Energy and Protein Intake During Pregnancy in Relation to Preterm Birth: *A Case Control Study*

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Objective: To find the association of maternal energy and protein intake with preterm birth.

Design: Case-control study.

Setting: Two hospitals at Lucknow in Northern India.

Participants: Cases (*n*=350) were defined as mothers (age 18-40 y) of singleton live preterm (<37 wks) neonates. Controls (*n*=350) were mothers who delivered a singleton neonate, consecutive to enrolled case, after completing 37 weeks of gestation.

Results: There was a statistically significant lower mean (SD) energy intake [cases 1624 (249) Kcal *vs.* controls 1911 (341) Kcal; *P*<0.001] and protein intake [cases 32.1 (6.1) *vs.* controls 37.2 (7.0); *P*<0.001] among women who delivered preterm neonates. Maternal energy and protein intake had significant positive correlation with neonatal weight, length, foot length, head circumference and chest circumference.

Conclusion: Lower energy and protein intake during pregnancy is possibly associated with preterm birth.

Keywords: *Diet, Low birth weight, Prematurity.*

P reterm birth is a major determinant of neonatal mortality and childhood morbidity [1]. There seems to be an upward trend [2,3], which contributes to almost 3.6 million preterm births accounting for 23.6% of the global preterm births reported each year [4]. Preterm birth has been consistently associated with maternal underweight and nutrient deficiencies during pregnancy [5-9]. Therefore, nutritional assessment needs to be an integral part of antenatal care and should be continued during pregnancy in order to reduce the risk of maternal, fetal and neonatal complications, as well as the short- and long-term adverse outcomes. We conducted this case-control study with the objective to find the association of maternal energy and protein intake with preterm birth.

METHODS

This was a hospital-based case-control study conducted in King George's Medical University, a tertiary-care teaching institute, and Ram Manohar Lohia Hospital, a tertiary-care government non-teaching institute, in Lucknow, Uttar Pradesh, India. These two hospitals were chosen on the basis of their highest delivery data per year. Ethical clearance for the study was obtained from the Institutional ethical committee of King George's Medical University. Written informed consent was obtained from participating mothers.

The gestational age of neonate was assessed by using modified Ballard score within 48 hours of birth [10]. Preterm was defined as birth less than 37 weeks of gestation [1]. Cases were defined as mothers (age 18-40 years) of live preterm neonates. Controls were eligible mothers who delivered a neonate at or after 37 weeks of gestation, consecutive to an enrolled case. Mothers who gave birth to twins or those with neonates having congenital abnormalities were excluded.

To detect a mean difference of 5 gm/day (SD 7 g) in protein intake (two sided α=0.05, power=90%), we required a sample of 292 women each for cases and controls. We planned to recruit 350 cases and 350 controls.

Medical records were reviewed to obtain the age, pregnancy details and illness status of included women. Data were collected by a trained Medical scientist. Socioeconomic status was defined using Modified Kuppuswamy's socioeconomic scale 2012 [11]. Social classes I and II were categorized as high, III as middle, and IV and V as low. Mothers were asked for their daily intake of supplements (Iron, folic acid, vitamin D and calcium) during pregnancy. A predesigned questionnaire was used for obtaining the information of their diet in one week preceding delivery. The questions were pertaining to intake of milk, lentils, wheat products, rice, fruit vegetables, fast food, meat products and Indian desserts.

Food frequencies for individual questions were converted into servings for a day or week, and then summed to give a total daily (or weekly) intake of protein and energy. Quantity was assessed by showing them household measurements like *katoris*, teaspoon and glass of standard sizes. Nutritional assessment was done on the basis of guidelines given by National Institute of Nutrition [12].

All neonates were weighed on a weighing machine corrected to one digit after decimal under the supervision of pediatrician, within 48 hours of delivery. Neonatal length was measured with infantometer. Neonatal foot length, head circumference and chest circumference were measured within 48 hours by non-stretchable measuring tape. Maternal Mid Upper Arm Circumference (MMUAC) was also obtained by non-stretchable measuring tape.

Statistical Analysis: Data were analyzed by SPSS version 14.0. Categorical data were compared by Chi-square test, and Student's *t* test was applied for continuous variables. Pearson's correlation coefficient was applied to analyze the correlation of maternal diet with various anthropometric variables of newborn. *P* value of <0.05 was considered to be significant.

RESULTS

A total of 700 mothers (350 with preterm delivery and 350 with term delivery) from both hospitals (240 cases and controls each from King George's Medical University and 110 cases and controls each from Ram Manohar Lohia Hospital) were recruited from April 2012 to April 2014 (*Fig*. **1**).

Table **I** shows the sociodemographic and anthropometric characteristics of cases and control mothers and their newborns. Cases had lower Maternal Mid Upper Arm Circumference (MMUAC) and lower post-delivery maternal weight.

Table **II** shows the dietary intake of mother in the week preceding the delivery. Mothers who delivered neonates before 37 weeks of gestation consumed lesser energy than the mothers who delivered term neonates [1624 (240) Kcal *vs*. 1911 (341) Kcal; (*P*<0.001). Mothers with term neonates consumed significantly more servings of wheat, lentils, vegetables and fruits than mothers with preterm neonates. Positive correlation was also observed between neonatal anthropometric measures (head circumference, chest circumference, neonatal whole length, foot length and weight), and maternal energy and protein intake (*Table* **III**).

Positive correlation was also observed between maternal anthropometric measures and energy intake. Maternal daily energy intake was positively associated
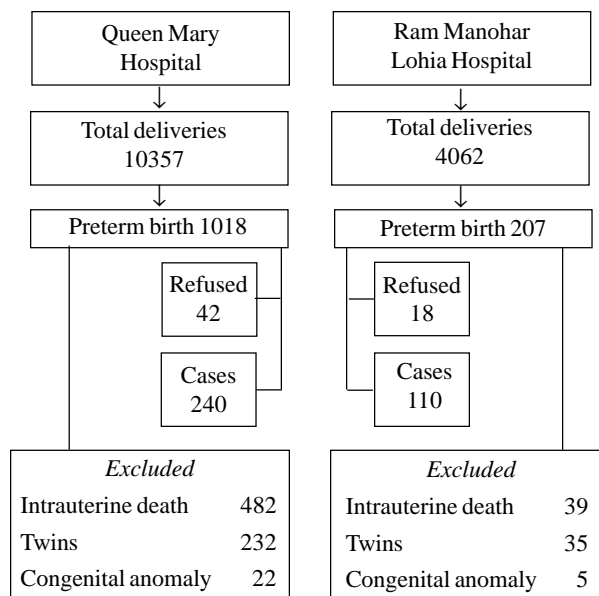
FIG.1 *Flowchart showing recruitment of cases.*

with maternal weight (r=0.2, *P*=0.001) and MMUAC (r=0.2, *P*<0.001). Protein intake was also significantly correlated with maternal weight (r=0.2, *P*<0.001) and MMUAC (r=0.1, *P*=0.002).

DISCUSSION

In this case-control study, we observed a statistically significant association of preterm birth with lesser maternal energy and protein intake. Maternal energy and protein intake also positively correlated with neonatal head circumference, chest circumference, birth weight, whole length and foot length.

The limitation of this study was that information of dietary intake in last one week was collected which is unlikely to capture the nutritional intake during entire pregnancy. To overcome the limitation of paucity of information on maternal diet, we also measured Maternal Mid Upper Arm Circumference which is reported to be a potential indicator of chronic nutritional status [13]. Recall method for estimating dietary intake and approximation of quantity of food consumed were the other limitations. The likely effect of other maternal, placental and fetal factors leading to preterm birth was also not evaluated in our study.

Our findings are supported by a Cochrane review that concluded that less energy intake during pregnancy is strongly associated with poor fetal growth, and underweight during pregnancy can also be possibly associated with the risk of preterm birth [14]. On the other hand, meta-analysis of five trials on balanced protein

TABLE I SOCIO-DEMOGRAPHIC AND ANTHROPOMETRIC CHARACTERISTICS OF CASES AND CONTROLS

Characteristics	Case (n=350)	Control (n=350)	P value	OR (95%CI)
Maternal				
age (y), mean	26 (4.3)	25.4 (3.8)	0.07	1.0 (0.9-1.0)
weight (Kg), mean (SD)	52.1 (6.7)	57.0 (5.9)	<0.001	0.8 (0.8-0.9)
Mid upper arm circumference (cm), mean (SD)	23.4 (2.3)	24.4 (1.9)	<0.001	0.8 (0.7-0.8)
Vegetarian diet, n (%)	210 (60.7%)	232 (66.3%)	0.12	0.7 (0.5-1.0)
Illiterate, *n* (%)	283 (80.9%)	3 (0.9%) <0.001	488.5	(152.0-1570.0)
Housewife	334 (95.4%)	320 (91.4%)	0.04	1.9 (1.0 - 3.6)
Socio Economic Status				
Middle (III)	123 (25.7%)	104 (30.2%)	0.005	1.7 (1.1-2.5)
Lower (IV and V)	139 (39.4%)	117 (33.9%)	0.003	1.7 (1.2- 2.8)
Neonatal				
Gestational age (wk), mean (SD)	33.7 (1.9)	38.4 (1.0)		
Weight (g), mean (SD)	1850.8 (378.4)	2820 (425.9)		
Whole length (cm), mean (SD)	43 (2.4)	46.9 (3.7)		
Foot length (cm), mean (SD)	6.3 (0.6)	7.6 (2.8)		
Head circumference (cm), mean (SD)	30.3 (1.6)	33.25 (1.1)		
Chest circumference (cm), mean (SD)	28.0 (1.6)	31.18 (1.1)		

TABLE II COMPARISON OF DIETARY INTAKE BETWEEN CASES AND CONTROLS

Diet	Cases Mean (SD)	Controls Mean (SD)	P value
Energy (Kcal/day)	1624 (249)	1911 (341)	<0.001
Protein (g/day)	32 (6.0)	37.2 (7.0)	<0.001
Milk (mL/day)	174 (66)	175 (45)	0.8
White clarified butter (g/day)	2.2 (2.9)	4.4 (3.6)	<0.001
Lentils (g/day)	67.6 (26.2)	73.8 (28.5)	0.003
Wheat (g/day)	136.4 (29.5)	147.1 (33.2)	<0.001
Cooked rice (g/day)	205.5 (87.3)	241.5 (79.2)	<0.001
Vegetables (g/day)	284 (83.6)	323.1 (93.3)	<0.001
Fish (pieces/week)	3.4 (1.1)	2.0 (0.4)	0.3
Chicken (pieces /week)	2.4 (2.2)	2.2 (0.6)	0.8
Mutton (pieces /week)	2 (0.7)	1.8 (0.3)	0.5
Dry fruits (no./week)	5.4 (2.2)	5.3 (1.7)	0.5
Indian desserts (no./week)	1.6 (0.5)	1.8 (0.8)	0.1
Fruits (no./week)	1.5 (0.3)	1.8 (0.4)	0.9

energy supplementation during pregnancy showed no difference between the incidence of term and preterm birth [15].

Our findings of positive correlation between maternal energy and protein intake and neonatal anthropometric measures are supported by another Indian study, reporting association of higher energy intake during pregnancy with birth weight [16]. Walker, *et al.* [17] reported that weight of the mother during pregnancy was associated with higher head circumference, chest circumference and whole length of neonate.

We conclude that lesser protein and energy intake is possibly associated with preterm birth. Although etiology of preterm birth is multi-factorial, maternal nutrition being

TABLE III CORRELATION OF NEONATAL ANTHROPOMETRIC MEASUREMENTS WITH MATERNAL DIETARY INTAKE AND ANTHROPOMETRIC MEASUREMENTS

	Pearson Correlation Coefficient (P value)					
	Neonatal weight	Neonatal Whole length	Foot length	Head circumference	Chest circumference	Gestational age
Post delivery maternal weight	0.3 (<0.001)	0.2 (<0.001)	0.1 (<0.001)	0.3 (<0.001)	0.3 (<0.001)	0.3 (<0.001)
Maternal mid upper arm circumference	0.2 (<0.001)	0.1 (<0.001)	0.2 (<0.001)	0.2 (<0.001)	0.2 (<0.001)	0.2 (<0.001)
Maternal energy intake	0.2 (<0.001)	0.2 (<0.001)	0.06 (0.07)	0.3 (<0.001)	0.4 (<0.001)	0.4 (<0.001)
Maternal protein intake	0.2 (<0.001)	0.2 (<0.001)	0.1 (0.01)	0.3 (<0.001)	0.4 (<0.001)	0.3 (<0.001)

WHAT IS ALREADY KNOWN?

• Poor maternal nutritional status is a cause of low birth weight.

WHAT THIS STUDY ADDS?

• Lower protein and energy intake during pregnancy is associated with preterm birth.

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a modifiable factor can be used in public health interventions to prevent preterm deliveries.

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