52.6)	53(52)		

[Table/Fig-7]: Diet diversity scores across pregnant women.
χ^2 = Chi-Square Value, NS = Not Significant

Diet Diversity Scores	Kuppuswamy Socio-economic Status Scale			χ^2	p-value
	Lower Class	Lower-Middle Class	Middle Class		
Low	0	3(7.5)	0		
Medium	5(100)	32(80)	58(76.3)	16.96	0.009
High	0	5(12.5)	18(23.6)		

[Table/Fig-8]: Socioeconomic status and diet diversity score of the study group.
*p-value< 0.05 for significant association between socio-economic status and diet diversity score
χ^2 = Chi-Square Value

Diet Diversity Score	Place of ANC visit			χ^2	p-value
	Maternity Home I	Maternity Home II	Maternity Home III		
Low	3 (7.14)	0 (0)	0 (0)		
Medium	30 (71.4)	36 (92.3)	29 (72.5)	8.269*	0.012
High	9 (21.42)	3 (7.69)	11 (27.5)		

[Table/Fig-9]: Chi-square test for place of ANC visit and diet diversity score.
*p-value< 0.05 for significant association between place of ANC visit and diet diversity scores.
χ^2 = Chi-Square Value

Category	N (%)	
Birth Weight of Neonate		
>2500g	102 (84.3)	
<2500g	19 (15.7)	
Mean Birth Weight of the neonate (kg)±SD	2.75±0.437	
Gender of the baby and Birth weight	χ^2 = 0.626 (NS); p = 0.391	
	LBW	NBW
Boys	9 (14.1)	55 (85.9)
Girls	10 (17.5)	47 (82.5)
Type of Delivery and Birth weight	χ^2 = 0.576 (NS); p = 0.600	
	LBW	NBW
Normal	14 (17.5)	66 (82.5)
C-Section	5 (12.2)	36 (87.8)
Gestational Week of Delivery and LBW	χ^2 = 2.71 (NS); p = 0.09	
	LBW	NBW
<37 week	2 (10.5)	0 (0)
>37 week	17 (89.5)	102 (100)

[Table/Fig-10]: Neonatal birth outcome.
χ^2 = Chi-Square Value NS = Not Significant

Out of 121 deliveries, 84.3% of the babies weighed more than 2500g. Only 15.7% were low birth weight. The mean birth weight of the neonate was 2.75±0.437kg. Gender of the baby and type of delivery were not significant with the birth weight category. Majority of pregnant women delivered after 37 weeks of gestation. A 10.5% of women who delivered low birth weight babies were preterm deliveries while remaining were full term deliveries [Table/Fig-10].

	Maternity Home I	Maternity Home II	Maternity Home III	p-value
Mean birth weight of neonate	2.58±0.34*	2.79±0.48	2.86±0.43*	0.014

[Table/Fig-11]: One-way ANOVA for mean birth weight of the neonate across three different antenatal clinics.
*p < 0.05 for significant difference of mean birth weight across maternity homes

There was a statistical difference between mean birth weight of neonate across Maternity Home II and Maternity Home III as determined by One-way ANOVA (F=4.459, p=0.014). A tukey post-hoc test was undertaken to identify comparative mean differences across maternity homes. It revealed that the mean birth weight was significantly higher (2.86±0.43) for Maternity Home III as compared to Maternity Home I (2.58±0.34). Maternity Home III had better diet diversity scores and mean birth weight of the neonate was higher in Maternity Home III [Table/Fig-11].

	Birth weight of the neonate		χ^2	p-value
	<2500g	>2500g		
Housewife	16 (84.2%)	80 (78.4%)		
Housemaid	0	18 (17.64%)	7.320*	0.026
Professional/ Shop-owner	3 (15.7%)	4 (3.92%)		

[Table/Fig-12]: Occupation of mother and birth weight of the neonate.
*p < 0.05 for significant association between occupation of mother and birth weight of neonate.
χ^2 = Chi-square value

There is a significant association between occupation of the mother and the birth weight of the neonate [Table/Fig-12]. An 84.2% of pregnant women who delivered low birth weight babies were housewife whereas only 15.7% were professional, indicating heavy domestic chores or physical activity being linked with LBW.

DISCUSSION

Considering the maternal anthropometric measurements, our study found significant difference in gestational weights across trimesters. These findings were similar to study published by Wise LA, 2010 [15] who found significant relationship between mean gestational weights in trimester and risk of low birth weight babies. Comparison of BMI of mothers who delivered LBW babies and normal birth weight babies suggest that more percentage of women who delivered LBW fell into underweight category as compared to the normal weight babies. Our study findings correspond to a study done in 2012 [16] who found that the prevalence of LBW babies decreased with increasing BMI. Another studyalso found a relationship between pre-pregnancy BMI and pregnancy outcome [17]. Their findings suggested that women can minimize the risk of low birth weight babies by maintaining normal pre-pregnancy BMI. Margerison-Zilko et al., found that gestational weight gain is associated with the birth weight of the child in third trimester [18]. A study published by Widen, E.M. et al, found that trimester specific gestational weight gain is associated with the neonatal size [19]. Chihara I et al., found that women with inadequate weight gain in pregnancy were found to deliver low birth weight infants whereas the one with excessive weight gain delivered high birth weight infants [20]. Similar findings were observed in the present study.

In our study the mean resting scores for mothers who delivered LBW babies was lower as compared to those who delivered normal birth weight babies and the mean domestic scores were more for LBW mothers indicating their physical activity levels to be high with lack of rest. This indicated that mothers involved in high maternal domestic activity and poor restdelivered LBW babies. These findings were in tandem with a study [21] reporting that women who exercised vigorously had mean birth weight lower than those who did not do regular vigorous exercise. Another study also concluded that excessive occupational physical activity has detrimental effect on the birth weight of the neonate [22].

Majority of the pregnant mothers delivered normal weight babies. Also, the diet diversity scores of these mothers were high, indicating that diet diversity scores influence birth weight. It was similar to a recent study by Zerfu TA et al., who investigated the association between diet diversity during pregnancy and LBW babies and proved that women diet diversity score of greater than four to be associated with lower risk of LBW [9]. In our study, women who had high diet diversity scores were from a better socio economic background whereas the ones with low diet diversity scores belonged to low socio-economic status. The women with high diet diversity scores belonged to Maternity Home I which was located in Borivali. This might be due to more availability of food items in Borivali. Borivali is a western suburb which is well connected to the South- Mumbai as well as the Vasai-Virar region which is rich in vegetation. The socio-economic status of people residing in Borivali was also higher than that of Mulund the last suburb situated in North West of Mumbai. Therefore, the socio-economic status of those women will be lower compared to other two. Thus low availability of foods, less purchasing power might be the reason for higher percentages of women (63.4%) having low diet diversity scores A study by Savy M et al., also found that diet diversity scores of women who were economically settled to be more [23]. Also, Bidi A et al., found a significant association with the socio-economic status of individuals and diet diversity scores [24]. In our study, majority of women who delivered LBW babies were housewives indicating their involvement in household chores like making roti, washing clothes, washing utensils, breastfeeding and stitching, whereas the ones who worked as professionals delivered NBW. This might be due to influence of maternal education. Similarly a study by Choudhary AK et al., in Urban Slums in Bhopal, also showed statistical significance between occupation of mother and birth weight of the neonate [25].

Thus, the present study was an amalgamation of three predictors of birth outcomes including diet diversity, anthropometry and physical activity across urban slums of Mumbai with varied dietary patterns and geographic variations and further studies in this area are required.

LIMITATION

Dietary diversity scores reflect the diversity in terms of consumption of different foods. However, it does not quantify the foods consumed. Thus, the quantity of diet consumption could have an impact. There might be seasonal variation.

CONCLUSION

The results of the present study emphasize on the relationship of diet diversity and physical activity on birth outcomes across different geographic locations. Diet patterns in different geographical areas had an effect on diet diversity scores which in turn have an effect on birth weight of neonate. Physical activity scores revealed that high maternal domestic activity decreases the birth weight of neonate. Considering diversity in terms of culture and diet, cross-sectional studies can be planned across various regions of India to understand the effect of diet diversity on birth weight of the neonate. We also recommend Ministry of Women and Child development to consider nutrition education as a possible intervention in improving the health of pregnant mothers and birth weight of the neonates.

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